COLUMBIA RIVER SALMON MITIGATION ANALYSIS
SYSTEM CONFIGURATION STUDY
PHASE I

UPSTREAM COLLECTION AND CONVEYANCE
SNAKE AND COLUMBIA RIVERS
TECHNICAL APPENDIX D

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EXECUTIVE SUMMARY

1. PURPOSE AND BACKGROUND.

The purpose of this report is to examine options that might reduce juvenile salmonid losses that result from migration through the existing hydropower dams and reservoirs on the Snake and Columbia River system. Conveying fish by using a new collection system upstream of Lower Granite Dam, in conjunction with either canals, pipelines, or transport vessels, are some alternatives being considered for the Columbia River Salmon Mitigation Analysis.

It may be possible to significantly improve upon present fish collection and conveyance systems if design constraints related to hydropower are no longer applicable. Most of the present systems were designed as major retrofits to existing hydropower generation facilities, with the primary motive to limit adverse effects upon future operations. This report presents preliminary design and cost estimates for various alternative means of collecting juvenile salmonids from upstream of Lower Granite Dam and transporting them by canal, pipeline, or vessel to below Bonneville Dam.

2. PROJECT ALTERNATIVES--GENERAL DISCUSSIONS.

Concepts for upstream collection and conveyance were considered that incorporated various methods for the collection of juvenile salmonids, as well as various methods of conveyance. Each alternative was designed to carry a total of 50 to 60 million juvenile salmonids during the downstream migration period (April through November), with an expected peak of 2 million fish per day. Juvenile salmonids would be introduced into the system from new collection facilities located upstream of Lower Granite Dam, as well as from the existing juvenile bypass system at each of the downstream dams.

Four basic alternatives were analyzed for costs and schedules. For each of these alternatives, a single upstream collection system using one design option was assumed (see following paragraphs). For each alternative, three different collection design flows [100,000; 160,000; and 225,000 cubic feet per second (cfs)] were evaluated. Alternatives related to other site locations, dual collection systems located upstream of Lewiston on the Snake and Clearwater Rivers, and other types of upstream collection designs will be evaluated further if this concept is carried into future studies. It should be noted that a dual collection system design for collectors located upstream of Lewiston would probably require the construction of dams to create proper hydraulic conditions for the fish diversion barriers. This might require additional biological, as well as cost-related, impacts not associated with a single collection system located downstream of Lewiston.

There are major questions and uncertainties associated with the different upstream collection and conveyance system concepts. Biological research and preliminary engineering studies will need to be completed prior tot he construction of any of these systems in order to resolve these uncertainties.

Basic concepts selected to develop alternative comparisons assumed that all project alternatives would use a single collection system on the Snake River in the vicinity of Silcott Island, located about 7 miles downstream of Lewiston. As previously mentioned, detailed site studies to evaluate this and other sites will be completed in later studies if this concept is carried forward.

An upstream collection system using a low velocity design, assuming a bridge structure/fixed-barrier collection component, was selected for developing costs and schedules. It was also determined that cost and schedule data related to floating platform/moving barrier concepts would be comparable to a bridge structure/fixed-barrier collection system.

3. PROJECT ALTERNATIVE DESCRIPTIONS.

All alternatives were assumed to consist of a single upstream fish collection system located in the vicinity of the Silcott Island site area. Each option would have fish sorting facilities, and would allow for additional intermediate fish collection at downstream dams.

Alternative 1 (Migratory Canal Option) provides for fish collection, sorting, and lifting to a migratory canal grade, and conveyance through each reservoir reach by a series of open channels, flumes, tunnels, and resting ponds.

Alternative 2 (Pressure Pipeline Option) provides for fish collection, sorting, and lifting to a buried pressure pipeline and related system along the reservoir shoreline.

Alternative 3 (Transport System Option) provides for fish collection, sorting, and transfer into existing barges, where collected fish would be transported downstream to below Bonneville Dam.

Alternative 4 (Floating Pipeline Option) provides for fish collection, sorting, and transfer into a floating open channel or enclosed low-pressure conduit to be conveyed downstream to below Bonneville Dam.

4. COST AND SCHEDULE INFORMATION.

Table ES-1 summarizes cost and schedule information for the previously described alternatives. Construction and project costs are reconnaissance-level, fully-funded costs. Operation and maintenance (O&M) costs are annual costs. Design and construction schedules shown, starting from the date of authority and appropriation, assume funds and resources are available when required. Costs and schedules indicating a range in values reflect differences in collection facility design flows (ranging between 100,000 and 225,000 cfs).

TABLE ES-1. COST AND SCHEDULE INFORMATION

Alternative	Project Costs	Fully-Funded Costs	O&M Costs	Schedule
1 (Migratory Canal)	$4.3 billion	$5.4 billion	$9.5 million	11 1/2 years
2 (Pressure Pipeline)	$4.0 billion	$5.1 billion	$9.5 million	11 1/2 years
3 (Transport)	$57 million to $362 million	$327 million to $469 million	$5.1 million	5 1/2 to 8 years
4 (Floating Pipeline)	$789 million to $856 million	$924 million to $1.0 billion	$31.8 million	11 1/2 years

5. ANADROMOUS FISH.

Designs currently engineered for upstream collection with conveyance systems are new and untested. One design advantage afforded to a new upstream collector is its independence of the powerhouse operational and structural constraints that have influenced the design of current collection and bypass systems at the lower Snake River dams. This will allow for a more biologically-functional design.

The success of any upstream collection concept coupled with barge transport would be highly dependent on the biological success of the fish transportation program currently operated for all Snake River salmonid stocks. If the primary objective of an action is to deliver the maximum number of live smolts to some point below Bonneville Dam, or into the estuary from the top of the Lower Granite reservoir, the improved collection and barge transport of smolts around the Snake and Columbia River dams would be one of the most reasonable alternatives (from a biological perspective) for increasing smolt-to-adult survival.

A low velocity guidance/collection facility located near the top of the Lower Granite reservoir for the collection, tagging, and subsequent transport of migrating smolts to the lower Columbia River has several potential advantages. These advantages include: 1) the collection of many smolts that get disoriented and delayed in the Lower Granite reservoir before reaching the dam, due to inadequate migrational cues; 2) the removal of smolts from less than optimal reservoir conditions where predator activity is assumed substantial; and 3) a reduced need for extreme levels of flow augmentation that continues to a real concern with the region's coordinated inability to store enough water and then efficiently shape and pass that water for any measurable benefit to downstream migration.

An upstream collector, designed as a low velocity system, would address the concern posed by many biologists in the region that the turbine intakes at dams offer inhospitable environments for the collection and bypassing of juvenile salmonids. Passage through current spillway configurations offers little benefits with stress-related tradeoffs, and can not be considered more optimal for the smolt population. A collector designed with surface orientation (as opposed to a turbine collector system), located upstream in the Lower Granite reservoir and designed specifically for salmonid smolt collection without any powerhouse constraints imposed upon the design could be a beneficial alternative, as long as the biological needs of the respective listed salmonid stocks are fully incorporated into the collector design and operation.

Critical research and site monitoring would have to determine the most appropriate location for constructing an upstream collector facility. The entire mainstream passage corridor is designated by the National Marine Fisheries Service (NMFS) as critical habitat for spring/summer and fall Chinook salmon. High velocity sites positioned outside of the Lower Granite reservoir would be too complex, and ecologically costly to salmon and native anadromous species. Low velocity sites would be less ecologically and biologically costly. All potential sites possess similar ecological and population effect tradeoffs (*i.e.*, rearing habitat, transport survival derivation, predator effects). This suggests that site selection would be difficult.

It was determined, through a sensitivity analysis with the Columbia River Salmon Passage (CRiSP 1.4) model, that an upstream collector near the top of the Lower Granite reservoir would need to achieve a fish guidance efficiency (FGE) equal to or above 75 percent, while maintaining no higher than an estimated 2-percent direct bypass mortality for spring Chinook salmon to surpass that survival provided by the 1993 base case operation (SOR 2C). This sensitivity analysis suggests that if the upstream collector concept is to be implemented, adequate research through prototype modeling in in-river conditions should be performed to determine that an FGE of 75 percent and bypass mortalities comparable to the current estimates of 2 percent can be achieved. It is also suggested that concurrent ecological and passage studies be designed to address the estuary survival of transported and in-river juvenile salmon. These types of studies would be pursued in Phase II.

Survival estimates for the dual collector concept (*e.g.*, separate collectors on the Clearwater River and Snake River near Asotin, Washington) are similar when like parameter values and assumptions are used (FGE estimates and 2-percent bypass mortality). The conveyance system needed for the dual collectors for transporting fish, at least down to the current Lower Granite transport facilities, would realistically contribute a higher mortality factor associated with stress, dependent on the means of conveyance. The dual collector scenario would have to employ one of the designs for a high velocity collector requiring the construction of new dams for flow/velocity control. It is believed that new dams, even if designed especially for salmonid passage, would not be biologically, ecologically, or regionally acceptable as a means of providing improved passage conditions for weak salmonid stocks, based upon past technologies and system operations.

The proposed migratory canal and floating pipeline conveyance options have received various critical reviews by such regional groups as the Technical Advisory Group (TAG). The TAG expressed a considerable amount of concerns with reliance on such untested artificial conveyance system designs. Primary concerns that are common to all of the currently proposed options are both biological and ecological. They include the following:

- Bio-engineering capability to artificially replicate natural ecological processes and biological conditions that are functionally interacting to the degree exhibited naturally (*i.e.*, resting ponds/areas, temperature, and flow regulation).

- The mechanical complexity of each proposed apparatus, and their synchronized operation, would require constant maintenance.

- In the low probability event that a means can be devised to artificially replicate the natural passage system into a pipeline or canal system, the need for adequate safe and efficient passage within the river system would not diminish or be considered mutually exclusive in any manner, especially for adults migrating upstream.

- Each option would require either some mechanical means of lifting the fish into the channel or a pumping/fanning system to move the fish.

- Exclusive increased concentration of salmonid smolts through a closed system would act to separate smolts from their natural food sources and the diversity in their food items.

- Increased concentration of salmonids smolts would be highly vulnerable to inescapable stress-related factors (*i.e.*, disease outbreaks and manifestations; predator invasion, including predation by larger steelhead smolts; increased inter- and intraspecies competition; and mechanical failure or accidents that would act as catastrophic events and potentially be detrimental to small population genetic fitness and viability).

6. PRELIMINARY CONCLUSIONS AND OBSERVATIONS.

The option of an upstream collector and barge transportation may warrant further study in Phase II, based on potential anadromous fish survival benefits and the NMFS Recovery Team draft findings. The estimated benefits associated with the collector with barge transportation appear to provide significant improvements in terms of juvenile salmon survival. This survival estimate seems to be consistent with the analysis prepared by the NMFS Recovery Team. The other biological effects (resident fish and wildlife impacts) do not appear to be significant with this alternative.

The migratory canal and pipeline proposals should be eliminated from further consideration, due to biological concerns and uncertainties.

This conclusion is drawn with full recognition that a high degree of uncertainty concerning the salmon life-cycle biology exists, and that there is controversy surrounding the relative merits of transport when compared to in-river migration. Knowledge of biological parameters in the estuary portion of the juvenile migration is severely lacking, and could be of significance in evaluating various recovery alternatives. Efforts are continuing to identify and formulate tests and research to reduce these levels of uncertainty. Should the results of these efforts, or any other current efforts, yield information that would lead to conclusions different from those drawn here, the Phase II work can be modified to respond in an adaptive management approach.

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SECTION 1 - INTRODUCTION

1.01. BACKGROUND.

This report presents the results of preliminary (conceptual) technical evaluations for various alternative means of collecting juveniles salmonids from upstream of Lower Granite Dam, and transporting them by canal, pipeline, or vessel to below Bonneville Dam. These concepts were presented in *Amendments to the Columbia River Basin Fish and Wildlife Program (Phase Two)*, dated December 11, 1991, and developed by the Northwest Power Planning Council (NPPC). Consideration of this concept is included as one of five alternatives (each with their own separate technical report) being studied under the Columbia River Salmon Mitigation Analysis (CRSMA), System Configuration Study (SCS).

It may be possible to significantly improve upon the present fish collection and conveyance systems if design constraints related to hydropower were no longer applicable. Most of the present systems were designed as major retrofits to existing hydropower generation facilities, with the primary motive of limiting adverse effects upon future hydropower operation.

1.02. PURPOSE.

Collecting and conveying fish by using a new collection system upstream of Lower Granite Dam, in conjunction with either manmade fishways (canals or pipelines) or barge transport systems, is one set of alternatives being considered in the CRSMA. The purpose of these concepts is to reduce juvenile salmonid losses that result from downstream migration through the existing hydropower dams and reservoirs on the Snake and Columbia River system.

Fishway conveyance concepts consist of canal or pipeline systems that roughly parallel the river alignment. The canal or pipeline will begin upstream of Lower Granite Dam (on the Snake River), and extend downstream of Bonneville Dam (on the Columbia River). The barge transport concept consists of utilizing an existing and expanded barge fleet. In each scheme, juvenile salmonids will be collected from the river upstream of Lower Granite Dam (and possibly at each dam), and directed to a conveyance system for further movement downstream. The intent of this concept is to improve downstream migration conditions between Lewiston, Idaho, and Bonneville Dam, a distance of approximately 350 miles.

1.03. SCOPE.

This report, which is a reconnaissance-level planning study of various upstream collection and conveyance alternatives being considered, is intended to provide conceptual designs, analysis, costs, and schedules. The information prepared for this reconnaissance-report is intended to be used in the planning process for comparison purposes only. This information is not of sufficient detail for use in obtaining project authorization and appropriations. In addition, preliminary evaluations concerning the environmental and economic effects of the concepts are provided.

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SECTION 2 - EXISTING CONDITIONS AND OPERATIONS

2.01. BACKGROUND INFORMATION.

A system of four hydroelectric dams on the Snake River, and four hydroelectric dams on the mainstem Columbia River below the confluence of the Snake and Columbia Rivers, has been constructed by the U.S. Army Corps of Engineers (Corps) over the past six decades in an effort to meet the region's energy, navigation, and water supply needs. As a result of these dams, the Snake and Columbia Rivers are no longer free-flowing between the city of Lewiston, Idaho, and Bonneville Dam (on the Columbia River). These dams generally do not store large amounts of water, as do other projects within the Snake and Columbia River systems (*e.g.*, Dworshak Dam on the North Fork of the Clearwater River). Rather, they are used to provide steady or peaking electric production to the Bonneville Power Administration (BPA) grid throughout the northwest United States.

Commercial sea-going barges are towed as far upstream as Lewiston, Idaho, through the lock facilities at each dam. Commercial shipments consist largely of commodities such as timber, grain, and raw materials from the inland northwest. This form of transportation plays a major role in the economy of the region.

Several stocks of anadromous salmonids inhabit the Snake River Basin. They migrate past the mainstem hydroelectric dams, both on their way downstream to the ocean and on their return upstream to spawn. The Snake River stocks include spring, summer, and fall Chinook salmon; sockeye salmon; and steelhead trout. The Snake River Coho salmon are now extinct. Total spawning runs of salmonids prior to the development of the Columbia River Basin have been estimated at 8 to 16 million in number. Current estimates indicate that only about 2 to 2.5 million fish return to the Columbia River, and only about 20 percent of these are wild fish. While it appears that the number of adult fish returning over Bonneville Dam (not including ocean and lower river harvest) has been increasing in recent years, this does not reflect the declining numbers of returning adults from the Snake River spring, summer, and fall Chinook and sockeye salmon stocks, of which wild fish represent only a small portion.

Each of the eight Corps mainstem lower Columbia and Snake River dams was constructed with adult fish passage facilities. Each facility was improved upon the last as the understanding of fish needs expanded. However, the need for juvenile fish passage facilities was not widely recognized until the 1960's, and only Lower Granite Dam was built with the means to protect juvenile fish as they pass through the project. Lower Monumental, Little Goose, and John Day Dams had rudimentary systems, but they proved to be inadequate. Juvenile fish are subjected to loss through the reservoir as a result of predation and delay, and through the dams as result of passage over the spillway or through the turbines.

Since Lower Granite Dam was completed, many measures have been implemented to improve passage survival. An extensive research program, started in the early 1950's, continues today. Both state and Federal fish agencies, along with the Corps and BPA, have developed these measures through time. Facilities and operations have improved as the knowledge of fish behavior has grown. Six of the eight Corps mainstem projects now have full state-of-the-art juvenile bypass facilities. Facilities at the other two projects will not be complete until 1996 and 1998, respectively, but methods intended to minimize mortality are currently in use (*e.g.*, spill and sluiceway operations). The National Marine Fisheries Service, through many years of research, has developed a program to collect the juvenile fish at Lower Granite, Little Goose, Lower Monumental, and McNary Dams; and transport them around all of the dams in barges. Transport eliminates the hazards and delays that result from reservoir and dam passage. However, only an estimated 22 to 38 percent of the Chinook that are released above Lower Granite Dam are transported (43 to 67 percent of the steelhead). Therefore, methods to improve in-river passage are sought. Part of the reason such a small percentage of the fish are transported is that many of the fish do not arrive at the upstream end of the Lower Granite reservoir, and some are lost as they pass through the pool. Methods to improve collection, bypass, and transport include flow augmentation, extended length turbine intake screens, and spill. New and more effective means of reducing the stress associated with dam passage are continually sought.

In spite of past and ongoing efforts at the dams, runs of returning adult Snake River salmon continue to decline. In addition to the effect of the dams, other factors (*i.e.*, reduction in habitat quantity and quality, harvest pressures, competition and diseases from hatchery fish, degradation of water quality, and the recent years of low flow) also play a role in the continued decline.

To better describe the systems currently being used to help migrating juvenile anadromous fish, the systems are arranged and discussed under the following categories: 1) juvenile fish bypass facilities; 2) juvenile fish transportation facilities; and 3) adult passage facilities.

2.02. JUVENILE FISH BYPASS FACILITIES.

Lower Granite, Little Goose, Lower Monumental, and McNary Dams each have juvenile bypass systems that are designed to collect and bypass anadromous fish around the turbines. The bypass systems allow the fish to be released directly to the river or diverted to holding and loading facilities for subsequent barge or truck transport. A juvenile bypass system, similar to the existing facilities upriver, is currently being designed for Ice Harbor Dam. State-of-the-art juvenile fish bypass, holding, and loading facilities are currently being constructed at McNary Dam.

Under existing lower Snake River project operations, the majority of migrant juvenile fish are, or soon will be, diverted from the turbine intakes with traveling screen mechanisms at all of the dam installations. The fish are directed up and away from the turbine intake into a gatewell chamber. Orifices in the gatewell chambers permit the fish to pass through the dam into a collection channel that transports them to a bypass flume at one abutment of the dam. Dewatering systems reduce the total flow in the collection channel significantly to effect a size reduction in the bypass flume. The fish are discharged from the bypass flume into a sorting and holding facility, and are then either released directly into the river, into barges, or into tank trucks for further transport downstream.

The juvenile bypass systems at Little Goose and Lower Monumental Dams are each comprised of submerged traveling screens (STS's), vertical barrier screens (VBS's), fish orifices, attraction lighting, a collection channel, a transportation channel, primary and secondary dewatering systems, and corrugated metal flumes (CMF's). The portions of the bypass system at Lower Granite Dam are similar to those at Lower Monumental and Little Goose Dams, but the Lower Granite Dam system uses a pressure pipe rather than an open channel CMF, and dewatering occurs at the fish sorting and holding facility rather than near the dam. Also, the release to the river at Lower Granite Dam occurs through the fish sorting and holding facility. No direct bypass from the main transportation pipeline straight to the river is available.

The new juvenile fish collection, bypass, holding, and loading facilities currently being constructed at McNary Dam will be similar in principle to the facilities at Little Goose and Lower Monumental Dams. Due to the greater number of fish and volume of water that will be passing through the McNary facilities, the facilities will be considerably larger than those of the dams upstream.

2.03. JUVENILE FISH TRANSPORTATION.

The Corps, Walla Walla District, has been transporting juvenile salmon and steelhead around Snake and Columbia River dams since 1969. From 1969 through 1980, transport was conducted by the National Marine Fisheries Service, as research under contract to the Corps. Fish tank trucks were the primary transport vehicles through the mid-1970's. Five 3,500-gallon fish tank trailers were acquired to accomplish this task. In response to a strong regional plea to save the fish runs from devastating losses that would have been caused by the severe drought of 1977, the Corps contracted with a local towboat and barging company to convert two barges for use in transporting fish from Lower Granite Dam to below Bonneville Dam. The program was deemed a success, and 2.2 million fish transported (1.8 million by truck and the rest by barge).

As a result of the success in 1977, regional fishery agencies requested that barging continue in 1978. The Corps converted two Army surplus barges for use as fish transportation vessels. Each of these two barges was capable of hauling approximately 26,000 pounds of fish in 86,000 gallons of water. Two towboats were contracted to push these barges from Lower Granite Dam downstream to the release areas below Bonneville Dam. By 1980, fish collection and loading facilities had been constructed at Little Goose and McNary Dams, and nearly 5 million fish were being barged annually. In 1981 and 1982, two barges of 50,000-pound capacity (100,000 gallons of water) were added, and the number of towboats was increased to four. The number of fish collected and transported continued to increase. In 1989, two additional barges were constructed, each capable of hauling 75,000 pounds of fish (150,000 gallons of water). Four towboats continued to be used. The smallest barges, when used, were transported in tandem with medium-sized barges. In recent years, up to 73 percent (approximately) of the fish that arrive at Lower Granite Dam have been collected there, while approximately 70 percent of those arriving at Little Goose Dam have been collected. Approximately 70 percent of the fish arriving at Lower Monumental Dam are expected to be collected when the new collection facility begins operation there in 1993. Thus, of the juvenile fish arriving at each project, a relatively high percentage are collected.

Currently, fish are collected at four dams: Lower Granite, Little Goose, Lower Monumental, and McNary. Tank trucks are used for transport early and late in the migration period when fish numbers are low, and barges are used during the peak of the fish migration when fish numbers are high. Two trucks are used at Lower Granite Dam, one at Little Goose Dam, and two at McNary Dam. Barges start at Lower Granite Dam, where they take on the greatest number of fish. They take on additional fish at Little Goose and McNary Dams before proceeding downstream to the release area between Skamania Light and Warrendale (below Bonneville Dam). The largest, most modern barges are used most of the season. Small barges, when used, are used in tandem with medium-sized barges. Barges are scheduled to arrive below Bonneville Dam during the night, so that releases can be made during hours of darkness to minimize the danger of predation by birds and fish. Trucking resumes when fish numbers decline, usually by late June on the Snake River and by late July at McNary Dam. Transportation is conducted from late March through October at the Snake River dams, and from late March through December at McNary Dam.

The number of juvenile fish migrating down the Snake and Columbia Rivers has increased over the past 15 years. On the Snake River, production has increased from a low of 3.4 million salmon and steelhead in the mid-1970's to over 28 million in recent years. Most of the increase is due to production by Lower Snake River Fish and Wildlife Compensation Plan hatcheries. When these hatcheries reach full production, as many as 47 million fish may be produced above Lower Granite Dam. On the Columbia River, natural production in the Hanford Reach has contributed up to 40 million fish in recent years, with hatchery production adding several million more fish. Recent efforts to increase production in the Yakima River (irrigation screening, hatchery construction, and improvement of natural production) and other mid-Columbia tributaries will also increase fish numbers there. In the Snake River, studies indicate that as many as 30 to 60 percent of the hatchery fish may die before reaching the Lower Granite reservoir. Similar studies have shown that up to 80 to 95 percent of wild fish tagged in upstream tributaries may not survive to reach the Lower Granite reservoir.

The past 20 years of research on various aspects of truck and barge transportation have indicated that no significant impact to homing or survival can be attributed to transportation. The majority of tests have also shown that transportation returns more adult fish than in-river passage. Research conducted subsequent to the improvements made at the collection facilities has consistently indicated that transporting all species of anadromous fish would be beneficial. While there is no consensus among conservation groups and fishery agencies of the Northwest that transportation is a permanent solution to fish passage problems at Corps-operated dams, It has strong regional support as an interim program. The transportation program is considered absolutely essential during low runoff years.

Transportation has been credited with playing a major role in doubling and quadrupling the steelhead runs into the Snake River, as well as the fall Chinook runs into the mid-Columbia River. While less successful for spring and summer Chinook, the blame for the decline of these runs cannot be irrevocably determined. The increased production of hatchery fish, which do not survive well, or the fact that virtually all of the hatchery and the majority of wild spring and summer Chinook are plagued with bacterial kidney disease, may both be contributing causes. What can be determined with a high degree of certainty is that collection and transport of Snake River salmon allows many more (up to 98 percent of those collected) fish to arrive below Bonneville Dam than does in-river passage (20 to 50 percent). Transport also moves the fish downstream while they are physiologically adapted to enter saltwater. Historically, it took 20 to 30 days for fish to get from the headwaters of the Salmon River to the ocean. With the reservoirs, it takes an estimated 30 to 90 days. Many fish would pass through the physiological smolting stage while migrating, and would not be able to enter saltwater when they arrived at the mouth of the Columbia River. While transportation helps them arrive there faster than the natural rate (3 to 4 days, counting holding and trucking or barging time), research has indicated that this does not diminish their ability to return.

2.04. ADULT FISH PASSAGE FACILITIES.

McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams each have an adult fish passage system that allows the passage of upstream migrating adult salmon and steelhead. Each adult fish passage system is comprised of fish entrances, a collection channel, attraction pumps, and a fish ladder. The arrangement, magnitude, and operation of the adult passage systems varies at each dam. McNary, Ice Harbor, and Lower Monumental Dams have a fish passage system and ladder on each shore. On these dual ladder projects, one of the passage systems is arranged as described above, while the other is a simpler system that lacks a collection channel.

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SECTION 3 - GEOLOGY

3.01. GEOLOGY OF THE LOWER SNAKE RIVER.

The lower reach of the Snake River extends from Lewiston, Idaho to its confluence with the Columbia River near Pasco, Washington. The Snake River flows across the east-central part of the Columbia Plateau in a general westerly direction for 139 miles. The river has entrenched itself in the plateau surface to a maximum depth of 2,000 feet. The larger tributary streams entering the Snake River between Lewiston and its mouth are the Tucannon and Palouse Rivers. Both rivers enter the Snake River in the reservoir impounded by Lower Monumental Dam. The predominant rock type is a thick sequence of Miocene flood basalts, collectively named the Columbia River Basalt Group. Flows include the Imnaha, Grande Ronde, Wanapum, and Saddle Mountains basalts.

a. Lewiston, Idaho to Lower Granite Dam.

At Lower Granite Dam, the Snake River has cut a canyon approximately 1,600 feet deep and 3,700 feet wide. The dam is constructed on flows of the Grande Ronde Basalt. The flows dip 1 degree west and northwest, and contain several intervening flow contact breccia layers. The canyon walls above the dam are composed of the upper flows of the Grande Ronde Basalt. Locally, remnants of Wanapum Basalt overlie the Grande Ronde Basalt. The uplands are mantled with loess deposits of varied thickness.

b. Lower Granite Dam to Little Goose Dam.

Downstream of Lower Granite Dam, terrace gravels and recent alluvium are deposited along both sides of the river. At Little Goose Dam, the Snake River has cut an 1,100-foot-deep, 3,600-foot-wide canyon. The dam is founded on Grande Ronde Basalt. Individual basalt flows range in thickness from 30 to 100 feet. The regional dip of the basalt flows is very gentle (1 to 3 degrees southwest).

c. Little Goose Dam to Lower Monumental Dam.

Remnants of a glaciofluvial gravel bar are present along both sides of the river, and extend from Little Goose Dam to Lyons Ferry. The Canyon just below Little Goose Dam exposes Wanapum Basalt and remnants of Saddle Mountains Basalt. Lower Monumental Dam is located downstream of the mouth of Devils Canyon. At this location, the Snake River has cut a canyon 800 feet deep and 4,400 feet wide. The dam is founded on Grande Ronde Basalt, and both embankments lie on thick deposits of glaciofluvial gravels. Soils overlying the bedrock are fairly thick on both sides of the river. Typical soils are sand, gravel, and silt. Dips of the basalt flows beneath the dam are generally northwest, at about 1 degree. The lower walls of the Snake River Canyon are composed of Grande Ronde Basalt, and the upper walls are of Saddle Mountains and Wanapum Basalts. As much as 200 feet of intra-canyon basalt is exposed.

d. Lower Monumental Dam to Ice Harbor Dam.

Silts and sands of the Touchet beds mantle glaciofluvial gravels downstream of Lower Monumental Dam. At Ice Harbor Dam, the Snake River Canyon is approximately 220 feet deep and 3,400 feet wide. The dam is founded on Saddle Mountains Basalt. Individual basalt flows range in thickness from 17 to 50 feet. The dip of the flows is less than 10 degrees to the southwest. Glaciofluvial gravels and loess deposits partially mantle both abutments, as well as the uplands surrounding the dam. In 1962, the upstream left abutment experienced three significant landslides in huge eolian sand deposits. The slides stabilized once they progressed to the basalt cliffs.

e. Ice Harbor Dam to McNary Dam.

Sedimentary deposits overlie the Columbia River Basalts in most of the Pasco Basin. These deposits range from coarse-to-fine gravels derived from the weathering of the Blue Mountains to the south and east; and fine, silty clay, lakebed sediments.

3.02. GEOLOGY OF THE LOWER COLUMBIA RIVER.

From its confluence with the Snake River, the lower Columbia River flows in a westerly direction for 324 miles until it reaches the Pacific Ocean. On the eastern side of the Cascade Mountains, the river passes out of the Pasco Basin, runs through the Horse-Heaven anticline at Wallula Gap, and on into the Umatilla Basin section of the Columbia Plateau. The river flows west, and follows the structural low of the Dalles-Umatilla syncline for 100 miles. The river has made deep cuts in the lava flows of the Columbia River

Basalt Group. Sediments of The Dalles Formation overlie the basalts in the Umatilla Basin. Immediately downstream of The Dalles, the Columbia River passes through the Ortley anticline into the 50-mile-long Columbia River Gorge.

Volcanic activity has produced a varied assemblage of rocks; especially lava flows, volcanic ash beds, mudflow deposits, and sedimentary rocks consisting mostly of angular volcanic debris. Basalt flows from Cascade volcanoes appear in the Columbia Gorge between Vancouver, Washington, and The Dalles, Oregon. East of The Dalles, all of the bedrock is Columbia River Basalt. The basalt in the gorge demonstrates that deformation of the region has involved more than the up-arching of the Cascades. Between Hood River, Oregon, and The Dalles, four very large folds in the basalt trend northeast across the Columbia River. Extensive landslides have occurred on the steepened undercut slopes. The northern shore of the Columbia River is nearly 50-percent landslide deposits from Camas, Washington, to Hood River; a distance of 34 miles. Individual slides range to a maximum of 14 square miles. The southern shore also has numerous, but significantly smaller, landslides.

a. McNary Dam to John Day Dam to The Dalles Dam.

The Columbia River is lined on both sides by ledges of plateau basalt. The rock exposed along the Columbia River is basalt that erupted in floods from the Grande Ronde volcano in northeastern Oregon. The basalts are overlain by sand and sandy-gravel sediments of the Dalles Formation, which form the valley sides along the western end of this reach.

The Columbia River Valley at McNary Dam is 250 feet deep and more than 1.5 miles wide. The dam is founded on the Saddle Mountains Basalt, and the shells of both embankments are founded on *in situ* alluvial materials. Extensive areas of glaciofluvial and reworked flood gravel terraces occur on both abutments of the dam. Eolian sand and silt mantle most of the gravel terraces.

The reservoir behind John Day Dam has had a significant amount of landslide activity, but no new major slides have developed in recent years. Some minor instability (*i.e.*, rock falls and slumps) exist on the Oregon shore.

The Dalles Dam structures have been excavated into Wanapum Basalt. Flows range from 60 to 100 feet thick. At The Dalles Dam, both the Columbia River Basalt and the Dalles Formation dip 2 degrees southwest. A general reconnaissance of the reservoir behind The Dalles Dam indicates that no major slides have occurred since 1968. On the Oregon shore, at Rufus, fan and alluvial deposits are highly erodible and susceptible to mass wasting.

They can host small-scale slump and debris flows. The thick sequences of surficial materials along the reservoir banks are possible sites for mass wasting (*e.g.*, slumps). The steep cliffs between The Dalles and the Deschutes River confluence are sites of rockfalls and slides.

b. <u>The Dalles Dam to Bonneville Dam</u>.

The Columbia River changes at Hood River, Oregon, to a narrow gorge that extends to the west. The gorge slopes are steep, range up to 3,000 feet in height, and include numerous vertical rock cliffs with associated talus accumulations. Several large landslides exist on the Washington side, where the river cut through the plateau basalts into the older rocks of the Ohanepecosh Formation. In this area, the rocks dip moderately to the south, so they naturally tend to slide toward the river. The biggest landslide, the Cascade slide, involves a section of the Washington bank several miles long, extending from North Bonneville eastward to Stevenson. The 700-year-old Cascade slide crowds the Columbia River against the Oregon side, and forms the narrows where Bonneville Dam was built. The Cascade slide is currently stable, but two smaller slides are visible upstream. The Wind Mountain slide, about 6 miles east of Stevenson, is probably the most active, and shows movement each year.

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SECTION 4 - PROPOSED ALTERNATIVES

4.01. GENERAL.

Various system components for upstream collection and conveyance discussed in section 5 were combined to form complete project alternatives. The alternatives described in the following paragraphs are not intended to be recommendations on what are necessarily considered to be the best combinations of the different components in section 5. However, they do demonstrate concept information for designing and constructing the different types of upstream collection and conveyance systems.

4.02. BACKGROUND INFORMATION.

Alternatives for upstream collection facilities and conveyance systems are addressed in NPPC's *Amendments to the Columbia River Basin Fish and Wildlife Program (Phase Two)*, section III.3, paragraph A(9), page 30, dated December 11, 1991. These alternatives would partially consist of a new collection facility or facilities located near the upstream end of the Lower Granite reservoir. In addition, a canal, pressure pipeline, transport vessel, or floating conduit systems would be used for moving collected juvenile salmonids to below Bonneville Dam. The capability to collect fish at the dams downstream of Lower Granite would be maintained or added, depending on the configuration of the alternative.

The goal of a new upstream collection and conveyance system would be to improve upon present system capabilities. Most of the new designs for juvenile fish collection systems have required major retrofits of the existing hydroelectric projects. If design constraints to accommodate hydroelectric facilities were no longer applicable, it might be possible to significantly improve upon existing system capabilities.

The function of the conveyance components of a new system would be to convey juvenile salmonids through, or around, the lower Snake and Columbia Rivers' eight dams and reservoirs. Conveyance systems would be intended to substitute for the in-river and reservoir migration of juvenile salmonids. The biological impacts of in-river and reservoir migration on juvenile fish are believed to be partially responsible for the decline in overall numbers of adult salmon returning to spawn in the upper Snake River watershed. Upstream collection and conveyance concepts are intended to better facilitate the survival of migrating juvenile salmonids through the Snake and Columbia Rivers, without significantly impacting the existing hydropower, navigation, and other functions of the river systems. The operation of a fish collection and conveyance system is currently anticipated to be seasonal, with full operation occurring during the months of March through October each year. This operation schedule coincides with the typical historical migration pattern of juvenile salmon.

The collection and conveyance of downstream migrant salmonids from above Lower Granite Dam to below Bonneville Dam has been considered in this study as a method of reducing fish mortality that results both from passage through hydropower turbines and from delays in slow-moving reservoirs. Migrant juveniles, under this plan, would be transferred into a selected conveyance system from collection facilities, and released back into the Columbia River downstream of Bonneville Dam.

Several alternatives for upstream collection and conveyance concepts were considered that incorporated various methods of collecting juvenile fish and moving them downstream. Each alternative was designed to carry a total of 50 to 60 million juvenile salmonids during the downstream migration period (April through November), with an expected peak of 2 million fish per day. Juvenile salmonids would be introduced into the system from new collection facilities located upstream of Lower Granite Dam, as well as from the existing juvenile bypass systems at each of the downstream dams.

4.03. PROPOSED ALTERNATIVES--GENERAL DISCUSSIONS.

Four basic alternatives were developed and analyzed. For each alternative, three different collection design flows [100,000, 160,000, and 225,000 cubic feet per second (cfs)] were evaluated. Basic concepts selected to develop alternative comparisons assumed all project alternatives would use a single collection system on the Snake River in the vicinity of Silcott Island, located about 7 miles downstream of Lewiston, Idaho. Alternatives related to other site locations, dual collection systems located upstream of Lewiston on the Snake and Clearwater Rivers, and other types of upstream collection designs, will be evaluated further if this concept is carried into future studies. It should be noted that a dual collection system design for collectors located upstream of Lewiston would probably require the construction of dams to create proper hydraulic conditions for the fish diversion barriers. This might require additional biological, as well as cost-related impacts not associated with a single collection system downstream of Lewiston. See section 5 for additional discussion related to upstream collection and conveyance system components.

There are major questions and uncertainties associated with the different upstream collection and conveyance system concepts. Biological research and preliminary engineering studies will need to be completed prior to the construction of any of these systems in order to resolve these uncertainties. See section 12 for discussion related to project uncertainties.

An upstream collection system using a low velocity design, assuming a bridge structure/fixed-barrier collection component, was selected for developing costs and schedules. It was also determined that cost and schedule data related to floating platform/moving barrier concepts would be comparable to a bridge structure/fixed-barrier collection system. See section 6 for cost and schedule information.

4.04. PROJECT ALTERNATIVE SUMMARY DESCRIPTIONS.

All alternatives were assumed to consist of a single upstream fish collection system located in the vicinity of the Silcott Island site. Each option would have fish sorting facilities, and would allow for additional intermediate fish collection at downstream dams. Alternative descriptions are summarized below. An expanded discussion and description of these options can be found in section 5.

Alternative 1 (Migratory Canal Option) provides for fish collection, sorting, and lifting to a migratory canal grade; and conveyance through each reservoir reach by a series of open channels, flumes, tunnels, and resting ponds.

Alternative 2 (Pressure Pipeline Option) provides for fish collection, sorting, and lifting to a buried pressure pipeline and related system along the reservoir shoreline.

Alternative 3 (Transport System Option) provides for fish collection, sorting, and transfer into existing barges where collected fish would be transported downstream to below Bonneville Dam.

Alternative 4 (Floating Pipeline Option) provides for fish collection, sorting, and transfer into a floating open channel or enclosed low-pressure conduit to be conveyed downstream to below Bonneville Dam.

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SECTION 5 - UPSTREAM COLLECTION AND CONVEYANCE SYSTEM DISCUSSION--CRITERIA, SITE CONSIDERATIONS, AND ALTERNATIVE DEVELOPMENT

5.01. DESIGN CRITERIA.

a. General.

The preliminary design for the various alternatives followed, wherever possible, currently used state-of-the-art fishway design criteria that have been coordinated with both fishery agencies and Indian tribes on previous projects. Where criteria did not exist for certain aspects of the alternatives, preliminary judgments to establish criteria were made in consultation with fishery experts at the Corps, Walla Walla District, and the University of Idaho. Preliminary criteria governing fish conveyance and transport, water flow, pressure change, water quality, security, and physical requirements were established and reviewed with the Technical Advisory Group (TAG) on 27 May 1992. (A description of the TAG is found in section 11.02 of this report.)

b. Upstream Collection System Components.

(1) General.

New or expanded criteria to be established that will have a significant impact on the size and function of an upstream collection facility include fish collection river design flow; maximum design river flow required to pass the project without causing major damage to structures; and acceptable barrier approach velocities. Other design criteria not listed in this study may also need to be established for features not previously used in this type of application and/or physical setting. Existing design criteria related to current state-of-the-art juvenile fish facilities will apply to comparable components for any new upstream collection system, unless otherwise noted below, or noted with the descriptions of the different concept designs.

(2) Flows and Velocity Design Assumptions.

(a) Fish Facility Collection Flows.

The final selection of fish collection river flow criteria will be based on biological, engineering, and cost-related considerations. In this study, the following flow conditions have been evaluated for the collection and transport options:

- Average flow conditions for the months of May and June. In the Snake River downstream of Lewiston, this value equals about 100,000 cfs. In the Snake and Clearwater Rivers upstream of Lewiston, these values equal about 68,000 cfs and 34,000 cfs, respectively.

- A flow condition midway between average May and June and 10-year event flows. In the Snake River downstream of Lewiston, this value equals about 160,000 cfs. (**Note:** No midway flows for the Snake and Clearwater Rivers upstream of Lewiston were developed, since this information was not used in this study.)

- A flow condition (for selected options) equal to 225,000 cfs, 10-year event. A 225,000 cfs design flow was selected to demonstrate, for one option, the impact on design if a design flow was selected to match existing fishway operational criteria for the lower Snake River projects.

(b) Maximum Flood Design Flows.

In the Snake River downstream of Lewiston, a Standard Project Flood (SPF) of 420,000 cfs was assumed. (**Note:** No maximum flood design flows for the Snake and Clearwater Rivers upstream of Lewiston were selected, since this information was not used in this study.)

(3) Barrier Velocities.

(a) Low Velocity Barrier Concepts.

Velocities approaching barriers were assumed to equal 5 feet per second (fps) or less, while velocities through the gross barrier areas (perpendicular to the barriers) during fish collection periods were assumed to equal 0.5 fps or less. (Note: Perpendicular velocity criteria selected for final design could range between 0.2 fps and 1.0 fps; depending on biological judgments related to fish swimming ability, behavior, and impingement on the barrier device.)

(b) High Velocity Barrier Concepts.

Velocity criteria related to high velocity concepts were assumed, based on hydraulic conditions related to specific types of designs. Velocities approaching barriers could range from 6 to 10 fps. Theoretical velocity vector components parallel to barrier surfaces could be between 8 and 10 fps, while components perpendicular to barrier surfaces could range between 2.5 and 3 fps.

c. Conveyance System Components.

The migratory canal, buried pressure pipeline, and floating pipeline system components required the selection of preliminary design criteria not previously developed, since projects of this nature and magnitude have not yet been constructed and operated. The transport system components assumed the use of current criteria for existing fish barging operations. The canal and pipeline criteria presented in table 5-1 are the result of input provided by experts in the field of juvenile salmonid conveyance. The criteria are considered to be very preliminary, and are subject to change. The lack of sound technical basis for these criteria may require significant resolution of the undetermined effects of some features of the system upon the juvenile fish prior to any prototype design. However, as a reasonable basis of preliminary design, these criteria were used to influence design decisions of the canal, pipeline, and floating conduit alternatives.

TABLE 5-1. Canal and Pipeline Design Criteria

Objective	Maximize survival and minimize predation Minimize stress on fish
Fish Capacity and Transport Requirements	50 to 60 million fish per year 6 to 90 fish per pound Peak migration, 2 million fish per day Collection upstream and at each dam
Water Flow Requirements	200 cfs 3 to 6 fps flow velocity 2 fps or less flow velocity in rest areas 25-percent water exchange at each resting pond every 10± miles Minimum flow depth 3.0 feet
Water Quality Requirements	Temperature within 2 degrees Fahrenheit (°F) of river temperature (70° maximum) 7.35 pounds per square inch gauge (psig) minimum maximum rate pressure change No supersaturation of dissolved gas
Security and Safety	Provide predation and vandalism protection Provide emergency facilities to return fish to river at 10±-mile intervals
Physical Features	Roughness features in canal section to create low velocity rest areas Minimal use of pressure pipe

5.02.. SITE SELECTIONS AND LAYOUTS.

a. Upstream Collection System Components.

(1) General.

Site selection is a critical factor related to how effective an upstream collection facility will be in diverting and moving fish. Site-specific river hydraulic conditions; including channel approach conditions, water velocities, and water depths impact the effectiveness of any design. Different site locations also have different biological, environmental, engineering, and social-related questions that must be answered.

(2) Site Locations.

Potential sites for a juvenile fish collection system located upstream of Lower Granite Dam were evaluated to obtain representative water depths and channel widths, so that the suitability of different types of upstream collection systems could be determined. Additional effort will be required to fully evaluate all potential sites, including those not addressed in this study.

A fish collection system might involve a single system on the Snake River between Lower Granite Dam and Lewiston, or it might consist of dual systems upstream of Lewiston on both the Snake and Clearwater Rivers. There has also been a suggestion to have a single system on the Snake River, upstream of Lewiston, to collect and transport only endangered stocks.

Plate 2-1 shows potential sites located either within or nearly within the normal backwater from Lower Granite Dam. The table on plate 2-1 gives flow data for different sites, with flow and river geometry assumptions noted on the drawing. As would be expected, the closer the site is to Lower Granite Dam, the deeper and wider the river typically becomes.

No recommendations will be made in this study for a preferred site or sites. However, in order to demonstrate the concept of an upstream collection system, a single collection system will be used. This system is located approximately 7 miles downstream of Lewiston, near Silcott Island (see enclosure 2-16). The following comments are made to provide possible insights into the final site selections:

- If the system is placed further upstream of Lower Granite Dam, juvenile fish will have to pass through less reservoir prior to being diverted, collected, and transported.

- Collection facilities located upstream of Lewiston will not have to accommodate barge traffic. However, small recreational-sized craft will still have to pass around the upstream facilities.

- Collection facilities located upstream of Lewiston, and out of the Lower Granite Dam backwater, will require a method to transfer fish to the reservoir if large fish transport vessels are used to transport the fish to below Bonneville Dam.

- More stable river flow conditions (*i.e.*, stable water levels, slower river velocities approaching barrier diversion systems, adequate water depths, *etc.*) can be found downstream, rather than upstream, of Lewiston. Relatively stable and predictable river hydraulic conditions are necessary for the proper operation of most fish collection systems. [**Note:** The need for stable flow conditions, adequate water depths, large flow areas for barriers, *etc.*, would probably mean that fish collection systems located upstream of Lewiston (out of the Lower Granite Dam backwater) would require the equivalent of a dam to create the hydraulic conditions necessary for any fish collection system to operate properly].

- Partial screening concepts might be more effective in deep water conditions because fish barrier/diversion screens can be placed deeper. Deep screen/collection slots would take advantage of juvenile fish behavior where: 1) juvenile fish tend to swim closer to the water surface; and 2) juvenile fish typically resist sounding to deep water levels if they are given an alternate route.

b. Conveyance System Components.

(1) Migratory Canal and Pressure Pipeline Systems.

Preliminary routing of the migratory canal and pressure pipeline systems was based on an evaluation of river water surface elevations (see enclosure 1-2), the geographic layout of the land, and manmade construction or land usage considerations over potential routes. Preliminary alignments selected to demonstrate these concepts are shown on enclosures 3-1 through 3-6.

(2) Transport System.

No site selection studies were completed for a transport system option other than what was required to connect a new upstream collection system to transport facilities, since a fish transport system is already in place in the river.

(3) Floating Pipeline System.

No site selection studies to determine the specific routing of a floating pipeline within the river were made, other than to examine how to typically route a floating pipeline system past a dam and adjacent to a river bank.

5.03.. UPSTREAM COLLECTION SYSTEM COMPONENTS.

a. General Information Related to Downstream Fish Protection And Collection Systems.

Substantial work has been completed and is ongoing , both in the Pacific Northwest and throughout the nation, related to designing and evaluating downstream migrant fish protection systems for hydroelectric projects. This effort includes establishing biological and engineering criteria; identifying research needs; and building, testing, and operating fish protection devices and systems. The effectiveness of fish diversion and collection systems is influenced by the species and size of fish, as well as by site-specific considerations (*i.e.*, water depths, velocities, and quality). No single method has thus far been developed that would satisfy all biological, engineering, and cost-effectiveness considerations for fish protection systems.

Considerable data is available on different fish diversion and collection methods, as well as the devices currently used or being tested. One publication available (a new edition is forthcoming) is *Assessment of Downstream Migrant Fish Protection Technologies for Hydroelectric Application*, prepared by Stone & Webster Engineering Corporation for the Electric Power Research Institute (EPRI) AP-4711, Project 2694-1, dated September 1986. This report discusses, summarizes, evaluates, and compares information gained from literature searches and surveys of different designs and concepts used and/or tested by the hydroelectric industry.

As presented in this EPRI report, and modified to fit the intent of this report, fish protection systems fall into four main categories: behavior barriers, physical barriers, collection systems, and diversion systems.

(1) Behavior Barriers.

Behavior barriers alter or take advantage of natural behavior patterns to attract or repel fish. These barrier types include electric screens, air bubble curtains, hanging chains, lights (incandescent, strobe, mercury), sound, popper, water jet curtains, hybrid barriers (combination of different types of behavioral barriers), chemicals, and visual keys.

(2) Physical Barriers.

Physical barriers physically block fish passage. These barrier types include bar racks, traveling and fixed screens, rotary drum screens, infiltration intakes, wedge-wire cylindrical screens, and barrier nets.

(3) Collection Systems.

Collection systems actively collect fish for return to their natural environment or to a fish transport system. These type of systems include modified traveling water screens, fish pumps, and gatewell collection systems.

(4) Diversion Systems.

Diversion systems divert fish to bypasses for the return to their natural environment or to a fish transport system. These type of systems include angled screens, angled rotary drum screens, inclined plane screens, inclined pressure screens, STS's, skimmers, louvers, gulpers, other bypass systems, and controlled spills.

b. Basis of Designs and Main Assumptions.

Conceptual designs, costs, and schedules were completed assuming a single facility located downstream of Lewiston. Versions of these designs would also apply for facilities located upstream of Lewiston on the Snake and Clearwater Rivers. However, acceptable river hydraulic conditions for a fish collection system upstream of Lewiston would be more difficult to obtain because of shallower river depths and higher water velocities. Other key assumptions include the following:

- Concepts shown in this report use physical barrier and diversion systems to get fish into a conveyance system, although portions of these designs might utilize a combination of behavior and physicals barriers to divert and collect fish.

- Designs should utilize existing technology as much as possible, and should be realistic from a construction and operation standpoint.

- The system should meet all current fishery-related design criteria, while still providing as much flexibility as possible to incorporate future changes in technology.

- The design should accommodate normal river fluctuations and flood flows.

- Miscellaneous project functions related to adult fish passage, navigation, debris, and sediment need to be addressed.

- Partial fish collection versus 100-percent fish collection is acceptable. (**Note:** An acceptable level will have to be determined considering fisheries-related benefits versus environmental, social, and economic costs.)

- Design river flows during fish collection, while still meeting fish facility criteria (assuming a single collection system in the Snake River downstream of Lewiston), could possibly range between 100,000 and 225,000 cfs (10-year event). (**Note:** See paragraph 5.01., Design Criteria, for a further discussions on river flows.)

- The upstream collection system design used to demonstrate this concept assumes the use of existing fish transportation barges to convey the fish. However, a lift system, in conjunction with a canal or pipeline conveyance system (see paragraphs 5.04., Migratory Canal Conveyance System Components; 5.05, Pressure Pipeline Conveyance System Components; and 5.07, Floating Pipeline Conveyance System Components) or new fish transport vessels in place of existing barges (see paragraph 5.06, Transport Conveyance system Components) might also be used to convey fish.

c. Description of Main Barrier Concepts.

(1) General.

The concepts for intercepting and diverting juvenile fish have been divided into low and high velocity barrier categories.

(a) Low Velocity Barrier Concepts.

Low velocity barrier concepts relate to methods used to intercept and divert juvenile fish wherever flow velocities approaching and passing through a barrier structure during fish collection periods do not impinge or damage fish. These systems are designed to allow fish to volitionally guide along the barrier with no contact. Barriers require large areas because of low approach and flow-through velocity requirements.

(b) High Velocity Barrier Concepts.

High velocity barrier concepts relate to methods used to intercept and divert juvenile fish wherever hydraulic conditions (flow velocities approaching and passing parallel to the barrier surface) do not cause fish to become impinged or damaged, although some fish do come in contact with the barrier. High velocity barriers can use substantially smaller areas, when compared to low velocity concepts, because of higher approach and flow-through velocity requirements.

(2) Low Velocity Barrier Concepts.

(a) General Information and Site Layout Discussion.

Three low velocity barrier systems have been developed: floating platforms with moving barriers (concept A, enclosures 2-4 and 2-5), flow control structure with fixed barriers (concept B, plate 2-6), and bridge structure with fixed barriers (concept C, enclosure 2-7).

Two site plans common to all three concepts were developed, assuming a Snake River collection site downstream of Lewiston. As discussed in paragraph 5.02, Site Selections and Layouts, no plans were developed for sites upstream of Lewiston although the general layouts may be comparable. It should be noted, however, that barrier systems upstream of Lewiston (out of the backwater effect of Lower Granite Dam) would require new dams to create adequate hydraulic conditions for proper barrier operations. Enclosure 2-2 depicts a site plan developed, assuming a fish collection river design flow of 100,000 cfs. Enclosure 2-3 shows a site plan developed, assuming fish collection river design flows of either 160,000 cfs or 225,000 cfs. All concepts would be able to safely pass the 420,000 cfs SPF.

Barrier systems could be composed of screens, louvers, behavior devices (lights, sounds, *etc.*), or a combination of different devices mounted on a framework of barrier supports. Final lengths and arrangements of barrier systems would be dictated by site location, as well as by the river design discharge and velocity criteria selected for diverting and collecting fish.

Each different concept would have comparable components that would apply for all options. Major facility features, assuming a location downstream of Lewiston at the Silcott Island site, include the following:

- Fish Barrier System (different for various concepts).

- Adult Fish Passage Facilities.
- Access Roads and Piers.
- Low Head Boat Passage Facilities.
- Fish Attraction Chambers.
- Fish Barge Chambers.
- Fish Sorting, Holding, and Loading Facilities.
- Maintenance Facilities.
- Upstream Debris Removal System.
- Relocated Park.

(b) Concept A--Floating Platform/Moving Barrier System.

The floating platform concept consists of a series of connected floating platforms with barriers that hang vertically into the river to divert fish to a collection and transport point (see enclosures 2-4 and 2-5). The platform system would be held in place by cables anchored to the shore, river bottom, and in-water piers.

Trash racks would be located on the upstream side of the platform. A fish barrier frame and movable barrier system would be suspended from the platform. The depths of barriers and open flow areas could be adjusted to provide partial or nearly full depth diversion. Barrier devices within the framework would be movable so that the entire line of barriers could be shifted to a single location for removal, cleaning, inspection, and repair. There may also be a benefit, related to enhancing fish movement past barriers and handling debris, in continuously moving barriers. Barriers would be moved by using a trolley/crane system connected to the barrier top, so that barrier devices could roll/float over the length of the platforms.

Under high river discharges when fish would not be diverted, barriers inserted within frameworks could be removed to pass flows without impinging fish.

(c) Concept B--Flow Control Structure/Fixed Barrier System.

The flow control structure/fixed barrier system would use a large-scale structure to divert fish swimming in the upper depths of the river to a collection and transport system. The lower portion of the structure would use a false floor and regulating gate to control flows and maximize fish collection (see enclosure 2-6).

This plan is a version of a concept mentioned by Harza Engineering Company in the preliminary draft report, *Analysis of Reservoir Drawdown*, prepared by NPPC's Columbia/Snake River Drawdown Committee, dated December 4, 1992. In this report, Harza recommended:

- Screening 90,000 cfs surface flow instead of the 225,000 cfs 10-year event;

- completing partial screening while passing excess flow beneath the main screening facility, and placing screens on a false bottom to minimize fish sounding; and

- considering the use of an 0.8-fps screen criteria instead of the original 0.4-fps screen criteria.

Harza described a screen diversion design that uses a system of screen or louvers, flow control gates, and false floors. Their description of this system is as follows:

> "The screen should extend from the water surface to a depth of 30 feet, leaving the bottom 20 feet (approximately) of the reservoir channel for unrestricted passage of high flows, sediment, and debris beneath the screen structure. The reservoir channel below the screens would be controlled with gates that would be closed at flows up to 90,000 cfs, forcing all water through the screening facility. When river flows exceeded 90,000 cfs, the gate would be lifted to release water from the bottom of the channel. Head loss through the gates and lower reservoir channel would be approximately equal to head loss through the screening facility (1/2 to 1 foot). Preliminary estimates show that

at least 120,000 cfs would flow through the lower channel when the head differential was 1/2 foot and gates were fully open across the river channel; the combined screening facility and lower channel flow would then be about equal to the 10-year flood flow for the Snake River.

The screening facility would be placed on a "false-bottom" structure extending 100 feet upstream of the vertical screen plates. The false bottom structure would separate the flow before fish could sense the approach of an obstruction (screen), and would minimize fish sounding under the screens. For fish to avoid the screens during high flow, they would need to do one of the following: 1) Swim with the lower 20 feet of the 50-foot-deep reservoir pool and maintain this position through the lower channel; 2) Sound at the location of the leading edge of the false bottom, 100 feet upstream of the screen; or 3) After encountering the screens, swim 100 feet upstream, then sound beneath the false bottom. All of these behaviors are uncharacteristic for downstream migrating smolts, so a very high percentage of fish are expected to reach the screens even when a large volume of flow is being passed beneath the screening structure."

Site plans shown on enclosures 2-2 and 2-3 for the 100,000 cfs and 160,000 cfs/225,000 cfs design flows, respectively, assumed that regulating gates would be fully open at these flows. If the regulating gates were fully closed and the barrier areas were sized to pass design flows, as discussed by Harza, screening areas above what was assumed in this study would be required.

Trash racks, a screen cleaning system, and miscellaneous related features would be required to keep the barriers clean of debris. Under high river discharges when fish would not be diverted, barriers would be removed and regulating gates would be opened to pass flows without impinging fish.

(d) Concept C--Bridge Structure/Fixed Barrier System.

The bridge structure/fixed barrier system would use a bridge and deck design to support a fixed barrier and related features in order to divert fish to a collection and transport system (see enclosure 2-7). The method of construction would use a caisson system for constructing pier supports to allow in-water construction. Partial, or nearly 100-percent, fish screening could be done. Trash racks, a screen cleaning system, and miscellaneous related features would be required. Under high river discharges when fish would not be diverted, barriers would be removed to pass flows without impinging fish.

(3) High Velocity Barrier Concepts.

(a) General Information.

Three high velocity barrier concepts have been developed. Two designs combine a fish skimmer/submerged screen concept comparable to the systems currently used at projects on the Lower Snake River (concepts D and E, see enclosures 2-9 and 2-10). One design uses modular inclined screens and control gates with slotted fishway entrances, similar in part to a system used at Wells Dam on the Columbia River, but without the turbines (concept F, see enclosure 2-11). All of these options would behaviorally collect a large majority of the fish with a small percent of the river flow.

A site plan showing a layout for a high velocity barrier system is shown on enclosure 2-8. This layout assumes a location downstream of Lewiston on the Snake River but, as previously discussed, a comparable design with different sized structures to accommodate lower design flows might be used on the Snake or Clearwater Rivers upstream of Lewiston. Barrier systems upstream of Lewiston, however, would require new dams to create adequate water depths to maximize fish collection and take advantage of juvenile fish behavioral tendencies to swim closer to the water surface.

The site plan on enclosure 2-8 was sized to divert and collect fish for flows up to 160,000 cfs, while still having the capability to pass a 420,000 cfs SPF. Different lengths of fish collection structures (enclosures 2-9 through 2-12) and a flow bypass structure (enclosure 2-13) could be constructed to accommodate different assumptions for fish collection design flows. However, the overall size and length of the facilities would be comparable for a fish collection facility designed for other than 160,000 cfs, since the project would still be sized to pass a 420,000-cfs SPF flow.

The different concepts would have comparable components that would apply for all options. Major facility features, assuming a location downstream of Lewiston at the Silcott Island site, include the following:

- Fish Collection Structure (different for each of the various concepts)
- Flow Bypass Structure.
- Adult Fish Passage Facilities.
- Access Roads.
- Low Head Boat Passage Facility.
- Fish Barge Chamber.
- Fish Sorting, Holding, and Loading Facilities.
- Maintenance Facilities.
- Upstream Debris Removal System.
- Relocated Park.

(b) <u>Concept D--Skimmer/Submerged Standard Screen System</u>.

The skimmer/submerged standard screen concept (see enclosure 2-9) uses a combination fish skimmer and diversion screen design to direct fish and water to collection and transport facilities.

Skimmer segments of the design would use a series of weirs spread across the length of the collection facility to direct fish and surface collection flows into a large collection channel. A large dewatering screen, and related components, would be required at the downstream end of this channel to remove excess flows prior to the fish reaching holding, loading, and transporting facilities.

The main fish diversion screens would be similar in design and operation to the existing turbine intake diversion screens at the lower Snake River projects. These screens would divert fish from large flow passageways into fish collection facilities. Angled screens, with a flow control system to regulate the amount of water removed, would be used to separate fish from water prior to entering collection channels. These channels would be similar in size to collection channels used at existing juvenile fish facilities.

(c) Concept E--Skimmer/Submerged Extended Screen System.

The skimmer/extended STS concept (see enclosure 2-10) uses a combination fish skimmer and diversion screen design similar to the system previously described for concept D, except it would use longer screen lengths to direct fish and water to collection and transport facilities. Water removal velocities would be less and screen angles would not be as severe when compared to the standard screen concept, because of longer screen lengths.

(d) Concept F--Vertical Slot-Flow Control/Modular Inclined Screen System.

The vertical slot-flow control/modular inclined screen concept (see enclosures 2-11 and 2-12) would use, in part, a configuration similar to the upstream face of Wells Dam (on the Columbia River), where spillway bays located above deep turbine intakes have been modified to serve as juvenile fish bypasses. The length of the fish collection structure would be broken into a series of fish collection bays and regulating bays, with every third bay being used to collect fish. Using only selected bays will maximize fish collection, while minimizing the amount of water that must be handled. Regulating bays used to pass and control flows without collecting fish could be modified at a later time to add fish collection components, if additional collection bays were needed. The upper levels of the regulating bays could also be fitted with adult fish passage capabilities (*e.g.*, vertical slot ladder), if desired.

Vertical slotted openings above flow regulating passageways, that create higher velocity conditions, would attract juvenile fish swimming in the upper water column to and through the slots. The fish, after passing through the slots, would move into a dewatering and collection system located above flow regulating passageways. The dewatering and collection segments of the design could use a high velocity screen design, such as the Modular Inclined Screens (MIS) being developed and tested by EPRI, to separate fish and water.

The MIS would have streamlined entrances with trash racks, dewatering stop-log slots, screens set at shallow angles to flows, and a fish bypass for diverting fish to holding, loading, and transporting facilities. Screens would be set on a pivot bar so they could be tilted and cleaned by back-flushing operations. A stationary screen with a cleaning brush would be required, however, if fish entrapment during back-flushing operations became a problem. Diverted fish would enter a collection channel similar in size to the collection channels used at existing juvenile fish facilities.

d. Key Features of Upstream Collection Besides Main Barrier-Related Components.

(1) General.

Key features required for an upstream collection system, in addition to the main river barrier and collection-related components previously described, were listed in paragraphs 5.03.c.(2)(a) and (3)(a). Some of these features are described in further detail in the following paragraphs.

(2) Trash-Shear Boom and Debris Removal System.

There would be a 4,000-foot-long trash-shear boom (see enclosures 2-17 and 2-24) that would be somewhat comparable (but more extensive) than the existing Lower Granite Dam trash-shear boom. In addition, there would be a debris removal system on the shoreline to handle debris.

(3) Fish Sorting and Transfer Facilities.

(NOTE: Additional information related to sorting facilities for the migratory canal and pressure pipeline options can be found in paragraphs 5.04.b.(2) and 4.05.b.(2), respectively.) Fish sorting and transfer stations consist of the portions of the main collection system that sorts and directs fish diverted from the main in-river barriers to either lift facilities [for the migratory canal or pressure pipe options (see paragraphs 5.04. and 5.05.)] or to fish barge or floating pipeline loading facilities [for the transport and floating pipeline options, respectively (see paragraphs 5.06. and 5.07.)]. This part of the facility would consist of the following components:

(a) Fish Attraction Channel.

There would be a 100-foot-long by 8-foot-wide by 20-foot-deep channel (water depths varying from 10 to 15 feet deep) that would have velocities of about 5 fps to help attract juvenile fish into the sorting and transfer system. Attraction water velocities would be created by downstream dewatering-related pumps and screening systems (see the following paragraph).

(b) Primary Dewatering.

There would be a 140-foot-long by 8-foot-wide inclined floor screen with a screen cleaning device and a pumped water withdrawal system that would be used to create proper attraction velocities in the previously described fish attraction channel. The upstream end of the screen would pivot to allow the entire screen to shift up and down (float or mechanically adjust), and to allow for a 5-foot fluctuation in the main river channel water surface elevation.

(c) Secondary Dewatering.

There would be a 10-foot-long by 8-foot-wide continuation of the primary dewatering system, but it would have an independent pumped water control system to fine-tune the flow into the fish separators. The downstream end of the screen would be adjustable (as part of the primary dewatering screen) so that the entire screen could move up and down as the water level in the river changed. This adjustable screen control section (acting, in essence, like a broad-crested weir), in combination with adjusting the water level within the fish sorting and transfer chamber to control the elevation at the entrance to the separators, would control the depth and water volume entering the separator system, and optimize fish passage conditions.

(d) Steelhead and Chinook Separator, Holding Facilities, and Transfer Method to a Conveyance System.

There would be a fish separator unit that would be about 8 feet wide by 21 feet long. The separator, as it pertains to the bars, would be comparable in part to the recently installed separator system at Lower Monumental (and to the unit soon to be installed at McNary). Depending on the type of transfer system from the separator to the conveyance system (see the following paragraphs), the separator might be floatable or mechanically adjustable in height to adjust for fluctuations in river elevations. Concepts that might be used in conjunction with the system include the following:

1. Conventional Separator and Related Components, Assuming Currently Used Fish Holding and Loading Methods.

A conventional separator and related components means that after fish pass through the separator bars, most of the system components (distribution flumes, raceways, *etc.*) would be comparable to existing holding and loading facilities at the previously mentioned projects. The actual loading of fish into a conveyance system would, however, require fish to be directed to either a lowered lift facility (for the migratory canal and pressure pipe options) or to a lowered loading facility (for the transport and floating pipeline options). A lowered fish lift or loading facility would be needed in order to have enough hydraulic head to gravity feed fish from the separator and related systems to a conveyance system.

2. New Separator System, Assuming Floating Fish Holding and Loading Methods.

A new separator system, assuming floating structure methods, means that after fish pass through the separator bars they would pass into a system of transfer channels and related features that would direct them to either a lift facility (for migratory canal and pressure pipe options) or to a loading facility (for transport and floating pipeline options). Minimal hydraulic head would be needed to move fish from the separator and related system, in contrast to the previously described separator system, because of the methods used to move the fish. After the fish passed through the separator bars, they would swim into large holding structures below the separator bars. These holding structures (transfer channels discussed in later paragraphs) would have pumped inflow and withdrawal systems used to attract and distribute the fish within the channels in order to minimize stressful conditions. The entire separator system and interior transfer channels would be a floating structure, and would be connected to moorage piers that would be capable of operating over a 5-foot fluctuation.

Floating interior transfer channels would be about 21 feet wide by 50 feet long by 12 feet deep. Interior wall widths would be set to match the separation spans on the separator. The water depth within the channel would be about 10 feet. The transfer channels would be composed of a system of pumped attraction and withdrawal flows, a crowder, screens, and bulkheads. The crowder would be used in combination with the pumped flows and bulkhead operations to move fish to the exterior transfer channels as well as to the conveyance system.

Floating exterior transfer channels would be about 21 feet wide by 80 feet long by 12 feet deep, with channels matching the interior transfer channel widths. The transfer channels would be composed of a system of screens, crowders, and bulkheads. These system components would be used to move fish from exterior transfer channels to the conveyance system.

(4) Adult Fish Return System.

An adult fish return system at the downstream end of the separator would be composed of either a fish ladder system (such as that shown on enclosures 2-18 through 2-20) or a lift bucket and crane system.

A fish ladder system would be composed of an approximately 130-foot-long (20 feet of which would be within the fish sorting and transfer chamber), 10-foot-deep, and 8-foot-wide weir pool (or other type) fish ladder. The fish entrance of the ladder would have a screened pumped water removal system in the ladder floor. A water removal system would be used to create flow conditions down the ladder comparable to the fish ladders on the lower Snake River projects. The fish exit would be composed of a false weir, with attraction flow, that would be comparable to the emergency fish ladder exit system at Lower Granite Dam.

One alternative to a fish ladder system would be a lift bucket arrangement that would collect fish in a hopper at the downstream end of the separator, so that the hopper containing adult fish and water could be dumped back into the river away from the facility.

(5) Adult Fish Passage Chamber.

Depending on the design, either one or two adult fish passage chamber(s) located at the upstream end of the main fish barrier(s) would be used to facilitate passage through the facility. Each chamber would be about 300 feet long, 20 feet wide, and 25 feet deep (see enclosure 2-22). The water depth would vary from 15 to 20 feet. Pumped flows would be supplied into floor diffusers to provide attraction flow. The downstream end of the chamber would have a 15-foot-wide telescoping weir that would be comparable to the adult fishway main entrance weirs at McNary Dam. The upstream end of the chamber would also have a telescoping weir but, in addition, it would have a false weir and attraction water system incorporated into the top section to allow adult fish to swim out of the chamber without allowing any downstream moving fish to enter the chamber.

(6) Low-Head Boat Passage Facilities.

(a) Boat Passage at the Main Fish Barrier.

A low-head lock system would be constructed that would allow boat passage past the main fish barrier (see enclosure 2-23). There would be a slight differential (normally about 1 foot or less, but possibly more in unusual situations) between the upstream and downstream sides of the screens. The lock would roughly be the size of the Lower Granite Lock (about 86 feet wide by 700 feet long, not counting approach wall widths and lengths), but would only be about 30 feet deep. Both the upstream and downstream ends of the locks would be operated to elevate or lower boats and barges within the lock. No lock filling or drain systems would be required.

(b) Boat Passage at the Debris Boom.

A simple swing gate/removable boom section would be used to allow the passage of boats past the debris boom (see enclosure 2-17).

(7) Miscellaneous Features.

A project office, including maintenance and visitor facilities, would be constructed at the site. Also, if part of the new facilities were located on Silcott Island, a new park would be required to replace the displaced Chief Timothy Park.

5.04. MIGRATORY CANAL CONVEYANCE SYSTEM COMPONENTS.

a. General Description of Alternatives.

This concept would consist of a system of gravity flow open canal sections, tunnels, and elevated flumes or pipes. This system would begin at either a single juvenile fish collector and lift facility in the Lower Granite reservoir just downstream of Lewiston, Idaho, or at two separate juvenile salmonid collectors and lift facilities on both the Snake and Clearwater Rivers upstream of Lewiston. The system would end just downstream of Bonneville Dam on the Columbia River, for a total length of 314 and 342 miles for single or dual collection facilities, respectively.

(1) Migratory Canal with Single Primary Fish Collection, Sorting, and Lift Facilities with Intermediate Additional Collection.

The migratory canal fishway system would convey juvenile fish primarily gathered from an upstream collection facility located in the Lower Granite reservoir to a point downstream of Bonneville Dam. A site for the upstream collection system, located about 7 miles downstream of Lewiston, Idaho (at Silcott Island), was selected to demonstrate this alternative. This option would also allow for the collection of fish at each of the downstream dams that currently have, or will have, the capability to collect fish.

The canal fishway system would begin near Silcott Island. A primary collection and related facilities (see paragraph 5.03., Upstream Collection System Components) located near the Silcott site would capture downstream migrant salmonids from the lower Snake River upstream of Lower Granite Dam. The configuration of the fish barrier system would direct fish toward collection and sorting facilities, where the juvenile fish would be sorted and passed into a fish lift or lock that would lift them 120 feet into the migratory canal fishway for continued conveyance downstream.

Most of the canal fishway would consist of a trapezoidal open channel with concrete and rock lining. Some reaches would consist of bored or shot tunnel through basalt, if the trapezoidal section was not feasible because of difficult terrain or other considerations. Elevated flume or pressure pipe would be used to bridge low-lying areas in some locations. Where the alignment passed through areas where security was of great concern, the canal could be constructed as a cut-and-cover pipe or culvert section. Throughout the open channel sections of the alignment, a portion of the channel cross section would incorporate rocks and boulders inset into the lining to provide in-channel rest areas for the fish.

Additional juvenile fish would be collected from the screening and bypass systems incorporated into the dam structures at each dam along the route . No additional collection facilities would be included for tributary streams downstream of the upstream collection site.

Resting ponds would be incorporated into the alignment at least every 10 miles, where construction conditions would permit. The canal flow with fish would pass into these ponds, where 25 percent of the total flow in the canal would be replaced with fresh, aerated water pumped from the river below. The canal would be fenced for security, and shaded by vegetation as much as possible.

Fish conveyed by the migratory canal would be released into the Columbia River downstream of Bonneville Dam through staggered discharge outfalls. The operation schedule of these release points would be random, and would be staggered to confuse predators.

(2) Migratory Canal System with Dual Main Fish Collection, Sorting, and Lift Facilities with Intermediate Additional Collection.

This alternative would be comparable to that previously described for a single collection facility, except that two separate collection facilities (located on the Snake and Clearwater Rivers upstream of the confluence at Lewiston, Idaho) would be used to collect juvenile fish and divert them into the canal fishway. For demonstration purposes, it is assumed that the Snake River collector would be located about 10 miles upstream of Lewiston, and the Clearwater River collector would be located about 6 miles upstream of Lewiston. A general discussion related to dual upstream collection systems is presented in paragraph 5.03., Upstream Collection System Components.

The collected juveniles would be lifted, with a lock system or a mechanical lift, to the elevation of the high migratory canal. Total lift heights required to move the juvenile fish into the Clearwater and Snake River canal fishways would be about 80 feet and 180 feet, respectively. Fish collected from the Clearwater River would be lifted into a canal, and carried under Lewiston through a tunnel. They would then move upstream along the right bank of the Snake River as far upstream as the Snake River collector structure. These fish would then be conveyed through an elevated flume across the Snake River, and combined with the Snake River juveniles in the collection ponds at the base of the final lift to the migratory canal. Water from this Clearwater canal would be pumped to the main migratory canal along with Snake River water, in an amount proportionate to the distribution of flow between the Snake and Clearwater Rivers. This should effect proper imprint of homing instincts on Clearwater River fish.

The remainder of the canal fishway system would be comparable to that previously described for a single collection system downstream of Lewiston.

b. Additional Information Related to Key Components of Migratory Canal System.

(1) Upstream Collection System.

Information related to upstream collection system components are discussed in paragraph 5.03., Upstream Collection System Components.

(2) Sorting Facilities.

Sorting facilities would be provided at a single Silcott site collector or at two separate upstream collector sites, depending on the option. Sorting facilities would also be contained within the existing juvenile bypass systems at each dam upstream of the confluence of the migratory canal and the existing bypass flume. In this way, fish collected at the upstream collector(s), and at each dam, would be required to endure passage through sorting facilities only once. The purpose of a sorting facility is to remove adult fish and debris, as well as larger non-salmonid species, from the transportation system. For the migratory canal system, the existing juvenile bypass flume would pass through a small sorting chamber similar to that found in the existing sorting facilities. Juveniles would be separated and transferred into a flume that would join the migratory canal. The canal discharge capacity would be about 200 cfs, while the existing juvenile bypass would carry about 30 cfs. A shunting gate would normally be held closed to direct the flow of the juvenile bypass into the migratory canal. However, should the necessity arise, the gate could be opened to divert the juvenile bypass flow back into the existing sorting, holding, and outlet facilities at the toe of the dam.

At the upstream collector(s), the sorting structure would carry about 230 to 250 cfs from the collection screens (see enclosure 3-15). This flow would enter a dewatering chamber, 62.5 feet long and expanding in width from 8 feet to 16 feet, to decrease the discharge of fish-bearing water to about 30 cfs. The dewatering chamber would consist of a false sloping floor and sidewalls of fine screen mesh. This would effectively trap the fish in the screened channel, yet still release water into the surrounding open channel. The reduced flow would pass into a sorting tank where bar screens of varying dimensions would separate juveniles from adults and larger non-salmonid species. Excluded fish would be piped to the release facilities below the collector structure, as would the excess discharge. Fish would normally travel from the sorter into the holding chamber for the fish lift or lock facility.

(3) Lift Facilities.

A lift system would be provided to move the fish from the collector elevation to the high migratory canal elevation. Two alternative concepts, a mechanical lifting tank and a lock system, have been developed to achieve this objective. The mechanical system consists of a large tank mounted on an inclined track that would cycle from bottom to top and back in about 5 minutes (see enclosure 3-13). The lock system would consist of a vertical reinforced concrete lock chamber, with upper and lower bulkheads and vertical crowder screens similar to that constructed at both Bonneville and McNary Dams (see enclosure 3-14). Total lift height would be about 120 feet for a single site collector, and about 180 feet and 80 feet for dual Snake and Clearwater River collectors, respectively.

The mechanical lift tank volume of about 3000 gallons was based on the maximum allowable concentration of fish in an enclosed chamber, the anticipated peak number of fish to be handled, and the expected cycle time of the lifting tank. Fish would enter the tank through a spill chute exiting from a small holding chamber. The lift would carry the tank with fish up an inclined ramp to the canal, where the water and fish would be poured from the tank into the canal. Total cycle time is expected to be about 5 minutes. Auxiliary water supply would be available on the tank carriage to maintain some minimum tank water volume, so that fish would not be spilled into a completely empty tank.

The fish lock design concept is based on a simplified and scaled-down version of the Bonneville Dam adult fish lock, which was used during the 1940's and 1950's to move migrating adults upstream of the dam. In the proposed juvenile fish lock, fish would be crowded from the collection and holding tank into the lock chamber, where a vertical bulkhead would close behind them to seal the lock. Fresh water would be pumped through a diffusion chamber, and into the floor of the lock chamber, to raise the water surface. An inclined submerged separator screen would follow the water surface and fish up to the top of the chamber. The volume of the fish-bearing water would be constantly exchanged through the crowder screen, and would total about 1400 cubic feet. Pump inflow required to raise the water surface in a 15-foot-diameter chamber, at a rate of 10 vertical feet per minute, would be about 30 cfs. When the water level in the lock reached the level of the canal, a bulkhead would open and the fish would be crowded into the canal by raising the inclined screen above the water surface. To complete the cycle, the bulkhead would close, and water would be evacuated from the lock through the floor inlet/outlet. For an 80-foot-high lift, this cycle would require about 17 minutes. If the pumped inflow were greater or the lock chamber smaller, the cycle time could be reduced if necessary. The design was based on transport criteria similar to that of the mechanical lift discussed above.

(4) Migratory Canal.

(a) General Information.

In general, the canal system invert would follow a uniform gradient from dam to dam. The invert of the channel at the downstream face of each dam would be 2 to 3 feet lower than that of the existing juvenile fish bypass channel, except at McNary Dam. At McNary Dam, it would be about 8 feet lower to accommodate a larger channel cross section. Gravity flow would feed fish into the channel from the existing fish bypass systems at each dam. The channel invert at the upstream face of each dam would be located at the high pool water surface elevation. Spiral flume sections would be used at the downstream side of each dam where elevation drops were required to meet the existing fish bypass systems. Approximate invert elevation profiles for the migratory canal system are shown plotted against the reservoir profiles on enclosure 1-2. Actual invert elevations may vary from what is shown on the drawing as a result of variations in invert slopes and cross sectional geometries along the alignment. The alignment is shown in enclosures 3-1 through 3-6.

The migratory canal would consist of one of several configurations of open trapezoidal concrete-lined channel, elevated open flume, elevated enclosed pipe, concrete-lined tunnel, or cut-and-cover enclosed culvert sections. Variations in canal type would depend upon construction conditions, security considerations, and other factors. The concrete-lined tunnel through the fractured basalt strata would be used where necessitated by conditions, especially in the upper reaches of the alignment along the Snake River (between Lewiston/Clarkston and Ice Harbor Dam). The elevated flume or enclosed pipe sections would be supported on piers, and pre-stressed beams would be used wherever the alignment crossed a deep canyon, valley, or tributary. The average slope of the canal system would approximate the natural river slope. Hydraulic head and cost efficiency would be maintained by flattening the invert slope through the open channel or tunnel sections, so that the steepened elevated flume or pipe sections could be downsized to reduce material and construction costs.

The criteria used to develop the migratory canal concept include the specific biological criteria listed in paragraph 5.01.c, Conveyance System Components, as well as construction criteria based on preliminary alignment and configuration. The design discharge of the migratory canal was computed by using the maximum expected daily migrant passage rate of about 2 million fish per day. Juvenile fish were assumed to weigh about 1/5 pound per fish, and acceptable density of fish in the moving water was assumed to be about one fish per 7.5 gallons of water per minute.

The open channel portions of the canal would be designed to carry the 200-cfs design discharge, at an average velocity of 3 to 6 fps. This average velocity would be expected to provide a total water particle travel time of 7 to 10 days from Lower Granite Dam to Bonneville Dam. This travel time approximates the pre-dam migration time on the Columbia and Snake Rivers between the same locations. It was assumed, for velocity computation purposes, that the conveyance portion of the channel would be concrete lined, with a Manning's "n" roughness value of about 0.013 (a figure that closely approximates the natural roughness of concrete for these velocities and depths). The Manning's roughness value for the non-conveyance portion of the channel with embedded rock was assumed to be about .035, which closely approximates the typical "n" value for rubble channels of moderate depth. The composite "n" value of .019 was determined by weighting the conveyance and non-conveyance portions of the channel by flow area and estimated proportion of conveyance. The average slope of the canal invert was determined by approximating the maximum available elevation of the invert of the canal at the downstream face of each dam and the forebay of the downstream dam, and then dividing by the approximate length of the canal. The invert elevations at the downstream face of each dam were dependent upon the elevation of the existing juvenile bypass flume. At the upstream side of each dam, the lowest elevation of the invert of the canal was restricted to the maximum normal operating pool elevation.

(b) Open Channel Sections.

Cross sections of the open channel portions (approximately 224 miles of total length for a single collector and 238 miles for dual collectors) of the canal will vary, depending on the material encountered and the side slopes. For estimating purposes, three generic excavated canal sections are assumed (see enclosure 3-7).

A Type I cross section would be used wherever the channel passed through easily excavated materials lying on low-gradient slopes. The bottom, or invert, of the channel would be approximately 17 feet wide, with a low, longitudinal retaining wall throughout the length to prevent dislodged rocks from migrating to the smooth concrete-lined portion of the channel. Concrete lining would be placed along the full wetted perimeter, in addition to the freeboard area, by slip lining or by fixed forming. Side slopes would be about 1 vertical to 1 horizontal. The average height of the side walls would be about 6 feet, providing about 3 feet of freeboard for emergency surcharge. One-half of the cross section would include angular rock of variable size embedded in the liner concrete. These rock-lined portions of the channel would be positioned along the inside of bends, and along the uphill side of the channel in straight sections, to reduce the frictional losses within the channel as well as to encourage a larger proportion of conveyance to be provided by the smooth concrete-lined portion. The rock would be designed to provide cover and in-channel areas of lower velocity for resting along the alignment. Vegetation of select varieties would be encouraged to grow on one or both banks of the channel to provide shading and potential invertebrate production. Security fencing would be provided along both banks of the channel, with high-strength wire strung above the channel to discourage predatory bird access. An access roadway would roughly parallel the canal alignment. Runoff from natural drainage courses would be passed under or over the canal through culverts, as required by site conditions.

Type II cross sections would be utilized where the underlying materials were primarily rock standing on steep cross slopes. The invert and right (or downhill) bank dimensions and configuration would be identical to that of the Type I channel. The left (or uphill) bank would rise from the invert, at a side slope of 1 vertical to 1 horizontal, for 2 or 3 feet. At this point, the bank would be vertical to the daylight point of the excavation. An access roadway would be provided along the top of the right (downhill) bank of the channel, and would roughly parallel the alignment.

Type III cross sections would be utilized where the underlying materials were difficult to excavate or stood on low-gradient slopes. The dimensions of the channel would be identical to that of the Type I cross section. However, the left and right banks of the channel would be formed against structural embankments. Fencing, bird wire, vegetation, and access roadway features would also be provided, much like those for the Type I channel.

Variations of Type I, II, and III cross sections would be utilized specifically for the reach of the canal between McNary Dam and John Day Dam (on the Columbia River). The maximum available gradient between dam structures within this reach is low, and requires a very large cross section for the design discharge of 200 cfs. The dimensions of the three types of canal design are increased to accommodate an average water depth of about 10 feet. The remaining features not dependent on the cross section geometry would remain the same (*i.e.*, vegetation, security measures, bird wire, *etc.*).

Along all sections of the open channel, wherever feasible, vegetation of manageable size would be encouraged to grow on the banks. This would provide shading and invertebrate production to supplement feeding facilities for the fish. Design discharge capacity is computed with the assumption that the entire rock-lined portion of the channel provides no conveyance. Vegetation would be carefully managed along the bank adjacent to the access roadway to ensure that inspection activities would not be compromised.

(c) <u>Elevated Flume/Pipe Sections</u>.

Where the alignment required the spanning of low-lying areas, the open channel or tunnel would transition into an elevated open flume or concrete pipe (approximately 39 miles of total length for single collectors and 40 miles for dual collectors) supported on piers and 80-foot-long pre-stressed concrete girders (see enclosure 3-8). The open channel flume would be approximately 10 feet wide at the invert, with vertical sidewalls 6 feet high to provide 3 feet of freeboard. It would be constructed of reinforced concrete prefabricated sections; and would be provided with security fencing, bird wire, and a grated catwalk for inspections. Some sections could incorporate a structural covering to accommodate an access roadway.

The concrete pipe would be about 6 to 8 feet in diameter, depending upon the invert slope. It would also be provided with an access walkway. Where elevated flume or concrete pipe was used, the invert slope could be greater than the excavated channel to reduce the required cross section for the design discharge. The reduction of flow area would reduce the physical dimensions of the structure and the required strength of the structural members, gaining economy in size and materials. Embedded rock for flow velocity reduction would probably not be used for the elevated flume or pipe sections.

(d) Tunnel Sections.

Some sections of the canal would be constructed by tunneling (approximately 44 miles of total length for a single collector and 57 miles for dual collectors) through the fractured basalt cliffs. Tunneling would be accomplished by either a tunnel-boring machine or the drill-and-shoot method; depending on the location, length of tunnel required, and the economics of each method. The minimum diameter of the tunnel would be 12 feet, including concrete lining (see enclosure 3-9). Rock could be embedded in part of the concrete lining to provide local velocity reduction and cover for the juvenile fish. Lighting would be provided throughout the tunnel, either continuous or variable, to match natural light cycles. Personnel access would be provided by an elevated walkway above the water surface. In addition, a small rail-type car track could be suspended above the water surface to accommodate seated observers through the longer sections of tunnel. Some beneficial water temperature reduction is expected to occur throughout the tunneled sections, due to heat transfer from the water to the surrounding rock.

(e) Cut-and-Cover Pipe Sections.

Some portions of the alignment would require construction of a cut-and-cover enclosed pipe (approximately 6 miles of total length for both single and dual collectors) for security reasons, or to reduce real estate acquisition costs. Typically, this type of construction would be used where the alignment passed near or through populated areas, or under existing structures or facilities. The pipe would be either a precast reinforced box culvert about 12 feet wide and 10 feet high, or a precast reinforced concrete pipe 12 feet in diameter. Inspection access would be provided throughout the pipe or culvert by an elevated walkway system similar to that for the tunnel described above.

(f) Resting Ponds.

Resting ponds would be provided at about 10-mile intervals (approximately 30 resting ponds for a single collector and 31 for dual collectors) throughout the entire alignment of the migratory canal system (see enclosure 3-10). These ponds would allow fish to rest or feed, as necessary. Resting ponds would be at least 1/3 of an acre in surface area, with an average depth of at least 10 feet. The pond would be shaded with shoreline vegetation and larger trees, both on the shore and in large concrete planters within the ponds. Some invertebrate production could be provided by such vegetation to supplement the feeding requirements of the wild fish. Hatchery fish would depend largely on artificial feeding at the pond sites. The ponds would be created by damming natural draws or excavating surface depressions, depending upon the existing topography. Dams would be constructed of concrete for those in steep ravines in basalt strata, or compacted earth for more gradual slopes and less stable materials. Ponds would probably be sealed to reduce seepage losses.

Fresh water would be pumped from intakes in the river below each pond to exchange at least 25 percent of the total channel discharge at each pond. Nitrogen desaturation and reoxygenation of the pumped inflow would be accomplished by pumping the fresh water to the top of a baffled chute spillway prior to its introduction to the resting pond (see enclosure 3-12). Baffled chute spillways have been used successfully in the past to effectively reduce excess nitrogen and reoxygenate water in reservoir outlet works and irrigation water spills. If required, additional aeration of the pond water could be provided with in-water aeration systems. Water temperatures would be maintained below acceptable levels [75 degrees Fahrenheit (^{o}F)], and within 2^{o}F of the river during periods of hot weather, by exchanging cooler river water, shading, and by evaporative cooling. Mist emitters situated around the pond would produce a fine mist that would drift over the pond as it evaporated. The energy consumed in the evaporation of the mist would come from the heat energy of the surrounding air. Evaporative cooling is effective in low-humidity, high air temperature conditions typical of the geographical area through which the canal will traverse.

To stabilize and attenuate water levels in the canal, 25 percent of the total channel discharge at the upstream end of the pond would be spilled back to the river through a long, screened side channel spillway and closed culvert alongside the canal structure (see enclosure 3-11). Spilled water could be directed into a turbine unit coupled to the exchange water pump to reduce energy consumption. Trash and floating debris would be removed by a small floating debris boom upstream of the side channel spillway. Debris would be directed into a sloped revolving screen designed to pass water and dump debris over the side of the channel. In addition to the side channel spillway just upstream of each resting pond, similar spillways would be provided at about 4,000-foot intervals along the entire length of the canal. These additional spillways would be used in the event of a downstream failure or sudden blockage of the canal, as well as to limit the normal maximum water level in the canal. Debris removal would not be necessary at these spillways.

(5) Collection at Dams with Existing Fish Collection/Bypass Facilities.

Structural modifications to eight existing dams would be limited to the addition of a bored conduit through the dam at the high forebay pool elevation, through which the migratory canal system will pass. Minor roadway modifications would be required in the immediate vicinity of the dam structure to accommodate the alignment of the migratory canal. Modifications to the existing alignment of the juvenile fish bypass flumes would have to be made so that they could be joined with the migratory canal. Construction of that portion of the migratory canal and appurtenant structures immediately upstream and downstream of the dams might also require the relocation of some existing structures.

(6) Release Below Bonneville Dam.

Fish conveyed by the canal alternatives would be released into the Columbia River downstream of Bonneville Dam through staggered discharge outfalls. Side channel spillways, of the type discussed in the migratory canal features section, could be used in conjunction with a closure gate on the main canal section. The operation schedule of these release spillways would be random, and would be staggered to confuse predators. In this way, the high concentration of predators currently noted within existing tailrace areas or release points would not have a chance to build up to such destructive levels. The outfalls would be staggered along perhaps as much as 1 mile of riverbank.

5.05. PRESSURE PIPELINE CONVEYANCE SYSTEM COMPONENTS.

a. General Description of Alternatives.

This concept would consist of a pressure pipe buried along the shoreline of each reservoir, beginning at either a large juvenile fish collector and lift facility in the Lower Granite reservoir just downstream of Lewiston, Idaho; or at two separate collectors and lift facilities on both the Snake and Clearwater Rivers upstream of Lewiston. The system would end just downstream of Bonneville Dam on the Columbia River, for a total length of about 314 and 324 miles for single and dual collection facilities, respectively.

(1) <u>Pressure Pipeline System with Single Primary Fish Collection, Sorting, and Lift Facilities with Intermediate Additional Collection</u>.

This option, in concept, would be very comparable with the previously described migratory canal option with single primary collection and sorting facilities [see paragraph 5.04.g.(1), Migratory Canal with Single Primary Fish Collection, Sorting, and Lift Facilities with Intermediate Additional Collection]. However, the conveyance of fish from the upstream end to below Bonneville Dam (a distance of about 314 miles) would be accomplished with a large diameter steel or concrete pressure pipe section rather than open channel, elevated flume, and tunnel sections. The pipe would carry fish from the upstream juvenile collection facility, and from each of the downstream dam's collection systems. Resting ponds, with 25-percent water exchange at each, would be provided about every 10 miles where feasible, much like the migratory canal. At each pond, the pipe would rise to the elevation of the pond, where it would discharge water and fish. Fresh water pumped from the river below would be combined with the pipe flow in the pond. An outlet structure would carry water and fish back into the pressure pipe and on downstream along the riverbank. The pipe would likely be buried throughout most of the alignment to help maintain cool water temperatures.

(2) <u>Pressure Pipeline System with Dual Primary Fish Collection, Sorting, and Lift Facilities with Intermediate Additional Collection</u>.

This option, in concept, would be comparable to that previously described for a single collection facility, except that collection would be accomplished with two separate upstream collectors on the Snake and Clearwater Rivers, as in the migratory canal system with dual main fish collectors [paragraph 5.04.a.(2), Migratory Canal System with Dual Primary Fish Collection, Sorting, and Lift Facilities with Intermediate Additional Collection]. The total length of the system would be about 342 miles.

b. <u>Additional Information Related to Key Components of the Pressure Pipe System</u>.

(1) <u>Upstream Collection System</u>.

Information related to upstream collection system components is discussed in paragraph 5.03., Upstream Collection System Components.

(2) Sorting and Lift Facilities.

The sorting and lift facilities for this alternative would be the same as that for the migratory canal (paragraphs 5.04.b.(2), Sorting Facilities; and (3), Lift Facilities], except that fish would be conveyed into a pressure pipe system from the top of the lift instead of into an open channel.

(3) Pressure Pipe System and Resting Ponds.

The pressure pipe alternative (see enclosure 3-16) would consist of a 6- to 12-foot-diameter steel or concrete pipe buried along the bank of the reservoir, within the boundaries of Federal property adjacent to the river. Where the reservoir banks are too steep or solid to excavate easily, the pipe could be submerged in the reservoir itself. Pressure changes in the pipe would be limited to no more than one-half of one atmosphere (about 7.35 pounds per square inch) in 1 minute of travel time to accommodate the capability of juvenile fish to withstand pressure changes. The pipe would rise gradually to free-surface, open resting ponds located in natural depressions or draws above the reservoir, at approximately 10-mile intervals. The slope of the rising and falling sections of pipe would be determined by the flow velocity and the maximum allowable rate of pressure change discussed above. For most reaches, the rising and falling portions would be from 500 to 4000 feet long, depending on the change in elevation and flow velocity in the pipe. Provisions for lighting the pipeline may be required to reduce prolonged darkness-related stress on the juvenile fish. At present, the effect of prolonged darkness and pressure on juvenile fish is not well known. Hydraulic head would be conserved throughout the system. Water exchange, aeration, rest, and feeding for fish would be provided in the resting ponds, as in the free-surface canal alternative. A buried pressure pipe system would help keep water temperatures low, and reduce the necessity for water temperature control facilities.

(4) Collection at Dams with Existing Fish Collection/Bypass Facilities, and Release Below Bonneville Dam.

Structural modifications to existing dams would be comparable to that for the migratory canal alternatives [paragraph 5.04.b.(5), Collection at Dams with Existing Fish Collection/Bypass Facilities]. Fish release below Bonneville Dam would also be comparable to that of the migratory canal alternatives [see paragraph 5.04.b.(6), Release Below Bonneville Dam].

5.06. TRANSPORT CONVEYANCE SYSTEM COMPONENTS.

a. General Description of Alternatives.

This concept consists of using either existing or expanded/improved fish transport barge fleet and loading facilities, beginning at either a single juvenile fish collection structure in Lower Granite reservoir just downstream of Lewiston, or at collection facilities on both the Snake and Clearwater Rivers upstream of Lewiston. Fish would be transported downstream, depending on the option, between 314 and 350 miles. They would then be released below Bonneville Dam on the Columbia River.

(1) Transport System with Single Primary Fish Collection, Sorting, and Holding Facilities with Intermediate Additional Collection.

This option, which would utilize some of the same features as the present barging program (paragraph 2.03., Juvenile Fish Transportation), would transport juvenile fish primarily gathered from a large collection facility (see paragraph 5.03., Upstream Collection System Components) located in the Lower Granite reservoir to a point downstream of Bonneville Dam. This option would also allow for the collection of fish at each of the downstream dams that currently have, or will have, the capability to collect fish. Juvenile fish reaching an upstream collection system would, after being separated by size, be directed into a barge and transported downstream. As was the case for the migratory canal and pressure pipe alternatives, a site for the upstream collection system located about 7 miles downstream of the confluence of the Snake and Clearwater Rivers near Silcott Island (see paragraph 5.03.b., Basis of Design and Main Assumptions) was selected to demonstrate this concept.

(2) Transport System with Dual Primary Collection, Sorting, and Holding Facilities with Intermediate Additional Collection.

This option would be comparable to that previously described for a single collection facility, except that collection would be accomplished with two separate upstream collectors on the Snake and Clearwater Rivers. The collection facilities would convey fish into an open channel or enclosed pipeline leading several miles downstream along the riverbanks to transport vessel-loading facilities located near Lewiston, within the navigable pool of the Lower Granite reservoir.

b. Additional Information Related to Key Components of the Transport System.

(1) Upstream Collection System.

Information related to upstream collection system components is discussed in paragraph 5.03., Upstream Collection System Components.

(2) Connection Canals to Link Collection System(s) to Fish Transport Vessels.

(a) Single Collection Facility Located Downstream of Lewiston.

No connection canals are required, since the collection facility would be located within the navigable pool of the Lower Granite reservoir.

(b) Dual Collection Facilities Located Upstream of Lewiston.

Fish would be conveyed downstream through open channels or enclosed pipes several miles along the banks of the Snake and Clearwater Rivers, from upstream collection facilities to transport vessel-loading facilities located near Lewiston (within the navigable pool of the Lower Granite reservoir). The two separate open channels or pipes would be of about the same geometry and configuration as that of the migratory canal open channel or free-surface flow pipe [see paragraph 5.04.b.(4), Migratory Canal].

(3) Sorting, Holding, and Loading Facilities.

Fish diverted by an upstream barrier system would be diverted into sorting and holding facilities prior to transfer to a transport vessel or truck. These facilities could be somewhat comparable to the existing holding and loading facilities on the lower Snake River, except that the separator and sorting-related facilities would be tailored to match this type of collection and sorting system. Discussions related to the two options for sorting, holding, and loading facilities are presented in paragraph 5.03.d.(3), Fish Sorting and Transfer Facilities.

(4) Fish Transport Barges/Vessels.

(a) General.

Depending on the system used to sort, hold, and transfer fish from the main barrier system to a fish transport vessel (see previous paragraphs), transport options would use either existing fish barges or entirely new vessels. Using existing fish barges with conventional sorting and holding facilities would require a barge chamber (a version of a navigation lock) to lower barges below the river water level, and allow gravity fish loading from the separator and holding facilities. Using new fish transport vessels, in conjunction with floating sorting and holding facilities, would require loading fish with a system of attraction flows and crowders. There is no evidence at the present that suggests that the actual transportation process using the existing barges harms the fish. However, some groups are concerned that barging may be harmful to the fish.

(b) Existing Fish Barge Option.

The existing fish transport barges (see enclosure 4-1 for a typical general arrangement of an existing fish barge), comparable in design, numbers, and operation to the present barge fleet, would still be used to transport fish to below Bonneville Dam.

(c) New Fish Transport Vessels (FTV's) Option.

New FTV's would be about 21 feet long by 80 feet wide by 16 feet deep (see enclosure 4-2). The maximum draft would be about 14 feet. The FTV's would contain six cells that would be about 160 feet long by 8 feet wide, with a water depth of 10 feet. (Each cell, which would be open on the top and covered with shading, would be sized to roughly equal about four times the volume of one raceway at the new Little Goose Juvenile Fish Facilities.) The FTV's could be operated in either a "net pen" fashion, or as a closed system with recirculated, aerated (and possibly temperature-controlled) water. Components of the FTV's would include screens and bulkhead gates at both ends of the cells, a crowder, shading, sprinklers to disturb the water surface, a removable floating breakwater barrier at the front end of the FTV's, miscellaneous pumps, water distribution and drain floor diffusers, piping over the length of each cell, packed columns, *etc.* While operating in a "net pen" fashion, the FTV's would travel at a rate roughly equal to the time it would take for a juvenile fish to swim to the ocean (about 7 1/2 days). In addition to the FTV's themselves, a storage and maintenance facility would be constructed near the collection facility to maintain and store the FTV's when not in use.

(d) Fish Barge/Transport Options Used for This Study.

For this report, it was assumed that existing barges and trucks would be used to transport fish from an upstream collection system to below Bonneville Dam. Future studies will have to be completed to determine if other barge designs might be more effective than the existing barges.

(5) Collection at Dams with Existing Fish Collection/Bypass Facilities.

No changes to the existing dam structures would be required for the transport alternatives. The collection and transport of fish at the dams would continue to use the existing systems.

5.07. FLOATING PIPELINE CONVEYANCE SYSTEM COMPONENTS.

a. General Description of Alternatives.

This concept would consist of a flexible, floating, continuous conduit located on the surface of each reservoir, beginning at either a single juvenile fish collector in the Lower Granite reservoir just downstream of Lewiston, or at two separate collectors on the Snake and Clearwater Rivers upstream of Lewiston. Special pumps would be required to maintain free-surface, open-channel flow conditions within the conduit. The system would end just downstream of Bonneville Dam on the Columbia River, for a total length of about 320 and 333 miles for single or dual collection facilities, respectively.

(1) Floating Pipeline System with Single Primary Fish Collection and Sorting Facilities with Intermediate Additional Collection and Pump Stations.

This option would use a single collection system similar to that previously described for the migratory canal, pressure pipeline, and transport options. However, this alternative would convey fish from the downstream collector by means of a floating low pressure or open channel conduit. A system of intermediate pumps or water movement systems would maintain flow velocities within the desired limits. Fish would primarily be gathered from an upstream collection facility located in the Lower Granite reservoir, and ultimately conveyed to a point downstream of Bonneville Dam. As was the case for all of the alternatives previously discussed, a site for the upstream collection system located about 7 miles downstream of the confluence of the Snake and Clearwater Rivers at Silcott Island was selected to best demonstrate this alternative. This option would also allow for the collection of fish at each of the downstream dams that currently have, or will have, the capability to collect fish.

This floating pipeline/pump fishway, as proposed by Idaho National Engineering Laboratory, would convey migrating juvenile salmonids 320 miles through a system of segments of anchored floating open-channel or submerged low-pressure conduit. The floating or naturally buoyant pipe or open channel system would lie on the reservoir surface out of the path of navigation. Where necessary, the conduit would be submerged to permit navigation access from shoreline areas. Required flow velocity through the conduit would be maintained by some type of modular pumping mechanism that would not be injurious to the fish. The conduit would pass through each dam, as necessary, by means of a variable-level adjustable gate and bored conduit. The flow from the floating conduit would pass through the dam, and drop elevation quickly through a long spiral or switchbacked CMF pipe to the tailwater area of the dam.

Additional juvenile fish would be collected at each dam along the route from the screening and bypass systems incorporated into the dam structures. The juveniles would then be discharged into the floating conduit just downstream of the dam. No additional collection facilities would be included for tributary streams downstream of the upstream collection site.

Resting ponds, in the form of in-reservoir net pens, would be incorporated into the alignment at least every 10 miles. The conduit flow with fish would pass into these ponds, where 25 percent of the total flow in the conduit would be exchanged with fresh, aerated water pumped from the river.

Fish conveyed by the floating pipeline and pump system would be released into the Columbia River downstream of Bonneville Dam through staggered discharged outfalls. The operation schedule of these release points would be random, and staggered to confuse predators.

(2) <u>Floating Pipeline System with Dual Main Fish Collection and Sorting Facilities with Intermediate Additional Collection and Pump Stations</u>.

This option, in concept, would be comparable to that previously described for a single collection system except that collection would be accomplished with two separate upstream collectors on the Snake and Clearwater Rivers, as in the migratory canal system with dual main fish collectors [paragraph 5.04.a.(2), Migratory Canal System with dual Main Fish Collection and Sorting Facilities with Intermediate Additional Collection and

Dump Stations]. The collection facilities would convey fish into an open channel or enclosed pipeline leading several miles downstream along the riverbanks to connect with the floating pipeline and pump system located near Lewiston (within the navigable pool of the Lower Granite reservoir).

b. Additional Information Related to Key Components of Floating Pipeline System.

(Note: A more detailed discussion of the design of the floating conduit concept, as proposed by Idaho National Engineering Laboratory, is found in enclosure 5-4).

(1) Upstream Collection System.

Information related to upstream collection system components is discussed in paragraph 5.03., Upstream Collection System Components. For a single collection facility downstream of Lewiston, fish would be transferred from the sorting facility into the floating conduit in the immediate vicinity of the collector. For dual upstream collectors on the Snake and Clearwater Rivers upstream of Lewiston, fish would first be conveyed downstream to connection facilities within the navigable pool of the Lower Granite reservoir, much like the transport alternative (see paragraph 5.06., Transport Conveyance System Components).

(2) Floating Pipeline and Pump System.

As discussed in previous paragraphs, Idaho National Engineering Laboratory has proposed an in-reservoir floating or submerged conduit for fish conveyance as an alternative to an open concrete-lined channel. The conduit, as proposed, would be sized for a 200-cfs discharge. It would consist of a flexible, thin membrane conduit with numerous intermediate pumps or water movement systems to maintain flow velocity within the required limits. The conduit would float above anchored tie-downs along the bank of the reservoir, or be submerged in a low pressure system under shipping traffic routes or shoreline boating access lanes. Enclosure 3-1 is a conceptual sketch prepared by Idaho National Engineering Laboratory to show the expected operating condition and structural configuration of the open channel and closed conduit portions of the floating conduit fishway. Resting areas would be provided by in-reservoir net pens. Passage through each dam would be provided by a new conduit bored through the structure and connected to the existing juvenile bypass systems, as shown in enclosures 5-2 and 5-3. In this manner, juveniles from both the floating conduit and the existing bypass would be combined and conveyed further downstream.

The connection between the Idaho National Engineering Laboratory's floating conduit and the existing dam structure would be accomplished with a sliding connector plate. Flow would pass through the sliding connector plate into a dewatering wet well. Dewatering from 200 cfs to 170 cfs would be provided by a floor screen in the wet well. A 17-foot-wide adjustable weir would control the water level in the floating conduit and in the wet well. Downstream of the weir, a second chamber would stabilize flow conditions prior to passing through a 4-foot by 4-foot slide gate and into a 36-inch-diameter, steel-lined conduit through the dam. The pipe would transition into a 48-inch-diameter corrugated steel pipe (CSP) upon exiting the downstream face of the dam. The CSP pipe would drop to the elevation of the river in about 1000 feet. It would carry about 170 cfs at a maximum of about 20 fps velocities under free-surface conditions. A switchback section of pipe would be used to drop the elevation of the pipe within the limited available length.

Connection to the floating conduit in the tailwater pool would be accomplished with a flexible coupling. A transition section designed to pass the flow from super critical to sub critical without a hydraulic jump would be provided. Juvenile fish from the existing juvenile bypass system sorting, collection, and holding ponds at the base of the dam would be transported into the floating conduit through a small flume or pipe designed to carry 30 cfs. The downstream floating conduit would be designed to carry the combined flow of 200 cfs on to the next dam.

(3) Collection at Dams with Existing Fish Collection/Bypass Facilities.

Structural modifications to eight existing dams would be required to install a 15-inch-diameter dewatering conduit and a 3-foot-diameter bored and steel-lined conduit through each dam, in addition to a wet well and weir structure on the upstream face of each dam. The alignment of the downstream fish passage culvert for the Idaho National Engineering Laboratory conduit connection may require realignment of some existing downstream facilities.

COLUMBIA RIVER SALMON MITIGATION ANALYSIS
SYSTEM CONFIGURATION STUDY
PHASE I

UPSTREAM COLLECTION AND CONVEYANCE
SNAKE AND COLUMBIA RIVERS
TECHNICAL APPENDIX D

SECTION 6 - COSTS AND SCHEDULES OF ALTERNATIVES

6.01. GENERAL.

Cost and schedule information related to overall project alternatives are presented first in this section. Additional cost and schedule information related to upstream collection system concepts is presented independently from project alternatives in order to provided added insights as to how the components impact overall schedules and costs.

6.02. PROJECT ALTERNATIVES--COSTS AND SCHEDULES.

a. General.

Four basic alternatives were analyzed for costs and schedules. For each of these alternatives, a single upstream collection system using one design option was assumed (refer to the following paragraphs), and three different collection design flows (100,000, 160,000, and 225,000 cfs) were evaluated.

Although basic assumptions were made to select the components that would generally be used, the development of these alternatives, as stated in paragraph 4.01., are not intended to be recommendations on what are necessarily considered to be the best combinations of the different components. However, this analysis does demonstrate magnitude schedule and cost information for designing and constructing the different types of upstream collection and conveyance systems. Alternatives related to other site locations, dual collection systems located upstream of Lewiston on the Snake and Clearwater Rivers, and other types of upstream collection designs, will be evaluated further if this concept is carried into future studies. As discussed in section 4, Proposed Alternatives, it should be noted that a dual collection system design for collectors located upstream of Lewiston would probably require the construction of dams to create proper hydraulic conditions for the fish diversion barriers. This might require additional biological as well as cost-related impacts not associated with a single collection system downstream of Lewiston.

Basic concepts selected to develop alternative comparisons assumed that all project alternatives would use a single collection system on the Snake River in the vicinity of Silcott Island, located about 7 miles downstream of Lewiston. An upstream collection system that used a low velocity design with either a floating platform/moving barrier, or a bridge structure/fixed barrier component, was initially selected for developing costs and schedules. To simplify the analysis, however, it was decided to use cost and schedule data that assumed bridge structure/fixed barrier collection components in order to match previous drafts of this report. As discussed in paragraph 6.03., cost and schedule data related to floating platform/moving barrier concepts would be comparable to a bridge structure/fixed barrier collection system.

b. Alternative 1--Migratory Canal with Single Primary Fish Collection, Sorting, and Lift Facilities with Intermediate Additional Collection.

(1) Project Description.

This alternative assumes a single upstream fish collection system in the vicinity of the Silcott Island site; and provides for fish collection, sorting, and lifting to the migratory canal grade, as well as conveyance through each reservoir reach by a series of open channels, flumes, tunnels, and resting ponds.

(2) Cost Information.

(a) Construction and Project Cost Summary.

The reconnaissance-level project costs and fully-funded construction costs are estimated at about $4.3 and $5.4 billion, respectively. [See table 2, tables T-8(a) through (c), and chart 2.] The project cost is based on an October 1992 price level, and include the required biological research, feasibility studies, hydraulic model studies, feature design memorandums, and plans and specifications are included as an estimated 25 percent of the construction cost. Real estate costs (land and damages) are included and discussed in later paragraphs. Construction management is estimated at 15 percent of the construction cost. Contingencies used reflect the anticipated level of construction risk, unknowns, and the level of design detail available for this study. Fully-funded costs are escalated to the mid-point of construction, using OMB inflation factors.

(b) Operation and Maintenance Cost Summary.

Operation and maintenance costs are estimated at about $9.5 million annually. (See tables 2 and T-12.) The operational requirements for this alternative were determined through consideration of requirements at similar facilities. Estimated detailed operational requirements for each feature are shown on table T-13.

(c) Additional Information Related to Upstream Collection System Components.

Major features and costs for the upstream collection facility are identified in table T-3. Additional information related to variations of the upstream collection system concept is presented in paragraph 6.03.

(d) Additional Information Related to the Migratory Canal Conveyance System Components: Cost Assumptions, Construction Quantities, and Real Estate Quantities and Costs.

1. General.

Major features and costs for the migratory canal conveyance system are identified in table T-3. Tables T-1 and T-2 show the total length of channel types, assuming a single collection system downstream of Lewiston (used for the final estimate) and a dual collection system upstream of Lewiston (not used for the final estimate), respectively.

Several costs were considered above that needed solely for an upstream collection system. Fish and wildlife facility costs were assumed to be 5 percent of the construction costs, and cultural resource preservation costs were assumed to be 1 percent of construction costs. Tables T-8(a) through T-8(c) include environmental and cultural resource mitigation costs. Environmental mitigation and enhancement costs for modern civil works projects may conservatively be expected to range between 8 and 20 percent of the construction costs, depending on project type, severity of the impacts, and the complexity or difficulty of the required corrective action. This is all inclusive (fish, wildlife, cultural resources, and other environmental concerns). Because the project discussed herein is itself a fisheries mitigation project, all ameliorative measures are intended to target environmental values other than fisheries with an associated reduction in benchmark costs by about half (arbitrary), to 4 to 10 percent of construction costs. Terrestrial impact costs were set at the low end of this range (5 percent), since mitigation measures are reasonably straightforward, although potentially extensive. Typical features would include closely spaced ramps and covers over the open canal to provide pathways for migratory animals and others requiring river access; topsoiling and seeding or planting of staging areas, access roads, and borrow sites; aesthetic treatment of disturbed sites; habitat restoration and creation; terraces and subimpoundments; and wetland restoration and replacement.

The Corps planning and construction guidance [Engineer Regulation (ER) 1105-2-50 and ER 1130-2-438, respectively] supports a general 1 percent of construction cost standard for cultural resources. Features would include complete archeological and historic surveys of project areas, the evaluation of finds, negotiation of Programmatic Agreements, and curatorial disposition of any finds.

2. Real Estate.

Preliminary real estate studies considered two alternative collector/canal projects: 1) Alternative 1, beginning in the vicinity of a Silcott Island single fish collector downstream from Lewiston, Idaho; and 2) a variation of alternative 1, beginning with dual fish collector sites on the Clearwater River upstream from Lewiston, Idaho, and at the second collector site upstream from Asotin, Washington on the Snake River. Both projects end downstream of Bonneville Dam. Alternative 1 would eliminate the real estate costs, associated with dual collection systems, of acquiring lands through and around Lewiston, Idaho, and Clarkston, Washington. This option would consist of an estimated total land area of 1,271 acres (a 35-foot right-of-way), of which 682 acres (53 percent) would be located on privately-owned lands, with the remaining 589 acres (47 percent) being located on Government-owned lands (project and/or wildlife lands). The overall real estate costs for alternative 1 are estimated at $4,000,000. These overall costs would include land costs, administrative costs to acquire the lands, and a 20-percent contingency factor. This figure does not include relocation expenses or any damages to real or personal property as a result of this proposed project.

The variation of alternative 1 with dual fish collectors upstream of Lewiston would be somewhat longer in length than alternative 1. It would require an estimated total land acquisition of 1,395 acres, of which 795 acres (57 percent) would be on privately-owned lands and 600 acres would be over Government-owned lands. Real estate costs for this particular project would be estimated at $5,000,000. See tables T-4 through T-7 for a complete breakdown of real estate costs and uses, by reach, (or reservoir) for these project alternatives.

The real estate cost estimates for alternative 1 and the variation of alternative 1 are based on limited investigation of land uses, real estate costs for privately-owned lands, and associated administrative costs by reach. It should be noted that the investigation of real estate costs is proportional to the constraints imposed by the level of detail required for this report.

(3) Schedule Information.

(a) Summary.

Assuming that funds and resources are available when required, it is estimated that from the date authorization and appropriation are granted, it will take approximately 11 1/2 years to design and construct alternative 1. Time required for biological research and preliminary engineering studies (see paragraph 5.04.) is not included in this timeframe. Chart 2 presents this same information in bar chart form.

(b) Additional Schedule Information Related to Upstream Collection Facility Components.

Chart 1 shows summary information for different upstream collection system components. For a low velocity, fixed-barrier design (which would also be comparable schedule-wise to a floating platform system), the time required for design and construction of just this piece of alternative 1 would range between 5 1/2 and 8 years, for design flows ranging between 100,000 and 225,000 cfs, respectively. Additional schedule information related to the upstream collection facility (and variations in its design) is presented in paragraph 6.03.

(c) Additional Schedule Information Related to Migratory Canal System Components.

Construction efforts for the canal alternative would begin with a prototype test reach during the design stage of the other reaches. The test reach would take approximately 3 years for pre-engineering and design studies, 1 year to acquire lands, 2 years to construct, and 2 years to test. Evaluation of the system after completion would be ongoing. The test reach would probably extend from an existing juvenile collection bypass flume at one dam to an existing juvenile sorting, holding, and loading facility at the tailwater of the next downstream dam.

Pre-engineering and design studies for other canal reaches would begin concurrently with the construction of the prototype test reach, with land acquisition and construction occurring over the next 8 years. Evaluation of the system after construction would be ongoing.

The extensive scope of the construction of a project of this magnitude would require the concerted effort of several contractors to complete the project within the designated timeframe. Within any one reach, several segments of the alignment would be constructed simultaneously. The construction sequence and schedule for this type of construction project is not as complex as for other projects of similar cost, since individual features of the system are not extremely complex and their completion is not generally dependent on completion of the other features.

c. Alternative 2--Pressure Pipeline with Single Primary Fish Collection, Sorting, and Lift Facilities with Intermediate Additional Collection.

(1) Project Description.

This alternative (similar to alternative 1, except with a different fish conveyance system) assumes a single upstream fish collection system in the vicinity of the Silcott Island site; and provides for fish collection, sorting, and lifting to a buried pressure pipeline and related system along the reservoir shoreline.

(2) Cost Information.

(a) Construction and Project Cost Summary.

The reconnaissance-level project costs and fully-funded construction costs are estimated at $4.0 and $5.1 billion, respectively. [See table 2, tables T-9(a) through (c), and chart 2.] The project cost is based on an October 1992 price level, and includes the required biological research, feasibility studies, hydraulic model studies, feature design memorandums, and plans and specifications are included at an estimated 25 percent of the construction cost. Real estate costs (lands and damages) are included and discussed in later paragraphs. Construction management is estimated at 15 percent of the construction cost. Contingencies used reflect the anticipated level of construction risk, unknowns, and the level of design detail available for this study.

(b) Operation and Maintenance Cost Summary.

Operation and maintenance costs are estimated at about $9.5 million annually. (See tables 2 and T-12.) The operational requirements for these alternatives were determined through consideration of requirements at similar facilities. Estimated detailed operational requirements for each feature are shown on table T-13.

(c) Additional Cost Information Related to Upstream Collection System Components.

Major features and costs for the upstream collection facility are identified in table T-3. Additional information related to variations of the upstream collection system concept is presented in paragraph 6.03.

(d) Additional Cost Information Related to the Pressure Pipeline Conveyance System Components: Cost Assumptions, Construction Quantities, and Real Estate Quantities and Costs.

1. General.

Major features and costs for the pressure pipeline conveyance system are identified in table T-3. Pipeline lengths are assumed to be comparable to lengths shown on tables T-1 and T-2 for the migratory canal alternative.

As was the case for alternative 1, several costs were considered above that needed solely for an upstream collection system. Fish and wildlife facilities costs were assumed to be 5 percent of the construction cost, and cultural resource preservation costs were assumed to be 1 percent of construction cost. Tables T-9(a) through T-9(c) include environmental and cultural resource mitigation costs. Additional discussion related to environmental mitigation, enhancement costs, and cultural resources would be comparable to previous information presented in paragraph 6.02.b(2) with alternative 1.

2. Real Estate.

Because of time and money limits placed on investigating and collecting real estate information for all of the alternatives, it was not possible to differentiate specific real estate costs between alternatives 1 and 2 in this report. Therefore, it was assumed real estate costs associated with alternative 2 would be equal to costs associated with alternative 1. Thus, the overall real estate costs for alternative 2 (single collection facility option) are estimated at $4 million. This would include land costs, administrative costs to acquire the lands, and a 20-percent contingency factor. This figure does not include relocation expenses or any damages to real or personal property as a result of this proposed project. Real estate costs for the variation of alternative 2 (dual collection facilities option) would be estimated at $5 million.

(3) Schedule Information.

(a) Summary.

It was assumed this option would have schedule requirements comparable to alternative 1 with a migratory canal conveyance system. Thus, assuming that funds and resources are available when required, it is estimated that from the date authorization and appropriation is granted, it will take approximately 11 1/2 years to design and construct alternative 2. Time required for biological research and preliminary engineering studies (see paragraph 5.04.) is not included in this timeframe. Chart 2 presents this same information in bar chart form.

(b) Additional Schedule Information Related to Upstream Collection Facility Components.

Chart 1 shows summary information for different upstream collection system components. For a low velocity, fixed-barrier design (which would also be comparable schedule-wise to a floating platform system), the time required for design and construction would range between 5 1/2 and 8 years for design flows ranging between 100,000 and 225,000 cfs, respectively. Additional schedule information related to the upstream collection facility (and variations in its design) is presented in paragraph 6.03.

(c) Additional Schedule Information Related to Pressure Pipeline System Components.

Construction efforts for the pressure pipe alternative would begin with a prototype test reach during the design stage of the other reaches. The test reach would take approximately 3 years for pre-engineering and design studies, 1 year to acquire lands, 2 years to construct, and 2 years to test. Evaluation of the system after completion would be ongoing. The test reach would probably extend from an existing juvenile collection bypass flume at one dam to an existing juvenile sorting, holding, and loading facility at the tailwater of the next downstream dam.

Pre-engineering and design studies for other pressure pipeline reaches would begin concurrently with the construction of the prototype test reach, with land acquisition and construction occurring over the next 8 years. Evaluation of the system after construction would be ongoing.

The extensive scope of the construction of a project of this magnitude would require the concerted effort of several contractors to complete the project within the designated timeframe. Within any one reach, several segments of the alignment would be constructed simultaneously. The construction sequence and schedule for this type of construction project is not as complex as for other projects of similar cost, since individual features of the system are not extremely complex and their completion is not generally dependent on completion of the other features.

d. <u>Alternative 3--Transport System with Single Primary Fish Collection, Sorting, and Holding Facilities with Intermediate Additional Collection</u>.

(1) <u>Project Description</u>.

This alternative assumes a single upstream fish collection system in the vicinity of Silcott Island; and provides for fish collection, sorting, and transfer into existing barges where collected fish would be transported downstream to below Bonneville Dam.

(2) <u>Cost Information</u>.

(a) <u>Construction and Project Cost Summary</u>.

The reconnaissance-level project cost and construction costs are estimated to range between $256 and $362 million for collection facility design flows ranging between 100,000 and 225,000 cfs, respectively. Likewise, the reconnaissance-level, fully-funded costs are estimated to range between $327 and $469 million for collection facility design flows ranging between 100,000 and 225,000 cfs, respectively. [See table 2, tables T-10(a) through (c), and chart 2.] The project cost is based on an October 1992 price level, and includes the required biological research, feasibility studies, hydraulic model studies, feature design memorandums, and plans and specifications are included as an estimated 25 percent of the construction cost. Real estate costs (lands and damages) are included as an estimated 20 percent of the construction cost. Construction management is estimated at 15 percent of the construction cost. Contingencies used reflect the anticipated level of construction risk, unknowns, and the level of design detail available for this study.

(b) <u>Operation and Maintenance Cost Summary</u>.

Operation and maintenance costs are estimated at approximately $5.1 million annually. (See tables 2 and T-12.) The operational requirements for this alternative were determined through consideration of requirements at similar facilities. Estimated detailed operational requirements for each feature are shown on table T-13.

(c) Additional Information Related to Upstream Collection System Components.

Major features and costs for the upstream collection facility are identified in table T-3. Additional information related to variations of the upstream collection system concept is presented in paragraph 6.03.

(d) Additional Information Related to Barge Transportation Conveyance System Components: Cost Assumptions, Construction Quantities, and Operations and Maintenance Costs.

Major features and costs for the barge transport system are identified in table T-3. It was assumed existing barges would be used to transport fish.

Because of the smaller construction areas involved for this alternative (relative to the other options), environmental mitigation, enhancement costs, and cultural resources costs were included in the estimated construction cost and contingency [see tables T-10(a) through T-10(c).].

(4) Schedule Information.

(a) Summary.

Assuming that funds and resources are available when required, it is estimated that from the date authorization and appropriation is granted, it will take from 5 1/2 to 8 years to design and construct alternative 3 for collection facility design flows ranging between 100,000 and 225,000 cfs, respectively. Time required for biological research and preliminary engineering studies (see paragraph 5.04.) is not included in this timeframe. Chart 2 presents this same information in bar chart form.

(b) Additional Schedule Information Related to Upstream Collection Facility Components.

Chart 1 shows summary information for different upstream collection system components. For a low velocity, fixed-barrier design (which would also be comparable schedule-wise to a floating platform system), the time required for design and construction would range between 5 1/2 to 8 years for design flows ranging between 100,000 and 225,000 cfs, respectively. Additional schedule information related to the upstream collection facility (and variations in its design) is presented in paragraph 6.03.

(c) Additional Schedule Information Related to Transport System Components.

There would be no additional schedule time required beyond the construction of the upstream collection facilities, since it is assumed existing fish barges would be used to transport fish.

e. Alternative 4--Floating Pipeline System with Single Primary Fish Collection and Sorting Facilities with Intermediate Additional Collection and Pump Stations.

(1) Project Description.

This alternative assumes a single upstream fish collection system in the vicinity of the Silcott Island site; and provides for fish collection, sorting, and transfer into a floating open channel or enclosed low pressure conduit for conveyance downstream to below Bonneville Dam.

(2) Costs.

(a) Construction and Project Cost Summary.

The reconnaissance-level project costs are estimated to range between $789 and $856 million, depending on the design flow selected for the collection system. Likewise, the reconnaissance-level, fully-funded costs are estimated to range between $924 million and $1.0 billion, again depending on the design flow selected for the collection system [see table 2, tables T-11(a) through (c), and chart 2]. The project cost is based on an October 1992 price level, and includes the required biological research, feasibility studies, hydraulic model studies, feature design memorandums, and plans and specifications are included as an estimated 25 percent of the construction cost. Real estate costs (lands and damages) are included as an estimated 20 percent of the construction cost. Construction management is estimated at 15 percent of the construction cost. Contingencies used reflect the anticipated level of construction risk, unknowns, and the level of design detail available for this study.

(b) Operation and Maintenance Cost Summary.

Operation and maintenance costs are estimated at $31.8 million annually (see tables 2 and T-12). The operational requirements for this alternative were determined through consideration of requirements at similar facilities. Estimated detailed operational requirements for each feature are shown on table T-13.

(c) Additional Information Related to Upstream Collection System Components.

Major features and costs for the upstream collection facility are identified in table T-3. Additional information related to variations of the upstream collection system concept is presented in paragraph 6.03.

(d) Additional Information Related to the Floating Pipeline Conveyance System Components: Cost Assumptions, Construction Quantities, and Operations and Maintenance Costs.

1. General.

Major features and costs for the floating pipeline conveyance system are identified in table T-3. Pipeline lengths are assumed to be comparable to lengths shown on tables T-1 and T-2, shown for the migratory canal alternative.

As was the case for alternatives 1 and 2, several costs were considered above those needed solely for an upstream collection system. Fish and wildlife facilities costs were assumed to be 5 percent of the construction cost, and cultural resource preservation costs were assumed to be 1 percent of construction cost. Tables T-11(a) through T-11(c) include environmental and cultural resource mitigation costs. Additional discussion related to environmental mitigation, enhancement costs, and cultural resources would be comparable to previous information presented in paragraph 6.02.b.(2)(c) with alternative 1.

2. Real Estate.

Real estate requirements are considered minimal compared to alternatives 1 and 2 (migratory canal and pressure pipeline systems), because most of the pipeline system would be within the river. It was, therefore, decided to use the comparable real estate costs (lands and damages) assumed for alternative 3 (transport system).

(3) Schedule Information.

(a) Summary.

It was assumed this option would have schedule requirements comparable to alternative 2 with a pressure pipe conveyance system. Thus, assuming that funds and resources are available when required, it is estimated that from the date authorization and appropriation is granted, it will take approximately 11 1/2 years to design and construct alternative 2.

Time required for biological research and preliminary engineering studies (see paragraph 5.04.) is not included in this timeframe. Chart 2 presents this same information in bar chart form.

(b) Additional Schedule Information Related to Upstream Collection Facility Components.

Chart 1 shows summary information for different upstream collection system components. For a low velocity, fixed-barrier design (which would also be comparable schedule-wise to a floating platform system), the time required for design and construction would range between 5 1/2 and 8 years for design flows ranging between 100,000 and 225,000 cfs, respectively. Additional schedule information related to the upstream collection facility (and variations in its design) is presented in paragraph 6.03.

(c) Additional Schedule Information Related to Pressure Pipeline System Components.

Construction efforts for the floating pipeline alternative would begin with a prototype test reach during the design stage of the other reaches. It was assumed that a test reach would take approximately 6 years for pre-engineering and design studies, construction, and testing. Evaluation of the system after completing would be ongoing. The test reach would probably extend from an existing juvenile collection bypass flume at one dam to an existing juvenile sorting, holding, and loading facilities at the tailwater of the next downstream dam.

Pre-engineering and design studies for other pressure pipeline reaches would begin concurrently with the construction of the prototype test reach, with construction occurring over the next 8 years. Evaluation of the system after construction would be ongoing.

The extensive scope of the construction of a project of this magnitude would require the concerted effort of several contractors to complete the project within the designated timeframe. Within any one reach, several segments of the alignment would be constructed simultaneously. The construction sequence and schedule for this type of construction project is not as complex as for other projects of similar cost, since individual features of the system are not extremely complex and their completion is not generally dependent on completion of the other features.

6.03. UPSTREAM COLLECTION SYSTEM COMPONENTS--ADDITIONAL COST AND SCHEDULE INFORMATION.

a. General.

Schedule and cost information for upstream collection system concepts were developed based on designs presented in paragraph 5.03. Because of the preliminary nature of these designs, cost and schedule data should only be used to make relative comparisons between concepts described in this report.

Costs and schedules were developed assuming a single upstream collection system located downstream of Lewiston, at the Silcott Island site on the Snake River. Dual collection systems located upstream of Lewiston, or a single collection system located downstream of Lewiston (at a location other than the Silcott site), would have somewhat comparable design and construction schedules. However, site-specific considerations could significantly effect schedules and costs. It was also assumed for this analysis that fish would be loaded into a fish transport conveyance system rather than a lift system leading to a canal or pipeline conveyance system. The fish barge lowering lock component needed to use existing fish barges would actually be more expensive than the lift system needed to get fish into other types of conveyance systems (see table T-12).

Two schedules and cost estimates were developed (100,000 and 160,000 cfs fish collection design flows) for each low velocity concept. An additional concept for the bridge/fixed-barrier system was evaluated, assuming a 225,000 cfs fish collection design flow. These designs also allow for passing a 420,000-cfs SPF by removing barrier devices during high flow periods.

One schedule and cost estimate was developed for each high velocity concept, assuming a 160,000-cfs fish collection system. Separate schedules and costs for a 100,000-cfs fish collection system were not developed, since it was assumed this design would be comparable in magnitude and costs to a 160,000 cfs design because overall sizes for both systems would require comparable facilities to pass a 420,000-cfs SPF.

b. Fully-Funded Construction and Project Costs.

Information below, and in chart 1, indicate fully-funded construction and project costs for the different concepts. These costs are considered very preliminary, and are only intended to provide magnitude comparisons between options. Costs related to potential biological and engineering research have not yet been developed.

Concept	Fully-Funded Construction Costs
Low Velocity Concepts	
A--Floating platform/moving barrier system	
Fish collection design flow = 100,000 cfs	$241,664,000
Fish collection design flow = 160,000 cfs	$335,635,000
B--Flow control/fixed barrier system	
Fish collection design flow = 100,000 cfs	$1,175,555,000
Fish collection design flow = 160,000 cfs	$1,239,616,000
C--Bridge structure/fixed barrier system	
Fish collection design flow = 100,000 cfs	$240,182,000
Fish collection design flow = 160,000 cfs	$327,820,000
Fish collection design flow = 225,000 cfs	$382,345,000
High Velocity Concepts	
D--Skimmer/submerged standard screen system	$873,195,000
E--Skimmer/extended screen system	$891,986,000
F--Vertical slot (flow control/modular inclined)	$982,292,000

c. Schedule Information.

(1) General.

The information below describes tentative research, design, and construction schedules for the different concepts. Basic assumptions made to develop the schedules are also discussed. Chart 1 presents this same information in bar chart form.

(2) Feasibility Studies.

Biological research and preliminary engineering studies (see paragraph *5.04*.) will need to be completed prior to the construction of any upstream collection system. The present schedule for the CRSMA calls for evaluating possible plans (reservoir drawdowns, system improvements, *etc.*), for an unspecified time, that might be used to improve fishery conditions. Biological research and preliminary engineering studies could be completed during this time to answer major questions related to an upstream collection system.

(3) Feature Design Memorandums and Plans and Specifications.

It was assumed, for all concept designs, that feature design memorandums could be completed in 1 year, and plans and specifications could be completed in 1 1/2 years.

(4) Construction.

Construction schedules were developed with the following assumptions:

(a) Cofferdam placement and removal, in addition to other major in-water work, can only be completed in work windows during August and September and from December through March.

(b) Unlimited resources (manpower, money, and materials).

The estimated time require to construct the different concept designs are as follows:

Concept	Construction Time
Low Velocity Concepts	
A--Floating platform/moving barrier system	
Fish collection design flow = 100,000 cfs	3 years
Fish collection design flow = 160,000 cfs	4 1/2 years
B--Flow control/fixed barrier system	
Fish collection design flow = 100,000 cfs	9 years
Fish collection design flow = 160,000 cfs	12 1/2 years
C--Bridge structure/fixed barrier system	
Fish collection design flow = 100,000 cfs	3 years
Fish collection design flow = 160,000 cfs	4 1/2 years
Fish collection design flow = 225,000 cfs	5 1/2 years
High Velocity Concepts (NOTE: Fish collection design flows = 100,000 and 160,000 cfs)	
D--Skimmer/submerged standard screen system	8 years
E--Skimmer/extended screen system	8 years
F--Vertical slot (flow control/modular inclined)	8 years

(5) Post-Construction Evaluations.

The testing of completed facilities will be required to evaluate new systems for proper operation. It was assumed this would be an ongoing process, with no specific completion time.

Table 2

Project Alternatives	Project Costs	Fully-Funded Costs	Annual Operation and Maintenance Costs
Alternative 1 - Migratory Canal with Single Primary Fish Collection, Sorting, and Lift Facilities with Intermediate Additional Collection	$4.3 billion	$5.5 billion	$9.5 million
Alternative 2 - Pressure Pipeline with Single Primary Fish Collection, Sorting, and Lift Facilities with Intermediate Additional Collection	$4.0 billion	$5.1 billion	$9.5 million
Alternative 3 - Transport System with Single Primary Fish Collection, Sorting, and Holding Facilities with Intermediate Additional Collection	$257 to 362 million	$327 to 469 million	$5.1 million
Alternative 4 - Floating Pipeline with Single Primary Fish Collection and Sorting Facilities with Intermediate Additional Collection and Pump Stations	$789 to 856 million	$924 million to $1.0 billion	$31.8 million

COLUMBIA RIVER SALMON MITIGATION ANALYSIS
SYSTEM CONFIGURATION STUDY
PHASE I

UPSTREAM COLLECTION AND CONVEYANCE
SNAKE AND COLUMBIA RIVERS
TECHNICAL APPENDIX D

SECTION 7 - ENVIRONMENTAL EFFECTS

7.01. ANADROMOUS FISH.

a. General.

Designs currently engineered for upstream collection with conveyance systems other than barge transportation are new and untested. An upstream collector structure would employ technology that has not been previously used, or is based on the modification of current collector designs on a scale that would have to be extrapolated above that for any collector currently operated or designed. One design advantage afforded to a new upstream collector is its independence of the powerhouse operational and structural constraints that have influenced the design of current collection and bypass systems at the lower Snake River dams. In concert with expanded knowledge of salmonid behavior acquired since original collector and bypass designs, this independence from powerhouse constraints would allow more directed effort toward a biologically-functional design.

The success of any upstream collection concept would be highly dependent on the biological success of the fish transport program currently operated for all Snake River salmonid stocks. Transportation of juvenile salmonids has been under study for 20 years, although aspects of the beneficial effects across the life cycle for certain stocks continue to be contested. The National Marine Fisheries Service (NMFS) research on the transportation program measures the effects of transporting juvenile salmonids through the mainstem Snake and Columbia River hydrosystem by the calculated Transport Benefit Ratio (TBR) between in-river control fish and those fish transported in barges. The results for the 1986 and 1989 releases are considered the most representative of the hydrosystem's current operation and structural configuration, and suggest that transportation is beneficial in returning averages o f60 to 150 percent more adult spring Chinook salmon to Lower Granite Dam, and averages of 140 to 180 percent more adult fall Chinook salmon to McNary Dam.

The Salmon Recovery Team, designated by NMFS, believes that in order to increase the survival of migrating smolts from the Snake River Basin to near that of pre-dam levels will require either improved collection and transport of smolts around the mainstem dams or a system-wide drawdown to a near-natural river condition. Bother of these large-scale alternatives consist of very high biological uncertainty. The Recovery Team suggests that improved collection and transport of smolts would likely require the use of an upstream collector located at the top of the Lower Granite reservoir, for which a design would be new and unproven; while a Snake River drawdown to riverbed would take up to 17 years to implement, and could result in near constant river disturbance throughout the mainstem as a consequence of the required construction activities. The Recovery Team members report that, if the primary objective is to deliver the maximum number of live smolts to some point below Bonneville Dam or into the estuary from the top of the Lower Granite reservoir, improved collection and transport of smolts around most of the Snake and Columbia River dams is the most reasonable alternative (from a biological perspective) for increasing smolt-to-adult survival, at least for the near term until a long-term strategy can be designed. The Recovery Team realistically considers the definition of transport mortality as mortality that directly occurs during transit in the barge (*e.g.*, barging mortality), rather than the additive indirect mortality attributable to individual fish conditions that may lead to mortality after the individual fish exit the barge and are exposed to the estuarine conditions. Progress toward recovery needs to be started immediately. Recovery actions, such as the drawdown of all four Snake River reservoirs to near-natural river conditions, would have no immediate benefits, because implementing such a scenario would take too long. For these reasons, the Recovery Team recommended improved collection and transport as the most timely and flexible alternative that is near equal, biologically, to the expected benefits of a four-pool drawdown to near-natural river conditions. The Recovery Team considers the new upstream collector as a long-term action that would not be fully operational until the year 2006, following a design phase based upon adequate testing of modifications for fish behavior and passage efficiency components.

b. Upstream Collection Facilities and Barge Transport.

A low velocity guidance/collection facility located near the top of the Lower Granite reservoir for the collection, tagging, and subsequent transport of migrating smolts to the lower Columbia River has several potential advantages. These advantages include: 1) the collection of many smolts that get disoriented and delayed in the Lower Granite reservoir before reaching the dam, due to inadequate migrational cues; 2) the removal of smolts from less than optimal reservoir conditions, where predator activity is assumed to be substantial; and 3) a reduced need for flow augmentation, which continues to be a real concern with the region's unproven, although coordinated ability to store enough water volume and then efficiently shape and pass that volume for any measurable benefit to downstream migration.

A low velocity designed upstream collector would address the concern posed by many biologists in the region that turbine intakes at the dams offer inhospitable environments for the collection and bypassing of juvenile salmonids. Hydroacoustics have shown that the migrational distribution of the smolt population through a reservoir is vertically oriented within the upper 20 feet of water. Smolts are forced down vertically, by flow conditions, 80 (McNary Dam) to 100 (Snake River dams) feet deep into a turbine bay, where they are intercepted by a screen. Many parties favor alternatives tot he total reliance on the current turbine intake collectors for biological and stress-related reasons. A surface-oriented collector, located upstream in the Lower Granite reservoir, that could be designed specifically for salmonid smolt collection without any powerhouse constraints imposed upon the design could be such a beneficial alternative, as long as the biological needs of the respective listed salmonid stocks are fully incorporated into the collector design and evaluation.

A low or high velocity guidance/collection facility located near the top of the Lower Granite reservoir also has several potential negative attributes, and relies upon certain assumptions that need to be clarified by additional research. An upstream collector is viewed as beneficial, based upon the assumption that reservoir mortality due to predator activity is high and in-river passage conditions in relation to flow are poor or suboptimal at best. Feasibility work performed by NMFS on reach survival of spring Chinook salmon in the Lower Granite reservoir in 1993 provides limited data which indicates that reservoir mortality could be dramatically lower than previously estimated. If continued work planned for future years can be performed across a representative set of low and high flow year conditions, and the results can be developed into a similar low reservoir mortality trend with some degree of confidence, the potential system survival benefits estimated for the upstream collector concept would be diminished. In that event, resources could have been better spent on other proposed alternatives (*e.g.*, surface-oriented collector constructed in unison with the current submerged screen collectors used at the Snake River dams).

Critical research and site monitoring would have to determine the most appropriate location for constructing an upstream collector facility. The entire mainstem passage corridor is designated by NMFS as critical habitat for spring/summer and fall Chinook salmon. High velocity sites positioned outside of the Lower Granite reservoir would be too complex and costly ecologically to salmon and native anadromous species. Low velocity sites would be less costly, both ecologically and biologically. The demonstration site at Silcott Island is a good location selection for engineering purposes, but not for biological reasons. The need for extensive dredging would convert limited fall Chinook salmon shallow water rearing habitat to deep water habitat not directly used by any fish species under minimum operating pool or full pool operations; result in poor water quality conditions attributable to increased and/or prolonged suspended sediment resuspension; and may partially block the spawning access of gravid steelhead to historical Alpowa Creek redd habitat. All potential sites possess similar ecological and population effect tradeoffs, suggesting that site selection would be difficult. A general rule, determined by analytical modeling of salmonid survival through the hydrosystem, suggests that the closer a collector is constructed to Lower Granite Dam, the less the resultant benefit, as computed by transport survival and TBR estimates.

If the upstream collector could be operated for fall Chinook salmon, as presently assumed by the Recovery Team and others, the structure may act efficiently in removing very young subyearlings that are not physiologically ready to migrate, and require a period of time within the Lower Granite reservoir for rearing (Bennett *et al.*, 1993; and Curet, 1993). The analytical models currently used cannot adequately capture such an effect attributable to the uncertainties associated with subyearling behavior and physical/physiological conditions outside of assumed relationships for direct passage parameters. In order to optimize conditions for Snake River fall Chinook salmon, the collector systems at Lower Granite and Little Goose Dams would need to be fully operational at the time of initiation for subyearling outmigration and adequate in-river passage conditions through the Lower Granite and Little Goose reservoirs would need to be determined and maintained.

The Recovery Team requested that the regional modelers explore a scenario incorporating an upstream collector constructed at the top of the Lower Granite reservoir. The Recovery Team requested that the upstream collector be assumed to operate at a fish guidance efficiency (FGE) of 95 percent for all stocks of Snake River salmonids, and that all fish collected be transported to the lower Columbia River under a high TBR (at least equal to the average estimated by NMFS for the McNary studies for fall Chinook salmon and the Lower Granite/Little Goose studies for spring Chinook salmon) with no collected fish returned back to the river. Given the uncertainty in the actual ability to efficiently collect 95 percent of the entire Snake River outmigration, the resulting system survival would depend almost entirely on the assumed transport survival. However, the 95-percent collection efficiency specified by the Recovery Team is higher than that estimated, based upon research, for any existing system. Estimates of FGE for Chinook passing existing dams range from 20 to 47 percent for fall Chinook salmon, and 37 to 72 percent for spring Chinook salmon. Because of the assumed high FGE for the upstream collector, it was assumed that no transportation would be needed at the collector dams currently in place on the Snake River. McNary would continue to transport. The modelers cautioned that there is no direct information on the benefits of transporting fall Chinook from the Snake River, and assumed that benefits are derived from studies conducted at McNary Dam from the population at large. This population disproportionately consists of Columbia River fall Chinook salmon, with few Snake River fall Chinook salmon believed to be mixed within the population. The TBR's from the McNary studies suggest that, on the average, transport results in at least 140 percent more adults returning then the numbers of fish left to migrate in-river as juveniles. Because of the lack of transport studies for Snake River fall Chinook salmon from Lower Granite or Little Goose Dams, the uncertainties associated with the effectiveness of transportation are far greater for fall Chinook salmon than for spring Chinook salmon at Little Goose for 1986 and 1989 (Matthews *et al.*, 1991). This results in assuming a proportionally higher transport benefit assigned to the new upstream collector if it is located at the top of the Lower Granite reservoir. This is likely true for spring Chinook salmon but, for Snake River fall Chinook salmon, an alternative interpretation could be equally likely: increased straying, disease, or other compensatory fish viability problems could result in a lower transport benefit estimate attributable to the selected site and its geographical distance from the release point. The estimated bypass mortalities used for the current bypass structures at the current Snake River collector dams were assumed to be equal for the new collector structure. No effects or impacts attributable to the actual construction of the structure were accounted for or estimated. Construction impacts, including their modification of the flow patterning, could be substantial if not adequately managed with biological criteria.

Modeling for the Recovery Team was accomplished by the three dominant modeling parties within the region using the juvenile mainstem passage models only. A full effects analysis would require revised passage model survival estimates incorporated into the respective life-cycle models, since a full evaluation of an upstream collector is dependent on the assumptions for transport survival and TBR's. The juvenile mainstem passage models used within the region [Columbia River Salmon Passage (CRiSP) 1.4, Passage Analysis Model (PAM), and Fish Leaving Under Several Hypothesis (FLUSH)] are all highly sensitive to the transportation survival parameter values. Assumptions about the effectiveness of transportation (TBR's) are incorporated into their simulations that estimate juvenile system survival for the respective Snake River salmonid stocks migrating from the top of the Lower Granite reservoir to below Bonneville Dam. Transport survival is generally estimated, based on modeled in-river survival and an assumed post-release mortality factored in, using return ratios of transported and control groups of juvenile salmonids. Considerable uncertainty has led to disagreement regarding the effectiveness of transportation, particularly for returning wild adult Chinook salmon. Uncertainty about transportation effectiveness is typically addressed by using alternate transport submodels that reflect different data interpretations, and assumptions forwarded by the respective modeling parties. Although some model structure, data interpretation, and assumption derivation differ between the model groups, the ranking of alternatives between respective alternatives and the associated uncertainties related to the accuracy of assumptions are similar when the parameter inputs and assumptions for transportation are standardized between models for sensitivity comparisons (Cullinan, 1993; and NMFS Recovery Team, 1993).

System survival estimates for the state and tribal fishery agencies' FallFLUSH sensitivity analysis increased over the base case by 445 to 549 percent for low flow years modeled, depending on the transport survival assumption. System survival estimates for the state and tribal fishery agencies' SpringFLUSH increased over the base case by 130 to 132 percent for low flow years, whereas the Northwest Power Planning Council's (NPPC) PAM results in about half of the estimated increases of 61.2 to 62.8 percent for low flows when compared to SpringFLUSH. Because the modeled transport benefit is assumed by FLUSH to decrease at high flows for both Chinook stocks, the benefit of an upstream collector decreases at higher flows but remains greater than that of the current condition (1992 to 1993) base case to which it was compared. The SpringFLUSH shows improvements in survival of 11.1 to 44.7 percent above the base case during high flow years, whereas PAM indicates that a -9.4-percent decrease from the base case condition occurs when transportation is assumed to be less effective (*e.g.*, transport survival of transport survival of transported fish declines with declining flow volumes for a specific year).

The CRiSP 1.4 model results for the Recovery Team's requested assumptions for a new upstream collector located in the Lower Granite reservoir indicate that such a structure with 95-percent FGE resulted in the highest benefit to juvenile fall Chinook salmon survival. The estimated benefit to spring Chinook salmon was positive, but not as great as with a major drawdown to river level. Drawdown to a near-natural river level with no transportation gave the highest survival for spring Chinook salmon, but lowered fall Chinook salmon survival compared to current (1992 to 1993) operations. These results contain considerable uncertainties. Differences in model assumptions and choices of parameters may alter the outcomes and the identification of the best conditions. As previously addressed, a high degree of uncertainty is evident for fall Chinook salmon in these model runs, principally because the outcome is dependent on release date for the subyearling population distribution (which defines fish age and physiological readiness to migrate). The outcome is independent of the subyearlings physiological or behavioral need to rear in shallow water habitat located downstream of the collector in the Lower Granite reservoir. Conclusions on the upstream collector concept are based upon there being no adverse effects greater than those effects caused by current collection and bypass systems in place at Snake River dams. An upstream collector located near Lewiston, Idaho, in the Lower Granite reservoir, yielded estimated juvenile survival benefits (increases) or 19 percent for high flow years to 31 percent for low flow years for spring Chinook salmon; and increased benefits of 78 percent for high flow years to 181 percent for low flow years for fall Chinook salmon from the top of the Lower Granite reservoir to the Columbia River estuary.

A subsequent sensitivity analysis was performed for the single and dual upstream collector options, using the CRiSP 1.4 juvenile mainstem passage model with incorporation of the parameter value estimates and assumptions consistent with the System Operation Review. Probable FGE ranges and bypass mortality estimates were assumed to gauge the estimated system survivals against the base case, using 1991 to 1992 hydrosystem operations and the current transport system. It was determined that an upstream collector near the top of the Lower Granite reservoir would need to achieve an FGE equal to or above 75 percent, while maintaining an estimated 2-percent direct bypass mortality for spring Chinook salmon, to surpass the survival provided by the base case operation. Survival estimates for the dual collector are similar when like parameter values and assumptions are used (FGE estimates and 2-percent bypass mortality). The conveyance system needed for the dual collectors for transporting fish at least down to the current Lower Granite transport facilities would realistically contribute a higher mortality factor associated with stress. This additional mortality would likely be indirectly applied, and is only conjectural at this point in time. However, it was assumed to be 20 percent for defining some bounds for modeling purposes. It is evident that any additional mortality attributed indirectly to stress or directly, through contact with conveyance materials, would be accounted for in the juvenile system survival estimate. This sensitivity analysis suggests that, if the upstream collector concept is to be advanced, adequate research through prototype modeling in in-river conditions should be performed to determine that an FGE of 75 percent and bypass mortalities of less than 5 percent can initially be achieved before such a collector can be implemented for fish passage.

c. Upstream Collection Facilities and Migratory Canal, Pipeline, or Floating Conduit.

The analytical models used within the region for juvenile maintstem passage and life cycle of Snake River salmonids are not currently designed to incorporate any conveyance system other than transportation. Therefore, any modeling attempt would be totally speculative since those same assumptions made for model parameters would be reflected in the evaluation with or without the models. These conveyance options have received various critical reviews by regional technical groups such as the TAG. The TAG expressed a considerable amount of concerns with reliance on such untested artificial conveyance system designs. Primary concerns that are common to all of the currently proposed options are both biological and ecological. They include the following:

- The human ability to artificially replicate natural ecological processes and biological conditions that are functionally interacting to the degree exhibited naturally (*i.e.*, resting ponds/areas, and temperature and flow regulation). Not enough information is currently available to determine the general needs of salmonids and their interactions with such parameters in the natural system, so it cannot be acceptable to attempt to define the precise attributes of such parameters in a manner resolute enough to allow artificial replication.

- The mechanical complexity of each proposed apparatus, and their synchronized operation, would require constant maintenance.

- In the low probability event that a means can be devised to artificially replicate the natural passage system into a piping or canal system, the need for adequate safe and efficient passage within the river system would not diminish or be considered mutually exclusive in any manner. It is not proposed to provide artificial passage for adult salmonids returning from the ocean and transiting upstream to their natal spawning areas. Therefore, adults would need good river conditions for their passage. Good in-river passage conditions would also have to be maintained as a backup passage system for smolts, in the event of a system failure in the canal or pipeline systems.

- Each option would require either some mechanical means of lifting the fish into the channel, or a pumping/fanning system to move the fish. All known lifting and pumping systems have some mortality associated with their operation due to physical damage to fish tissue from impingement, blade strikes, pressure changes, rubbing, or a combination of these potential factors.

- Exclusive increased concentration of salmonid smolts through a closed system would act to separate smolts from their natural food sources and diversity in their food items. The hatchery component of the outmigration could potentially be maintained on supplemental food, but the wild fish component would be suppressed in growth and fitness at a greater level.

- Increased concentrations of salmonid smolts would be highly vulnerable to inescapable stress-related factors such as disease outbreaks and manifestations, predator invasion (including predation by larger steelhead smolts), increased inter- and intraspecies competition, and mechanical failure or accidents that would act as catastrophic events and potentially be detrimental to small population genetic fitness and viability.

- The water supply required to operate the canal or pipeline system optimally would have to be partitioned from the mainstem river or an upstream source (*e.g.*, the Dworshak reservoir). This option would diminish the available flow required for adult salmonids migrating upstream, as well as for those native resident fish species considered to be flow dependent (*e.g.*, white sturgeon).

The conveyance options would allow for the operation of separate collection facilities located on the Snake and Clearwater Rivers upstream of the Lower Granite reservoir. Benefits attributable to this dual collector scenario are hindered by their locations, because river conditions at sites outside of the Lower Granite reservoir do not currently allow for barge access. They must rely upon either canal, pipeline, or tunnel conveyance systems that would likely contribute to negative effects on salmonid survival and viability, as listed above. The dual collector scenario would have to employ one of the designs for a high velocity collector requiring the construction of new dams for flow/velocity control. New dams, even if designed especially for salmonid passage, would not be biologically, ecologically, or regionally acceptable as a means of providing improved passage conditions for weak salmonid stocks, based upon past technologies and system operations. Modified flow characteristics that reduce water velocity would likely create additional predator habitat conditions, particularly for native squawfish that are evolutionarily adapted to higher velocity conditions that were more prevalent during the historic natural river. This would act as an additive cumulative effect on top of the assumed predator impacts occurring throughout the mainstem system.

The free-flow reaches of the Snake River above the Lower Granite reservoir are currently suitable spawning and rearing habitat for fall Chinook salmon and white sturgeon, while the soft substrate habitats are used by lamprey. White sturgeon typically do not pass the current Snake River dams by disproportional use of the adult salmonid ladders. Rather, they prefer the navigation lock systems. This behavior has resulted in the fragmentation of their historical distribution and movements. Adult lamprey will pass the dams via an adult salmonid ladder system, but typically use the navigation locks as well, because of their partial dependence on their host's preferred route of passage. Building a fixed dam-like structure with no open, flow-through sections would have negative effects on fall Chinook salmon and white sturgeon production through increased delay and spawning and rearing habitat removal in an area of the mainstem system that is already considered a last refuge area for these populations. High velocity designs also accentuate the problem, often encountered at dams, of debris accumulation and removal. The best way to trap debris, in accordance with current technologies, would be through the consistent use of a boom-and-trash-rack system located far upstream of the collector. Such a structure would act as an added barrier to both juvenile and adult migrating salmonids. These potential problems would occur for any upstream collector option, but the magnitude of the potential effect would be commensurate with the local conditions of the site selected. Floating collector designs would offer the most biologically- and ecologically-compatible option, in that the structure could be flexible to inter- and intra-annual river conditions by the design of a transportable screening apparatus that can be moved to more optimal locations. The bottom should remain open below a depth of 35 to 40 feet to allow unrestricted passage for white sturgeon and adult salmonids, while not retarding sediment distribution and directly removing habitat suitable for fall Chinook salmon spawning and rearing.

7.02. RESIDENT FISH.

One concern of the upstream collection system is that operational conditions designed for the collection of juvenile salmonids may adversely impact populations of resident fish. Existing data from the Lower Granite Sedimentation Study, and other research efforts on resident fish in the Lower Granite reservoir, are being analyzed to evaluate the potential impacts to such a system. The assessment will emphasize life-stage timing and distribution of important resident fish versus operational aspects of the facility. Life stages considered will include adult spawning, juvenile rearing, and migration. Distribution of important species during different life stages is important because many resident fish migrate throughout the reservoir, or move back-and-fort from the reservoir to the free-flowing sections of the lower Snake River. Potential impacts of the screening system on resident fish include: 1) fish impingement on the screens; 2) mortality during the collection and transport of salmonids; and 3) delays and/or barriers to fish movement.

7.03. TERRESTRIAL ECOLOGY.

a. General.

The most obvious, and among the most important, effects of the migratory canal alternatives is the potential damage to various wildlife species and associated habitat along the route of the canal. The barge alternative would be unlikely to impact wildlife habitat. Damage from construction of the canal alternatives could come from a variety of project-related mortality factors (poaching, drowning, blasts, *etc.*), soil erosion and associated habitat reduction, direct habitat destruction, primary and cumulative interruption of migratory pathways, and invasion of competing species and/or disease. Other particularly important areas of concern include damage to wetlands, water quality, and aesthetics.

b. Wildlife and Habitat.

The migratory canal alternative would replace existing natural habitat with manmade structures, could constitute a trapping hazard to some wildlife populations, and would impose a migratory barrier. Staging areas and borrow pits would also result in the direct destruction of habitat. Several aspects of the canal alternative raise migratory concerns. The canal project may cause a new barrier where there is none, and it may have a cumulative effect where there is already one or more impediments (road and/or railroad). Effects may differ according to the time of day and season. Even where the canal does not constitute an impassable barrier, it may have a directing or channeling effect that may make some species more vulnerable to predation.

New habitat will be created that will be suitable in some cases for a new mix or emphasis of species, particularly small animals and birds. For example, sparrows, swallows, and starlings may be attracted to the elevated portions of the channel. Leakage and the resting ponds will provide new riparian vegetation. This latter aspect is one that, with good planning and direction, could be a desirable spin-off of this project. Diversity of habitat can probably be increased, but detailed and specialized study and designs will be requisite. Construction staging areas, roads, and borrow pits will destroy soils as well as vegetation and habitat. Restoration will require the replacement of topsoil prior to planting. Finally, the canal will spilt existing habitats into smaller units.

c. Endangered Species.

There are several bald eagle and peregrine falcon nests along the route of the channel proposed for the migratory canal alternatives (*e.g.*, in the cliffs directly above the Columbia River just east of Rufus, Oregon). There is no immediate evidence that any species of concern would be adversely impacted, but biological consultations and assessments pursuant to the Endangered Species Act would be required.

d. Wetlands.

There are likely adverse wetland/riparian impacts associated with the canal alternatives, because the alignment will cross wetland areas within the Columbia River floodplain and will also likely cross numerous small and not-so-small tributaries (with their associated wetland/riparian areas) to the Columbia. Primary, secondary, and cumulative impacts are likely to be substantial, given the length of the project. Many of these wetlands are situated in a critical part of the landscape (these wetlands (adjacent to the river, are interactive with the hydrologic regime of the Columbia and Snake Rivers, and are sites for wildlife breeding and fish protection, as well as nutrient cycling). Also, hydrologic regimes in the arid part of the project, that are fragile, will be at risk.

e. Invasive Vegetation.

The migratory canal will provide a transportation corridor for invasive plant species (*i.e.*, purple loosestrife, Russian olive, and yellow flag). A vigorous invasive-species monitoring and corrective-action program should be incorporated into the proposed project.

7.04. CULTURAL RESOURCES.

All construction activity for fish collection facilities, barge loading facilities, elevated flumes, excavated canals, and fish resting ponds have the potential to affect significant prehistoric cultural resource sites or historic properties related to early Euroamerican exploration and settlement. Most sites that would be impacted are not now known because the fish migratory canal alignment lies predominantly outside existing pool areas that have been covered by prior cultural resource inventory studies. Whereas the total inventory of sites is estimated to be substantially fewer than recorded for the floodplain bars, some kinds of sites (especially burials) are highly sensitive to regional Native American groups, and are estimated to be common for this project. A Programmatic Agreement for cultural resources would have to include several complex and costly elements; such as a methodology for complete archaeological and historic survey of the project area, evaluation of identified finds based on their potential eligibility for the National Register of Historic Places, appropriate mitigation for unavoidable adverse impacts, and the curatorial disposition and location for all finds made. The high potential for disclosing still more unmarked ancestral graves of local Native American groups also dictates a prearranged plan of action for these finds that has been coordinated with the tribes. Since the extent and kinds of mitigation for cultural resources are the result of a consultative process (36 Code of Federal Regulations, Part 800), and lacking specific information regarding the numbers, types, and locations of affected cultural resource sites, it is not appropriate to attempt to address potential project effects on cultural resources until inventory surveys and site evaluations have been completed.

7.05. OTHER.

a. General.

The collector is a necessary feature of the migratory canal if increased transportation is desired. However, the upstream collector facilities and migratory canal alternatives present many unproven technological ideas. While current approach-velocity criteria were used in the initial design, these criteria were established from much smaller screening devices (2000 cfs maximum), with short exposure times for fish. Given the estimated screen length, current approach-velocity criteria may be unsuitable.

Debris and sediment would be major problems with a facility of this size. Existing screening systems passing a few thousand cfs in protected situations have severe debris problems. Even with the upstream removal of large debris, smaller debris would concentrate in the collector/separator due to the 0.125-inch wedgewire mesh. This debris accumulation would be channeled into the collection facilities, resulting in probable fish-handling stress and survival concerns. Current fish separator technology may be unusable under these kinds of debris loads. There is evidence of these problems at some existing fish separators during high debris-load periods.

Sediment in the vicinity of the proposed facility site could be a major problem during periods of higher flows. Current information from the recent reservoir drawdown test shows areas of sediment deposit and sediment erosion near the site. The alterations of flow patterns at the facility would probably cause sediment deposition.

The ability to maintain desired water velocities through the screen with changes in river flow, wind/wave action, and debris-sediment load are major concerns with this significant extrapolation of current technology. The flow conditions and patterns created upstream of this facility would also be favorable for concentrating predators.

If the upstream collector is to be considered further, design concepts addressing these concerns would need to be developed. Existing technology might be considered (*e.g.*, the dam configuration at the Wells project, which collects a high percentage of outmigrants and a relatively small percentage of river flow).

An upstream collection facility would be a barrier to the upstream movement of resident fish (white sturgeon, in particular) that move up the Snake River from the Lower Granite reservoir to spawn. Downstream movement of fish entering the reservoir for rearing would also be affected, although resident fish could presumably be sorted and returned to the river.

The dredging required for the bypass channel at the Silcott Island site would convert shallow water to deep-water habitat. The side channel at Silcott Island is presently a productive rearing and spawning habitat for resident fish. Dredging would eliminate these values. Major dredging would not be required at the sites on the Clearwater River and the Snake River above the confluence.

The side channel at Silcott Island is currently excellent habitat for aquatic furbearers, waterfowl, and wading birds, because shallow-water emergent wetland and riparian habitats are present, and because of the proximity of the site to the Chief Timothy Habitat Management Unit. Shallow water and emergent wetlands would be lost if the side channel was dredged, with a concurrent loss of wildlife value. Also, disturbance from human activity at the site would likely increase, further reducing wildlife value. Losses of wildlife habitat at the other proposed sites, beyond losses directly resulting from facility construction, are likely to be minimal. These facilities may also block furbearer movement, particularly river otter, in the river. The concentration of fish at these facilities may also attract river otters, which may then have to be trapped to reduce predation.

b. Water Quality.

Decreased dissolved oxygen levels, nitrogenous waste buildup to toxic levels, and waterborne pathogens are potential impacts that will need to be evaluated and controlled for all of the alternatives. However, it may be less difficult to control these factors with the barge alternative, as compared with the canal alternatives. Turbidity, elevated temperatures, and potential algae buildup are other areas of concern. Chemicals that will be used to maintain this artificial environment must be closely examined from a synergistic standpoint, as well as from the standpoint that certain chemicals can suppress the immune systems of juvenile salmon and interfere with smoltification. Applicable laws, depending on which chemicals would be needed for maintenance, would be the Federal Insecticide, Fungicide, and Rodenticide Act and the Toxic Substances Act. There is also potential for water-quality degradation from fuel and oil spills caused by construction equipment, as well as in storage areas.

c. Construction Impacts.

Temporary impacts will be felt by the local communities, as well as by the environment, during construction of this project. Construction will result in the relocation of some underground utilities (*i.e.*, water and sewer lines, telephone and power cables, and natural gas lines). The relocation of these facilities could result in the temporary interruption of service. Construction of the open channel and the cut-and-cover channel will result in highway, road, and rail traffic detours during a 1- to 2-week construction period. Much of the construction of the open channel and cut-and-cover channel will be performed along, or near, the banks of the Columbia and Snake Rivers. Some minor degradation of water quality in the rivers could occur from construction site water runoff. Construction work will result in temporary air and noise pollution. An increase in construction-related traffic could result in traffic delays, especially in urban areas around the project. In the McNary Dam area, the fish canal passes across irrigation canals. There is a possibility of damage to the irrigation canals during construction. Construction in the Columbia Gorge area of the Columbia River is controlled and regulated by the Columbia Gorge Commission. The route of this alternative will pass through the Commission's jurisdiction and, as such, construction of this alternative through the area will require approval from them.

d. Superfund and Contaminants Problems.

Most of the contamination that occurs in the project area is likely to occur in the floodplains adjacent to the river (where most of the industrial activity exists). Construction of the migratory canal alternatives may aggravate these problems. An example of this is where the canal alignment traversing The Dalles area comes close to one Superfund site (Martin-Marietta). The floodplain here also contains a creosote plant with an associated contaminated aquifer.

e. Regulatory/Permit Process.

All Clean Water Act permitting questions should be explored thoroughly. Section 402 National Pollutant Discharge Elimination System permits may be required for areas that connect with the Columbia River. It is likely that a concrete canal will be considered a discharge conduit, so a permit may be necessary (in Idaho, permits for EPA; in Washington and Oregon, permits for the state). Section 404 permits will be necessary for construction in wetlands, streams, tributaries, intermittent streams, and any other waters of the United States. The project is also likely to be subject to permit requirements under Section 10 of the River and Harbors Act.

f. Aesthetics.

The migratory canal alternatives have the potential to be primarily and cumulatively what many could consider to be a visual degradation of the landscape.

g. Erosion/Sedimentation.

Construction activities could increase soil erosion and reservoir sedimentation.

h. Capital/Resources/Labor.

The project will require a large investment of capital and labor, as well as the use of irreplaceable petroleum-based fuel and other materials.

7.06. GENERAL DISCUSSIONS AND FUTURE COORDINATION.

The various low and high velocity concept designs presented in this study have different advantages and disadvantages related to biological and engineering research needs, design, construction, and operational effectiveness. A complete list of pros and cons related to the different concepts will be developed during coordination efforts with various groups and agencies involved in evaluating the different options. Variations of these concepts, as well as completely new designs, may emerge as a result of these discussions.

A determination of the upstream collection system concepts that will be carried into future studies will not be made until completion of the Phase I study.

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SECTION 8 - ECONOMIC EFFECTS

8.01. GENERAL.

The Federal objective of water and related land resource project planning is to maximize contributions to national economic development (NED) consistent with protecting the nation's environment; pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements [Water Resource Planning Act of 1965 (Public Law 89-80)], as amended (42 United States Code 1962a-2 and d-1). Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area, as well as in the rest of the nation. Contributions to NED include increases in the net value of those goods and services that are marketed, and also of those goods and services that may not be marketed. The strict use of NED analysis is not considered appropriate when dealing with an endangered or threatened species. Any attempt to assign a monetary value to an endangered or threatened species, given current techniques, would not account for its full existence value to society (Gary A. Ellis, 1994).

It is very difficult, if not impossible, to evaluate the value of a species unit (whatever it may be), in terms of dollars, when that commodity does not have a measurable standard of economic value as do most goods and services produced in the economic cycle. For this reason, as well as for the purpose of surveillance of this technical appendix, no attempt will be made to apply a dollar value to the benefit stream of perpetuating a species.

In terms of upstream collection and conveyance alternatives, there are no major economic impacts caused by the direct effects of modifying existing facilities with regard to of alternative opportunities foregone in terms of power, transportation, irrigation, and recreation economics. Therefore, total direct economic costs of this alternative are equal to the cost of implementing the actions within the respective implementation schedules.

Implementation costs include real estate, contingency costs, construction costs, professional engineering and design costs (PED), construction management costs, and interest during construction costs (IDC); collectively representing total investment costs. The total investment cost will be amortized using the current Federal discount rate of 8 percent (as of 1 October 1993) over the estimated project life. For comparative purposes, annualized operation, maintenance, and replacement costs will be added to the annualized investment costs to arrive at an annual total cost for each alternative. The implementation costs for the alternatives under consideration are summarized in the following tables.

COST CONFIGURATION INTEREST RATE 8.00 PERCENT AMORTIZATION PERIOD/INVESTMENT COSTS/100 YEARS	
ALTERNATIVE 1--SINGLE PRIMARY FISH COLLECTION SYSTEM/MIGRATORY CANAL	
INVESTMENT COSTS:	
Construction (including RE)	$3,900,563,000
PED	275,000,000
Construction Management	144,900,000
Total Project Costs	4,320,463,000
IDC (factor = .21*tpc, 11.5/2 yrs, 8 percent	907,297,230
Total Investment Costs	**$5,227,760,230**
ANNUAL COSTS:	
Interest and Amortization (investment costs)	$418,411,026
Operation and Maintenance Costs	9,500,000
Total Annual Costs	**$427,911,026**

COST CONFIGURATION INTEREST RATE 8.00 PERCENT AMORTIZATION PERIOD/INVESTMENT COSTS/100 YEARS	
ALTERNATIVE 2--SINGLE PRIMARY FISH COLLECTION SYSTEM/PRESSURE PIPELINE	
INVESTMENT COSTS:	
Construction (including RE)	$3,681,033,000
PED	238,750,000
Construction Management	125,350,000
Total Project Costs	4,045,133,000
IDC (factor = .21*tpc, 11.5/2 yrs, 8 percent	849,477,930
Total Investment Costs	**$4,894,610,930**
ANNUAL COSTS:	
Interest and Amortization (investment costs)	$319,746,961
Operation and Maintenance Costs	9,500,000
Total Annual Costs	**$401,246,961**
ALTERNATIVE 3--SINGLE PRIMARY FISH COLLECTION SYSTEM/TRANSPORTATION	
INVESTMENT COSTS:	
Construction (including RE)	$293,604,319
PED	45,000,000
Construction Management	24,150,000
Total Project Costs	362,754,319
IDC (factor = .21*tpc, 11.5/2 yrs, 8 percent	45,899,304
Total Investment Costs	**$408,653,623**
ANNUAL COSTS:	
Interest and Amortization (investment costs)	$32,707,158
Operation and Maintenance Costs	5,100,000
Total Annual Costs	**$37,807,158**

COST CONFIGURATION INTEREST RATE 8.00 PERCENT AMORTIZATION PERIOD/INVESTMENT COSTS/100 YEARS	
ALTERNATIVE 4--SINGLE PRIMARY FISH COLLECTION SYSTEM/FLOATING PIPELINE	
INVESTMENT COSTS:	
Construction (including RE)	$ 754,113,000
PED	66,250,000
Construction Management	35,650,000
Total Project Costs	856,013,000
IDC (factor = .21*tpc, 11.5/2 yrs, 8 percent	179,762,730
Total Investment Costs	**$1,035,775,730**
ANNUAL COSTS:	
Interest and Amortization (investment costs)	$ 82,899,744
Operation and Maintenance Costs	31,800,000
Total Annual Costs	**$114,699,744**

8.02. NAVIGATION.

The general assumption is that the main fish collection facility would be constructed at Silcott, Washington (river mile 131 on the Snake River), and would consist of a navigation lock and fish screens. For the barge transport alternative, a large barge loading facility would also be constructed at the collector structure. In 1990, there were approximately 5,000 upbound and 5,000 downbound commercial vessel trips on the Snake River. It is expected that during construction, navigation will be not be impacted. However, after construction, each tug and tow traveling through the Silcott area will have to navigate through these new locks. This is expected to add an extra 10 minutes of travel time in each direction, and this will result in additional transportation costs. In addition, the added traffic of the new fish transport barges may impact travel time as well.

8.03. RECREATION.

For the canal alternatives, a cut-and-cover channel will bisect the Hat Rock State Campground, the Corps campgrounds, and the boat ramps. This will reduce the available use of these facilities for 1 to 2 weeks during construction.

8.04. SOCIOECONOMIC EFFECTS.

a. Community Impacts.

Impacts to communities can occur when large numbers (compared to the area population) of construction workers and their families relocate to construction area communities, and these communities have an insufficient community services capacity to support the quick and temporary increase in population. Tunneling crews, numbering about 8 to 12 workers per site, would live in trailers at the worksites. Workers constructing the open channel and cut-and-cover channel along the river would live in trailers on barges that will be moved to each worksite. Crews working away from the river would live in moveable trailers at the work site. Impacts to local communities, as a result of demands placed on community services from these workers, is expected to be minimal.

The single upstream fish collection facility at Silcott, Washington is 8 to 10 miles from Clarkston, Washington, and Lewiston, Idaho. Clarkston and Lewiston have populations of about 6,800 and 28,100, respectively. A maximum of 45 to 55 construction workers would be working at this site at any given time. The other two fish collection facilities are located upstream, and are smaller in size. One facility is located on the Snake River (river mile 149), and the other is located on the Clearwater River (river mile 6). Both facilities are 5 to 8 miles from Clarkston and Lewiston. Due to the size of these cities and proximity to the worksites, most workers would be expected to reside in one of these communities. Depending on the number of workers and younger family members residing at any one time in these communities, there could be a strain on the local schools. Impacts on other city services would probably be minimal.

b. Native American Concerns.

The migratory canal alternatives show the canal alignment passing through lands ceded to several treaty tribes in Oregon, Washington, and Idaho. These include the Native American peoples of the contemporary Nez Perce, Umatilla, Yakima, and Warm Springs reservations. Treaty rights concerning access to usual and accustomed treaty fishing sites (or the "in lieu" fishing sites) could become a major issue if the project limits or precludes future access to treaty fishing sites. Other concerns include a potential for the disturbance of ancestral graves located along the project alignment. Unresolvable concerns, with regard to lands access, could result in the realignment of the canal. Consultation needs to be carried out with each affected tribal government early in the planning process.

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SECTION 9 - MITIGATION OPPORTUNITIES

9.01. ANADROMOUS FISH.

Mitigation for adverse effects on anadromous fish, other than salmonids, would be limited to the specific problem areas. The construction of a new collection screen structure in the Lower Granite reservoir may create a migration obstruction for anadromous fish. Adult salmonid fish ladders would be constructed to allow anadromous fish of all species to migrate upstream beyond the collector screen. Downstream migrant juvenile salmonids, and all other migrant fish, would be collected on the screen structure. Sorting facilities would separate non-salmonid anadromous fish, and bypass them back into the river immediately downstream of the collector structure.

Similar facilities would be constructed for the dual upstream collectors on the Snake and Clearwater Rivers. Upstream migrating anadromous fish would utilize the fish ladder to continue their migration. Downstream migrating anadromous fish would be collected on the screen structure, separated from salmonid species, and bypassed into the river immediately downstream of the structure.

9.02. RESIDENT FISH.

Resident fish would be affected by the construction of the collector structures. Some existing habitat would be lost to the collector screen and appurtenant structures. Additional habitat could be provided to mitigate for that lost by constructing side channels, additional rearing areas, *etc.*, along the reservoir (in proportion to that lost). The movement of resident fish upstream and downstream of the collector structure would be allowed through the fish ladder and the screen/separator facility.

9.03. TERRESTRIAL ECOLOGY.

a. General.

Mitigation, in the form of impact avoidance, minimization, rectification, reduction, and/or compensation, in accordance with the President's Council on Environmental Quality rules, would be a major feature and goal of project planning and design.

In addition to environmental challenges, there may be opportunities for enhancement in some environmental parameters, especially for the canal alternatives. Strategic, but limited, use of the water in the channel at various points may introduce or increase riparian-type habitat into arid or shrub steppe areas where there is little or none at present. The resting ponds offer enhancement possibilities, and there may be beneficial uses for excavated materials (*i.e.*, subimpoundments and terraces). Migratory routes for wildlife and access to water can probably be improved in some areas. Strategic environmental enhancement, thus, will also be a focus of later project development.

Mitigative planning, design, construction, and operation will need to be an integral part of any upstream collector or artificial transportation project to avoid, minimize, rectify, reduce, or compensate for adverse impacts. There may be opportunities for the enhancement of some environmental parameters. A number of basic approaches at each stage of project development will contribute to overall mitigative success. For example, during reconnaissance planning, a strong commitment to, and understanding of, mitigative policy will set the stage so that during feasibility planning the appropriate studies needed to understand potentially-impacted resources will be funded, scoped, and carried out in a timely and meaningful way. Design of the project will need to be innovative and responsive to planning findings. Environmentally-sensitive construction practices are requisite throughout. Monitoring and adjustment during the operation of the project will help assure the best possible results. Periodic assessments should be made to determine if the project is operating in compliance with Federal, state, and local regulations. The integration of environmental planning and engineering can be expected to add about 5 percent to the costs of each project stage.

b. Wildlife and Habitat.

Mitigative strategies focus on habitat damage avoidance, replacement/enhancement, and migratory assurance. There are a number of possibilities for consideration:

(1) Avoid splitting habitat areas into smaller units whenever possible. Route to the edge of large tracts, if feasible.

(2) Use strategic, controlled "leaks" to irrigate native (local) grasses, flowers, shrubs, and trees (particularly along the south side of the channel to create shade, edge, riparian habitat, and aesthetic values).

(3) After construction, replace topsoil on all roads, staging areas, and borrow sites prior to replanting with native vegetation.

(4) Use excess excavation material beneficially whenever and however possible (*e.g.*, construct migratory pathways and access to water where none currently exists). Use aggressive planning and designing to minimize borrow, by using cut material in fills to the maximum extent possible.

(5) Provide a careful design of elevated sections to facilitate both habitat and species diversity, as well as sheltered migratory routes. The elevated sections of the canal seem to offer some of the best opportunities for creative mitigation and enhancement.

(6) Use ramps and lids up to 200 feet long at strategic areas for wildlife migration. In some areas along the route, such structures may need to be placed at intervals of 1 mile or less.

c. <u>Wetlands</u>.

Mitigative approaches to wetland impacts might include the following considerations and measures:

(1) Avoid wetlands whenever and however possible.

(2) During design, wherever possible, incorporate "natural" river or stream system characteristics. If a more natural system were designed, there would be numerous opportunities for wetland and riparian creation and enhancement. Incorporating bioengineering techniques into the project may allow mitigation <u>with</u> the project.

(3) Use aquatic plants at resting ponds that provide both fish and wildlife habitat (polygonum, potomegeton, elodea, *etc.*). Use native trees and shrubs along the edges for wildlife habitat.

(4) Use excavated material to create vegetated ponds or subimpoundments at suitable areas along existing Snake and Columbia River reservoirs.

d. Invasive Vegetation.

A vigorous invasive species monitoring and corrective action program should be incorporated into the proposed project. The barge transport alternative should not require such measures.

9.04. CULTURAL RESOURCES.

The mitigation of cultural resources results from consultation with State Historic Preservation Offices and other interested parties, (*i.e.*, Native American tribes and the Advisory Council on Historic Preservation). Although the affected cultural resource sites are now unknown, it is likely that mitigation activities would include data recovery and the curation of recovered finds, site stabilization, documentation for affected historic structures, and the establishment of a monitoring program to evaluate the effects of vandalism or erosion during operations.

9.05. OTHER.

a. Water Quality.

Water quality would be monitored throughout the construction period, and any required corrective action would be taken, as appropriate. During the operation of the migratory canal alternative conveyance project, resting ponds would have to be well aerated to ensure proper oxygen balance. Enough flow exchange to keep nitrogenous waste buildup to a minimum would be required.

b. Aesthetics.

Mitigation for aesthetic concerns would be best approached during the design phase to ensure that the design is compatible with other qualities.

c. Erosion/Sedimentation.

Mitigation would include sensitive design and construction practices to limit the susceptibility of the construction site to erosion.

d. Air Quality/Noise.

Mitigation would include sensitive construction practices so that air quality would not be seriously compromised, and noise pollution would be kept to a minimum.

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SECTION 10 - CONCEPT DISCUSSIONS--UNCERTAINTIES AND POTENTIAL BIOLOGICAL AND ENGINEERING RESEARCH

10.01. GENERAL.

There are major questions and uncertainties associated with the different upstream collection and conveyance system concepts. Biological research and preliminary engineering studies will need to be completed prior to the construction of any of these systems in order to resolve any uncertainties.

The most significant challenge related to upstream collection and conveyance concepts will be satisfying biological objectives. This challenge also applies to drawdown and all options being considered in other studies. It is uncertain at this time what level of improvements might be expected in overall fish populations if any of these alternatives are actually constructed. Complicating this situation, as discussed in paragraph 2.01., Background Information, is that many of the juvenile fish migrating downstream from rivers and tributaries above Lewiston do not arrive at the upstream end of the Lower Granite reservoir. In addition to the effects dams have on fish, other factors related to hatcheries, reduction in habitat quantity and quality, fish harvest questions, and recent years of low flow also play a role in the continued decline.

This report, as discussed in paragraph 1.03., Scope, is a reconnaissance-level planning study of various upstream collection and conveyance alternatives under consideration. Because of the magnitude of the proposed measures, and the preliminary nature of these conceptual alternatives, there may be many ways to approach the various designs and associated problems. If these options were evaluated further and in more detail, considerable cost savings or significant functional improvements might be realized. Alternate designs should be considered in future studies.

All of the systems discussed in this study must be capable of collecting and conveying fish safely and acceptably downstream to Bonneville Dam. The results can only be judged successful when the number and health of returning spawning adults indicates a significant improvement over the present migration cycle. Ideally, the evaluation of these concepts would require the construction of at least one collection facility (full size, or possibly a scaled-down version), with test reaches of different types of conveyance systems. This construction would be followed by a test program lasting through at least one fish life cycle to fully evaluate the ultimate success of the various options. However, an extensive construction and evaluation program of this type would be very costly in terms of both money and time. Therefore, research during the feasibility phase would not include the evaluation of full-scale prototype collection and conveyance facilities due to prohibitive costs and time constraints. Instead, the feasibility phase would concentrate on smaller-scale hydraulic and biological modeling, as well as prototype designs and tests, to obtain data related to fish responses and facility concepts.

The option to return to the existing fish passage modes would be maintained in order to minimize the risk to the fishery should some component of an upstream collection and conveyance system fail. The present migration route through and around the dams would then be considered a backup system.

10.02. UNCERTAINTIES RELATED TO UPSTREAM COLLECTION SYSTEM COMPONENTS.

Major biological and engineering-related questions and uncertainties for the different upstream collection system concepts include the following:

a. Biological Questions.

(1) How far upstream of Lower Granite Dam could fish be collected before impacting the natural instincts (homing) of fish to return for spawning?

(2) What percentage of juvenile fish would be diverted (FGE) for partial barrier systems?

(3) What impact would another barrier system upstream of Lower Granite Dam have on adult fish passage?

(4) How would fish behaviorally respond to a large barrier system?

(5) What type of barrier would be most effective for an upstream collection system: physical (screens, louvers, *etc.*), behavioral (electrical, sonic, *etc.*), or a combination of physical and behavioral systems?

(6) Would predator fish habitat be substantially increased by the addition of a new barrier system?

(7) What impacts would extensive debris-handling requirements have on fish collection?

(8) What impacts would a large barrier system have on resident fish (particularly sturgeon)?

b. Engineering Questions.

(1) How would increased concentrations of floating debris (and possible sediment) be handled in both the main barrier and fish holding and loading facilities?

(2) What would be the best facility layouts, orientations, *etc.*, to optimize functional, operational, and cost considerations?

10.03. UNCERTAINTIES RELATED TO CONVEYANCE SYSTEM COMPONENTS.

a. Migratory Canal, Pressure Pipeline, and Floating Pipeline Systems.

Many major biological and engineering-related questions and concerns exist regarding the migratory canal, pressure pipeline, and floating conduit systems. Of primary importance to the migratory canal and pressure pipeline systems is the lift mechanism required to safely move fish from the collection and sorting facilities (at about the same elevation as the river) up to the elevation of the canal or pressure pipeline system (some 80 to 180 feet above). Important concerns regarding the safety and biological acceptability of the low-head pump system required for the flexible, thin membrane conduit must be addressed for the floating conduit system. As discussed in paragraph 5.01., Design Criteria, the design of all these concepts would require the establishment of criteria for many features that have not yet been implemented in any prototype. Major biological and engineering-related questions regarding individual features of these systems must also be answered. These issues would include the design of resting ponds, water exchange rates, flow conditions within the fish conveyance structures, temperature requirements, fish feeding requirements, emergency release from conveyance systems to the river, the interconnection of the fishway with existing projects, predation, and vandalism, as well many other questions.

b. Transport Options.

An assumption associated with a fish transport conveyance system is that transporting fish around the dams and reservoirs using barges and trucks is biologically acceptable. Although fish barging operations have been conducted since 1969, some groups are concerned that barging operations do not benefit the fish and may play a part in the continued decline of the fish runs. Since barging fish has been just one component of a total system (other components of the system include STS's, VBS's, gatewell orifices, transportation channels, *etc.*), it is difficult to determine what parts of the system are most detrimental to the fish. Also, as discussed in paragraph 2.01., Background Information, a relatively small portion of the Chinook juveniles released naturally or from hatcheries above the Lower Granite reservoir are actually transported to the ocean via existing barge operations. However, no evidence currently suggests that the actual transportation process harms the fish.

10.04. POTENTIAL BIOLOGICAL AND ENGINEERING RESEARCH.

Many features of the design of an upstream collection and conveyance system would be dependent upon the results of research efforts. Studies and projects that might be completed to answer questions related to different concept designs include the following:

a. Conducting a more extensive literature review of different types of fish barrier devices (screens, electrical, sonic, *etc.*) and fish conveyance systems.

b. Constructing only a portion of a full-sized, in-river floating barrier system; possibly a version of what is currently used for a fish trap in the vicinity of Lewiston (see enclosures 2-26 and 2-27), as well as a research vessel or shoreline-based research station (see enclosures 2-26 and 2-28). These facilities could be used for research related to the following:

(1) Measuring FGE for partial barrier systems;

(2) observing how fish behaviorally respond to a large barrier system;

(3) conducting a long-term transport research program to evaluate fish homing instincts;

(4) evaluating the effectiveness of different types of barriers (physical and behavioral); and

(5) testing a wide variety of designs related to both existing and new fish collection and conveyance-related features (*i.e.*, approach velocity criteria, debris collection/control, fish lift and lock facilities, sorting facilities, *etc.*).

c. Conducting both small- and large-scale hydraulic models or segments of prototype project features, in conjunction with fish behavior testing, to evaluate specific feature designs as well as general site considerations. These tests would be conducted at fishery and hydraulic laboratories. Tests might include the following:

(1) Building a large-scale or full-sized fish attraction chamber/separator system to develop and test new concepts, and improve debris handling as well as fish separation methods.

(2) Constructing sections of different types of barrier devices to be used in a large tank arrangement for monitoring fish behavior, as well as for evaluating debris-related considerations.

(3) Conducting miscellaneous other tests related to specific features of the project.

d. Building first a non-site specific general model and then, later, building a site-specific general model to evaluate river hydraulic conditions. These models would evaluate:

(1) Flow lines that would indicate the potential FGE's of barrier devices;

(2) water velocities at, and around, barriers to aid in answering fish behavior-related questions;

(3) attraction water and other flow features related to adult fish passage;

(4) river velocities as they pertain to the creation of predator habitat; and

(5) fish barrier and trash shear boom orientations related to the movement of debris and sediment.

e. Conducting extensive field evaluations of potential upstream fish collection facility sites to evaluate site-specific conditions (water temperatures, hydraulic conditions, *etc.*) that would have a bearing on both biological and engineering-related questions.

f. Exploring more effective ways to control predator fish populations in small reservoir systems.

g. Evaluating the potential impacts to resident fish (sturgeon, in particular) by using in-river radio tracing studies in the vicinity of potential upstream collection sites.

h. Conducting extensive field evaluations at existing fish diversion/collection projects, with similarities to components discussed in this report, to help determine actual fish diversion and collection rates, debris impacts, operation and maintenance problems, *etc.*

i. Completing numerical modeling of heat transfer characteristics of conveyance structures.

j. Constructing a prototype test reach of the migratory canal, pressure pipeline, or floating pipeline conveyance systems to assess the biological effects and meet the objectives of various parts of the design.

Alternative 4, the floating conduit proposed by the Idaho National Engineering Laboratory (INEL), would require significant research efforts to determine the most effective and non-injurious method of maintaining flow velocity. The INEL has proposed a research program that includes prototype test section construction and evaluation, with a duration of about 1 to 2 years. The INEL conduit design would also require hydraulic modeling efforts for the connection wet well at the upstream face of the dam, as well as the conduit flow path through the dam and into the existing juvenile collection bypass system. Water surface control structures, such as the sliding connection between the conduit and the wet well, and the adjustable weir, would have to be physically modeled and evaluated to determine proper design and configuration.

10.05. POSSIBLE VARIATIONS.

a. General.

There are several possible variations of the concept designs presented in this study that would be evaluated prior to selection and final design of any of the alternatives. Proposed designs of features included in the alternatives would be evaluated to improve compatibility with the biological functions of the fish. Other issues would be investigated to improve the cost effectiveness, constructability, operation, *etc.*, of alternative designs.

b. Upstream Collection System Components.

Several concept designs were evaluated in paragraph 5.03., Upstream Collection System Components. These designs varied based on assumptions primarily related to design discharges, type of barrier systems, and site layouts. The above variations, in addition to others, would be pursued in later studies if any of these basic alternatives are carried forward to the feasibility stage.

c. <u>Migratory Canal, Pressure Pipeline, and Floating Conduit Option Components</u>.

Since the designs of the migratory canal, pressure pipeline, and floating conduit fishway options are so conceptual and complex in nature, there are a multitude of variations in designs possible. Some of these variations have already been discussed in section 4, Proposed Alternatives. Variations in the design of resting ponds, water exchange systems, fish conveyance structures, fish feeding locations, emergency release systems from the main fish conveyance systems, and other features could be beneficial. For example, it may be possible to collect fish with a much-improved collection system at Lower Granite Dam rather than with the proposed new upstream collector structure. Lifts would not be required to transfer the fish into the migratory canal or pressure pipeline fishway with this variation. Another example of a beneficial refinement to the migratory canal and pressure pipeline alternatives would be the use of an improved lining material for the resting ponds that prevents seepage. Water exchange rates and reoxygenation criteria may also be refined in future design efforts.

In general, refinement of the design features of the various system features will follow according to specific site requirements, with regard to topography and foundation conditions. No further attempt will be made at this time to expand on other potential alternative designs, but variations would be pursued in later studies if any of these alternatives are carried forward.

d. <u>Transport Option Components</u>.

The fish transport vessel used to develop the designs discussed in paragraph 5.06., Transport Conveyance System Components, assumes the use of conventional-type barge transport vessels. Also presented in the aforementioned paragraph was a design concept for a composite net pen/conventional barge system. Several variations of this vessel could be pursued. The above variations, in addition to others, would be investigated further in later studies if any of these alternatives are carried forward to the feasibility phase.

10.06. <u>IMPACTS TO EXISTING SYSTEMS</u>.

a. <u>General</u>.

All of the alternatives would cause various levels of impact to existing systems, and may require structural modifications and changes in project operations.

b. Upstream Collection System Components.

The construction of an upstream collection system, which applies to all of the alternatives considered in this report, would result in some changes in the operation and nature of the rivers. These changes are largely dependent upon the site chosen for the alternative juvenile collection system (*i.e.*, a single primary collection structure between Lower Granite Dam and Lewiston, or dual primary collection structures upstream of Lewiston). For either of these plans, the operation of the existing juvenile bypass systems at each of the downstream dams would be affected, since these systems would no longer be used during normal operations. If a collection site is selected downstream of Lewiston, navigation on the river would be affected during the fish collection season by the addition of one lockage delay. If dual collection sites upstream of Lewiston are selected, no significant impacts to commercial navigation would occur, except for the increased number of fish transport vessels on the river (with the transport alternative). However, private craft navigation may be inconvenienced by the lift delay over the collector structure, or by the additional distance traveled to the forebay launching area.

After construction was complete, additional or reassigned staff would be required to operate the new facilities. The upstream collection system would require significant levels of staffing for proper operation. Some staff could be reassigned from the operation of existing sorting, holding, and loading facilities to the new facilities, since operation of the existing systems would be suspended. Staffing levels have been estimated in section 8, Economic Effects.

c. Migratory Canal, Pressure Pipeline, and Floating Conduit Options Components.

Existing juvenile fish bypass systems would be permanently affected by the migratory canal, pressure pipeline, and floating conduit options. Existing bypass flumes would be connected with conveyance structures; and operation of the existing sorting, holding, and loading facilities would be suspended the majority of the time. New sorting facilities would be constructed at the elevation of the conveyance structures at each dam to accomplish the required handling of fish formerly performed at the existing facilities. The new sorting facilities would only handle those fish captured by the existing juvenile bypass systems at each dam. The fish would be released from the new sorting structures directly into the conveyance system.

Some impact to the operation of the existing projects would be experienced during construction of all of these alternatives, including traffic delays, road relocations, and construction equipment interference.

After construction, additional or reassigned staff would be required to operate the new facilities. The upstream collection system, fish lifts or locks, pumps, navigation locks, sorting facilities, and the conveyance systems would all require significant levels of staffing for proper operation. Some staff could be reassigned from the operation of existing sorting, holding, and loading facilities to the facilities of the proposed alternatives, since operation of the existing facilities would be suspended. Staffing levels for each feature of these alternative concepts have been estimated in section 8, Economic Effects.

d. Transport Option Components.

Construction of any new transport vessels and support facilities would not be likely to cause impacts to the existing dam projects. After construction, additional or reassigned staff would be required to operate the new facilities, including the upstream collection system component. Some staff could be reassigned from the operation of existing sorting, holding, and loading facilities since operation of the existing facilities would be suspended. Staffing levels of this concept have been estimated in section 8, Economic Effects.

The use of existing fish transport barges would have minimal impacts to existing systems.

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SECTION 11 - COORDINATION

11.01. GENERAL.

Study results presented in the document have been coordinated with various public groups and agencies. Consultation with the U.S. Fish & Wildlife Service (USFWS), required under the Fish & Wildlife Coordination Act, was initiated early in the study effort. The USFWS is preparing a planning aid letter addressing the alternatives presented here. When the planning aid letter is completed, the context will be reflected in this document. Coordination and consultation was maintained with the TAG, formed for the purpose of overseeing these studies and providing assistance in assessing the biological impact of each alternative. Finally, coordination was maintained with the public through a series of public meetings.

11.02. THE TAG.

A group of technical experts representing regional fish agencies and tribes, river operating agencies and user groups, conservation groups, and other interested parties was formed in the spring of 1991 to develop plans for the 1992 lower Snake River reservoir drawdown test. This group has continued to meet since the completion of the March drawdown test, and has been designated as the CRSMA TAG.

The TAG is responsible for developing and reviewing criteria for the alternatives being considered by the Corps in the SCS; reviewing technical reports produced under this study; developing and evaluating recommendations for methods to obtain additional information regarding alternatives proposed for study under the NPPC's Fish and Wildlife Program Amendments; development of the scope of the Biological Plan for the lower Snake River reservoir drawdown; and providing guidance to the contractor responsible for completion of this document. Input from the TAG is provided to the NPPC's Drawdown Committee, as well as to the Corps.

11.03. ADDITIONAL TECHNICAL COORDINATION RELATED TO UPSTREAM COLLECTION SYSTEM COMPONENTS.

Additional technical coordination was completed to further develop upstream collection component designs, because this part of the system is considered a key to the success of all options evaluated. The following individuals, companies, and agencies (besides the Corps) provided input, either directly or indirectly, that was used in further developing upstream collection system concepts:

- Ned Taft and Tom Cook, Stone & Webster Environmental Technology & Services, Boston, Massachusetts.
- Chuck Sullivan, EPRI, Palo Alto, California.
- Charlie Listen and Perry Johnson, U.S. Bureau of Reclamation, Denver, Colorado.
- Ben Rizzo, USFWS, Newton Corner, Massachusetts.
- Mufeed Odeh, S.O. Conte Anadromous Fish Research Center, USFWS, Turner Fall, Massachusetts.
- Al Bruesch and Myint Lwin, Bridge and Structures Office, Washington Department of Transportation, Olympia, Washington.
- Harza Engineering Company, Bellevue, Washington.
- Bob Pearce, National Marine Fisheries Service, Portland, Oregon.
- Philip Weitz, National Marine Fisheries Service, Pasco, Washington.

11.04. PUBLIC INVOLVEMENT.

As part of the process to provide information to the public, the Corps conducted a series of seven meetings to inform the public and specific interest groups about a number of ongoing Corps programs intended to benefit salmon in the Columbia and Snake River systems. One of the primary objectives was to discuss the purpose and scope of the SCS, as well as the long-term alternatives being considered to improve the downstream migration success of juvenile salmon. Alternatives presented in this report were discussed during these meetings. In addition, the Corps discussed two other subjects: 1) the results of the March 1992 drawdown test of two Snake River dams; and 2) the

Interim Columbia and Snake River Flow Improvements Measures for Salmon Supplemental Environmental Impact Statement (SEIS), which will address interim river management actions while long-term solutions are being developed. The locations and dates for these meetings were as follows:

LOCATION	DATE
Portland, OR	6 July 92
Hermiston, OR	7 July 92
Pasco, WA	8 July 92
Grand Coulee, WA	9 July 92
Boise, ID	14 July 92
Lewiston, ID	15 July 92
Kalispell, MT	16 July 92

The meetings began with a general overview slide presentation concerning each of the three primary topics. Following the presentation, the audience broke into four discussion groups. Each discussion group represented a specific area of interest:

1) The SCS
2) The SEIS
3) Lower Snake River and John Day Drawdown
4) System Improvements

Because of the lower attendance level at the Grand Coulee and Kalispell meetings, it was decided to conduct panel discussions with one group. The meetings were considered to be successful, in that beneficial discussions occurred during the group sessions.

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SECTION 12 - PHASE II STUDY REQUIREMENTS

Study requirements for the Phase II, or feasibility, stage for these alternatives have been suggested previously in this report for individual features. As discussed previously, research may run concurrently with some feasibility stage design tasks for elements of the selected alternative or alternatives. The understanding of the causes of the decline of the Snake River salmon stocks is far from complete, and the effects of the hydropower dams on these runs can only be surmised at present. Thus, any measures to remedy the decline, as forwarded in this report, must be open to considerable scrutiny during the feasibility stage design effort.

During the feasibility stage, the first step will be to establish better biological criteria and functional objectives for the selected alternative(s). These criteria should be fully coordinated with the resource agencies, and developed with their full cooperation and involvement. As feasibility-level design progresses, some modification of criteria may be required in response to the increased knowledge base as new information is acquired through affiliated research.

Design of the functionally simplistic items would be conducted early in the feasibility phase, with more complex structures and equipment designed in stages to best accommodate new biological objectives. The upstream collector system components would require extensive conceptual design work, concurrent technical review and suggestion by the resource agencies, and considerable coordination of the design team to respond quickly to changes in scope. A project design team would be assembled to carry out the complex and intensive design activities required to complete the project in the short time allowed. Field work required for design to proceed differs considerably with each alternative presented. The migratory canal and pressure pipeline alternatives would require field survey work to determine possible alignments, establish ground control, and confirm system configurations. The transport alternatives would also require survey efforts to determine alignments and the configuration of collector structures and associated facilities. The floating conduit alternative would require adequate bathymetric surveys of the reservoirs to determine topographical constraints for the anchoring system.

Research activities would be required to establish design guidelines for features of the selected project alternative during the feasibility phase. For example, as suggested in paragraph ***5.04.***, a test reach of the migratory canal, pressure pipeline, or floating pipeline conveyance systems (alternatives 1, 2, and 4, respectively) would be constructed early in the feasibility phase to assess the biological effects and meet the objectives of the design. Other features of the system would also require extensive concurrent research during the feasibility design phase. As another example, biological effects of large barrier structures could only be assessed and design concepts improved through concurrent physical scale and biological live-test modeling of features of the structure.

The transport alternative would require the least time for design work, and could be readily tested in the field with existing equipment. The upstream collection system component, however, would require significant research and design effort to arrive at an acceptable facility.

The Phase II design and research activities could ideally begin immediately after Phase I is completed, following action on the alternatives presented in the complete CRSMA Report. ***Section 9*** presents the anticipated (ideal) design and construction schedules for the alternatives presented in this report.

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SECTION 13 - SUMMARY AND CONCLUSIONS

13.01. GENERAL.

Concepts for upstream collection and conveyance were considered that incorporated various methods for the collection of juvenile salmonids, as well as various methods of conveyance. Each alternative was designed to carry a total of 50 to 60 million juvenile salmonids during the downstream migration period (April through November), with an expected peak of 2 million fish per day. Juvenile salmonids would be introduced into the system from new collection facilities located upstream of Lower Granite Dam, as well as from the existing juvenile bypass systems at each of the downstream dams.

Four basic alternatives were analyzed for costs and schedules. For each of these alternatives, a single upstream collection system using one design option was assumed (see following paragraphs). For each alternative, three different collection design flows (100,000, 160,000, and 225,000 cfs) were evaluated. Alternatives related to other site locations, dual collection systems located upstream of Lewiston on the Snake and Clearwater Rivers, and other types of upstream collection designs will be evaluated further if this concept is carried into future studies. As discussed in section 4, it should be noted that a dual collection system design for collectors located upstream of Lewiston would probably require the construction of dams to create proper hydraulic conditions for the fish diversion barriers. This might require additional biological and cost-related impacts not associated with a single collection system downstream of Lewiston.

Basic concepts selected to develop alternative comparisons assumed all project alternatives would use a single collection system on the Snake River in the vicinity of Silcott Island (located about 7 miles downstream of Lewiston). An upstream collection system, using a low velocity design with either a floating platform/moving barrier or a bridge structure/fixed-barrier component, was initially selected for developing costs and schedules. To simplify the analysis, however, it was decided to use cost and schedule data assuming just a bridge structure/fixed-barrier collection component, in order to match previous drafts of this report. Cost and schedule data related to floating platform/moving barrier concepts would be comparable to a bridge structure/fixed-barrier collection system.

13.02. ALTERNATIVE 1--MIGRATORY CANAL WITH SINGLE PRIMARY FISH COLLECTION, SORTING, AND LIFT FACILITIES WITH INTERMEDIATE ADDITIONAL COLLECTION

a. Project Description.

This alternative assumes a single upstream fish collection system in the vicinity of the Silcott Island site; and provides for fish collection, sorting, and lifting to the migratory canal grade, and conveyance through each reservoir reach by a series of open channels, flumes, tunnels, and resting ponds.

b. Cost Information.

(1) Construction and Project Costs.

The reconnaissance-level project and fully-funded costs are estimated at about $4.3 and $5.4 billion, respectively [see table 2, tables T-8(a) through (c), and chart 2].

(2) Operation and Maintenance Costs.

Operation and maintenance costs are estimated at about $9.5 million annually (see tables 3 and T-12).

c. Schedule Information.

Assuming that funds and resources are available when required, it is estimated that, from the date authorization and appropriation is granted, it will take approximately 11 1/2 years to design and construct alternative 1. Chart 2 presents this same information in bar chart form.

Chart 1 shows summary information for different upstream collection system components for alternative 1. For a low velocity fixed-barrier design (which would also be comparable schedule-wise to a floating platform system), the time required for design and construction of just this piece of alternative 1 would range between 5 1/2 and 8 years for design flows ranging between 100,000 and 225,000 cfs, respectively.

d. Additional Information.

Incorporated into the migratory canal components of alternative 1 would be provisions for the exchange of 25 percent of the discharge at about 10-mile intervals along the alignment, means of limiting water temperature to 70° F, gas saturation controls, and provisions for feeding the fish. As part of this system, ponds of at least 1/3-acre, located at about 10-mile intervals, would be used for resting, feeding, and water exchange. The canal would include features that would allow juvenile fish to hold-up and rest in low flow velocity areas as they migrate.

This option would require, at the upstream collection system, an initial lift of fish and pumping of water at a rate of 200 cfs to the elevation of the canal. The required lift would range between 80 and 180 feet above the river below, depending on the location of the collector structure. This alternative would also collect juvenile fish from existing juvenile bypass systems at each of the downstream hydropower projects.

This upstream collection and conveyance concept will require research efforts to resolve design issues regarding several of the key elements of the system. Specifically, the main fish barrier system (and other components of the collector system), sorting facilities, fish locks or lifts, roughened portion of the canal, and other components will all require some research to determine the most effective design. Some uncertainty remains about the overall success of moving the entire volume of migrating juvenile salmon through a small channel of limited discharge capacity (compared to the natural river system). Another specific concern has been raised about the ability to provide sufficient food for the migrating juveniles throughout the length of the migratory canal. It may be difficult to ensure proper feeding for wild fish, since they may not consume artificial fish as well as hatchery fish normally do. Security of the canal system from destructive vandalism, poaching, and intentional or accidental contamination may be a significant concern.

13.03. ALTERNATIVE 2-PRESSURE PIPELINE WITH SINGLE PRIMARY FISH COLLECTION, SORTING, AND LIFT FACILITIES WITH INTERMEDIATE ADDITIONAL COLLECTION.

a. Project Description.

This alternative (similar to alternative 1, except it has a different fish conveyance system) assumes a single upstream fish collection system in the vicinity of the Silcott Island site; and provides for fish collection, sorting, and lifting to a buried pressure pipeline and related system along the reservoir shoreline.

b. Cost Information.

(1) Construction and Project Cost Summary.

The reconnaissance-level project and fully-funded costs are estimated at about $4.0 and $5.1 billion, respectively [see table 2, tables T-9(a) through (c), and chart 2].

(2) Operation and Maintenance Cost Summary.

Operation and maintenance costs are estimated at about $9.5 million annually (see tables 3 and T-12).

c. Schedule Information.

It was assumed this option would have comparable schedule requirements as alternative 1 with a migratory canal conveyance system. Thus, assuming that funds and resources are available when required, it is estimated that, from the date authorization and appropriation is granted, it will take approximately 11 1/2 years to design and construct alternative 2. Chart 2 presents this same information in bar chart form.

Chart 1 shows summary information for different upstream collection system components for alternative 2. For a low velocity fixed barrier design (which would also be comparable schedule wise to a floating platform system), the time required for design and construction of just this piece of alternative 2 would range between 5 1/2 and 8 years for design flows ranging between 100,000 and 225,000 cfs, respectively.

d. Additional Information.

Incorporated into the pressure pipeline components of alternative 2 would be provisions for the exchange of 25 percent of the discharge, at approximately 10-mile intervals, along the alignment, means of limiting water temperature to 70° F, gas saturation controls, and provisions for feeding the fish. As part of this system, ponds of at least 1/3-acre area, located at approximately 10-mile intervals, would be used for resting, feeding, and water exchange.

Alternative 2 would require, at the upstream collection system, an initial lift of fish and pumping of water at a rate of 200 cfs to the elevation of the canal. The required lift would range between 80 and 180 feet above the river below, depending on the location of the collector structure. This alternative would also collect juvenile fish from existing juvenile bypass systems at each of the downstream hydropower projects.

This upstream collection and pressure pipeline conveyance concept will require research efforts to resolve design issues regarding several of the key elements of the system. Specifically, the main fish barrier system (and other components of the collector system), sorting facilities, fish locks or lifts, and other components will all require some research to determine the most effective design. Some uncertainty remains about the overall success of moving the entire volume of migrating juvenile salmon through a small pressure pipeline of limited discharge capacity (compared to the natural river system). Another specific concern has been raised about the ability to provide sufficient food for the migrating juveniles throughout the length of the pipeline. It may be difficult to ensure proper feeding for wild fish, since they may not consume artificial fish food the way hatchery fish normally do.

13.04. ALTERNATIVE 3--TRANSPORT SYSTEM WITH SINGLE PRIMARY FISH COLLECTION, SORTING, AND HOLDING FACILITIES WITH INTERMEDIATE ADDITIONAL COLLECTION.

a. Project Description.

This alternative assumes a single upstream fish collection system in the vicinity of Silcott Island; and provides for fish collection, sorting, and transfer into existing barges where collected fish would be transported downstream to below Bonneville Dam.

b. Cost Information.

(1) Construction and Project Cost Summary.

The reconnaissance-level project cost is estimated to range between $256 and $362 million for collection facility design flows ranging between 100,000 and 225,000 cfs, respectively. Likewise, the reconnaissance-level, fully-funded costs are estimated to range between $327 and $469 million for collection facility design flows ranging between 100,000 and 225,000 cfs, respectively [see table 2, tables T-10(a) through (c), and chart 2].

(2) Operation and Maintenance Cost Summary.

Operation and maintenance costs are estimated at approximately $5.1 million annually (see tables 2 and T-12).

c. Schedule Information.

Assuming that funds and resources are available when required, it is estimated that, from the date authorization and appropriation is granted, it will take approximately 5 1/2 to 8 years to design and construct alternative 3 for collection facility design flows ranging between 100,000 and 225,000 cfs, respectively. Chart 2 presents this same information in bar chart form.

Chart 1 shows summary information for different upstream collection system components for alternative 3. For a low velocity fixed-barrier design (which would also be comparable schedule-wise to a floating platform system), the time required for design and construction of just this piece of alternative 3 would range between 5 1/2 and 8 years for design flows ranging between 100,000 and 225,000 cfs, respectively.

d. Additional Information.

Alternative 3 would require, at the upstream collection system, a fish barge lock to allow gravity loading of fish from the collection facility into existing barges. This alternative would also collect juvenile fish from existing juvenile bypass systems at each of the downstream hydropower projects.

There would be no additional costs or schedule time required beyond the construction of the upstream collection facilities, since it is assumed existing fish barges would be used to transport fish.

This upstream collection and transport conveyance concept will require research efforts to resolve design issues regarding several of the key elements of the system. Specifically, the main fish barrier system (and other components of the collector system) will require some research to determine the most effective design.

13.05. ALTERNATIVE 4--FLOATING PIPELINE SYSTEM WITH SINGLE PRIMARY FISH COLLECTION AND SORTING FACILITIES WITH INTERMEDIATE ADDITIONAL COLLECTION AND PUMP STATIONS.

a. Project Description.

This alternative assumes a single upstream fish collection system in the vicinity of the Silcott Island site; and provides for fish collection, sorting, and transfer into a floating open channel or enclosed low-pressure conduit to be conveyed downstream to below Bonneville Dam.

b. Costs.

(1) Construction and Project Cost Summary.

The reconnaissance-level, project cost is estimated to range between $789 and $856 million, depending on the design flow selected for the collection system. Likewise, the reconnaissance-level, fully-funded costs are estimated to range between $924 million and $1.0 billion, again depending on the design flow selected for the collection system [see table 2, tables T-11(a) through (c), and chart 2].

(2) Operation and Maintenance Cost Summary.

Operation and maintenance costs are estimated at about $31.8 million annually (see tables 2 and T-12).

c. Schedule Information.

It was assumed this option would have comparable schedule requirements as alternative 2, with a pressure pipe conveyance system. Thus, assuming that funds and resources are available when required, it is estimated that, from the date authorization and appropriation is granted, it will take approximately 11 1/2 years to design and construct alternative 2. Chart 2 presents this same information in bar chart form.

Chart 1 shows summary information for different upstream collection system components for alternative 4. For a low velocity fixed-barrier design (which would also be comparable schedule-wise to a floating platform system), the time required for design and construction of just this piece of alternative 4 would range between 5 1/2 and 8 years for design flows ranging between 100,000 and 225,000 cfs, respectively.

d. Additional Information.

Incorporated into the floating pipeline components of Alternative 4 would be provisions for the exchange of 25 percent of the discharge at approximately 10-mile intervals along the alignment, means of limiting water temperature to 70^{o} F, gas saturation controls, and provisions for feeding the fish. As part of this system, in-river net pens of at least 1/3-acre area, located at approximately 10-mile intervals, would be used for resting, feeding, and water exchange.

Alternative 4 would require, at the upstream collection system, an initial lift of fish and pumping of water at a rate of 200 cfs to the elevation of the floating pipeline. This alternative would also collect juvenile fish from existing juvenile bypass systems at each of the downstream hydropower projects.

This upstream collection and floating pipeline conveyance concept will require research efforts to resolve design issues regarding several of the key elements of the system. Specifically, the main fish barrier system (and other components of the collector system), sorting facilities, fish locks or lifts, and other components will all require some research to determine the most effective design. Some uncertainty remains about the overall success of moving the entire volume of migrating juvenile salmon through a floating pipeline of limited discharge capacity compared to the natural river system. Another specific concern has been raised about the ability to provide sufficient food for the migrating juveniles throughout the length of the pipeline. It may be difficult to ensure proper feeding for wild fish, since they may not consume artificial fish food the way hatchery fish normally do.

13.06. ANADROMOUS FISH.

Designs currently engineered for upstream collection with conveyance systems are new and untested. One design advantage afforded to a new upstream collector is its independence of the powerhouse operational and structural constraints that have influenced the design of current collection and bypass systems at the lower Snake River dams. This will allow for a more biologically-functional design.

The success of any upstream collection concept coupled with barge transport would be highly dependent on the biological success of the fish transportation program currently operated for all Snake River salmonid stocks. If the primary objective of an action is to deliver the maximum number of live smolts to some point below Bonneville Dam, or into the estuary from the top of the Lower Granite reservoir, the improved collection and barge transport of smolts around the Snake and Columbia River dams would be one of the most reasonable alternatives (from a biological perspective) for increasing smolt-to-adult survival.

A low velocity guidance/collection facility located near the top of the Lower Granite reservoir for the collection, tagging, and subsequent transport of migrating smolts to the lower Columbia River has several potential advantages. These advantages include: 1) the collection of many smolts that get disoriented and delayed in the Lower Granite reservoir before reaching the dam, due to inadequate migrational cues; 2) the removal of smolts from less than optimal reservoir conditions where predator activity is assumed substantial; and 3) a reduced need for extreme levels of flow augmentation that continues to a real concern with the region's coordinated inability to store enough water and then efficiently shape and pass that water for any measurable benefit to downstream migration.

An upstream collector, designed as a low velocity system, would address the concern posed by many biologists in the region that the turbine intakes at dams offer inhospitable environments for the collection and bypassing of juvenile salmonids. Passage through current spillway configurations offers little benefits with stress-related tradeoffs, and can not be considered more optimal for the smolt population. A collector designed with surface orientation (as opposed to a turbine collector system), located upstream in the Lower Granite reservoir and designed specifically for salmonid smolt collection without any powerhouse constraints imposed upon the design could be a beneficial alternative, as long as the biological needs of the respective listed salmonid stocks are fully incorporated into the collector design and operation.

Critical research and site monitoring would have to determine the most appropriate location for constructing an upstream collector facility. The entire mainstream passage corridor is designated by the National Marine Fisheries Service (NMFS) as critical habitat for spring/summer and fall Chinook salmon. High velocity sites positioned outside of the Lower Granite reservoir would be too complex, and ecologically costly to salmon and native anadromous species. Low velocity sites would be less ecologically and biologically costly. All potential sites possess similar ecological and population effect tradeoffs (*i.e.*, rearing habitat, transport survival derivation, predator effects). This suggests that site selection would be difficult.

It was determined, through a sensitivity analysis with the Columbia River Salmon Passage (CRiSP 1.4) model, that an upstream collector near the top of the Lower Granite reservoir would need to achieve a fish guidance efficiency (FGE) equal to or above 75 percent, while maintaining no higher than an estimated 2-percent direct bypass mortality for spring Chinook salmon to surpass that survival provided by the 1993 base case operation (SOR 2C). This sensitivity analysis suggests that if the upstream collector concept is to be implemented, adequate research through prototype modeling in in-river conditions should be performed to determine that an FGE of 75 percent and bypass mortalities comparable to the current estimates of 2 percent can be achieved. It is also suggested that concurrent ecological and passage studies be designed to address the estuary survival of transported and in-river juvenile salmon. These types of studies would be pursued in Phase II.

Survival estimates for the dual collector concept (*e.g.*, separate collectors on the Clearwater River and Snake River near Asotin, Washington) are similar when like parameter values and assumptions are used (FGE estimates and 2-percent bypass mortality). The conveyance system needed for the dual collectors for transporting fish, at least down to the current Lower Granite transport facilities, would realistically contribute a higher mortality factor associated with stress, dependent on the means of conveyance. The dual collector scenario would have to employ one of the designs for a high velocity collector requiring the construction of new dams for flow/velocity control.

It is believed that new dams, even if designed especially for salmonid passage, would not be biologically, ecologically, or regionally acceptable as a means of providing improved passage conditions for weak salmonid stocks, based upon past technologies and system operations.

The proposed migratory canal and floating pipeline conveyance options have received various critical reviews by such regional groups as the Technical Advisory Group (TAG). The TAG expressed a considerable amount of concerns with reliance on such untested artificial conveyance system designs. Primary concerns that are common to all of the currently proposed options are both biological and ecological. They include the following:

- Bio-engineering capability to artificially replicate natural ecological processes and biological conditions that are functionally interacting to the degree exhibited naturally (*i.e.*, resting ponds/areas, temperature, and flow regulation).

- The mechanical complexity of each proposed apparatus, and their synchronized operation, would require constant maintenance.

- In the low probability event that a means can be devised to artificially replicate the natural passage system into a pipeline or canal system, the need for adequate safe and efficient passage within the river system would not diminish or be considered mutually exclusive in any manner, especially for adults migrating upstream.

- Each option would require either some mechanical means of lifting the fish into the channel or a pumping/fanning system to move the fish.

- Exclusive increased concentration of salmonid smolts through a closed system would act to separate smolts from their natural food sources and the diversity in their food items.

- Increased concentration of salmonids smolts would be highly vulnerable to inescapable stress-related factors (*i.e.*, disease outbreaks and manifestations; predator invasion, including predation by larger steelhead smolts; increased inter- and intraspecies competition; and mechanical failure or accidents that would act as catastrophic events and potentially be detrimental to small population genetic fitness and viability).

13.07. CONCLUSIONS.

The option of an upstream collector and barge transportation may warrant further study in Phase II, based on potential anadromous fish survival benefits and the NMFS Recovery Team draft findings. The estimated benefits associated with the collector with barge transportation appear to provide significant improvements in terms of juvenile salmon survival. This survival estimate seems to be consistent with the analysis prepared by the NMFS Recovery Team. The other biological effects (resident fish and wildlife impacts) do not appear to be significant with this alternative.

The migratory canal and pipeline proposals should be eliminated from further consideration, due to biological concerns and uncertainties.

This conclusion is drawn with full recognition that a high degree of uncertainty concerning the salmon life-cycle biology exists, and that there is controversy surrounding the relative merits of transport when compared to in-river migration. Knowledge of biological parameters in the estuary portion of the juvenile migration is severely lacking, and could be of significance in evaluating various recovery alternatives. Efforts are continuing to identify and formulate tests and research to reduce these levels of uncertainty. Should the results of these efforts, or any other current efforts, yield information that would lead to conclusions different from those drawn here, the Phase II work can be modified to respond in an adaptive management approach.

COLUMBIA RIVER SALMON MITIGATION ANALYSIS
SYSTEM CONFIGURATION STUDY
PHASE I

UPSTREAM COLLECTION AND CONVEYANCE
SNAKE AND COLUMBIA RIVERS
TECHNICAL APPENDIX D

SECTION 14 - REFERENCES

Ellis, Gary A., 1994,

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NMFS Recovery Team, 1993

TABLES

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-1

TOTAL LENGTH OF CHANNEL TYPES BY REACH FOR ALTERNATIVE 1 –
MIGRATORY CANAL CONVEYANCE SYSTEM (ASSUMES A SINGLE UPSTREAM COLLECTION SYSTEM DOWNSTREAM OF LEWISTON)

DAM/REACH	ELEVATED FLUME (FEET)	TUNNELS		PONDS EACH	CANAL TYPE (FEET)			CUT & COVER (FEET)	TOTAL LENGTH (FEET)	ROADS (MILES)	CROSSINGS (EACH)	
		NUMBER	FEET		I	II	III				ROAD	RAILROAD
LOWER GRANITE REACH	5,250	4	74,850	3	5,200	32,750	0	0	118,050	26	60	0
LITTLE GOOSE REACH	33,400	3	51,650	4	45,475	58,675	0	0	189,200	18	7	0
LOWER MONUMENTAL REACH	51,930	3	33,150	4	30,254	45,116	0	0	160,450	15	7	4
ICE HARBOR REACH	30,620	3	36,600	3	63,668	37,162	0	0	168,050	15	25	4
MCNARY REACH	15,100	1	2,800	5	97,845	91,505	1,850	5,350	214,450	20	41	6
JOHN DAY REACH	9,150	2	9,800	7	296,760	66,160	5,580	20,600	408,050	39	53	11
THE DALLES REACH	24,200	0	0	2	72,900	17,010	8,690	4,600	127,400	12	26	3
BONNEVILLE REACH	35,150	2	23,900	2	67,240	89,935	51,165	25	267,415	24	36	6
TOTAL:	204,800	18	232,750	30	679,342	438,313	67,285	30,575	1,653,065	169	255	34
NUMBER OF TOTAL MILES: (CONVERTED FROM FEET)	39		44		129	83	13	6	314 MILES			

N:\UC&CS\TABLE-T1

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-2

TOTAL LENGTH OF CHANNEL TYPES BY REACH FOR VARIATION OF ALTERNATIVE 1 - MIGRATORY CANAL CONVEYANCE SYSTEM (ASSUMES A DUAL UPSTREAM COLLECTION SYSTEM UPSTREAM OF LEWISTON)

DAM/REACH	ELEVATED FLUME (FEET)	TUNNELS		PONDS EACH	CANAL TYPE (FEET)			CUT & COVER (FEET)	TOTAL LENGTH (FEET)	ROADS (MILES)	CROSSINGS (EACH)	
		NUMBER	FEET		I	II	III				ROAD	RAILROAD
LOWER GRANITE REACH	10,550	10	143,350	4	44,775	61,825	5,300	0	265,800	26	60	0
LITTLE GOOSE REACH	33,400	3	51,650	4	45,475	58,675	0	0	189,200	18	7	0
LOWER MONUMENTAL REACH	51,930	3	33,150	4	30,254	45,116	0	0	160,450	15	7	4
ICE HARBOR REACH	30,620	3	36,600	3	63,668	37,162	0	0	168,050	15	25	4
MCNARY REACH	15,100	1	2,800	5	97,845	91,505	1,850	5,350	214,450	20	41	6
JOHN DAY REACH	9,150	2	9,800	7	296,760	66,160	5,580	20,600	408,050	39	53	11
THE DALLES REACH	24,200	0	0	2	72,900	17,010	8,690	4,600	127,400	12	26	3
BONNEVILLE REACH	35,150	2	23,900	2	67,240	89,935	51,165	25	267,415	24	36	6
TOTAL:	210,100	24	301,250	31	718,917	467,388	72,585	30,575	1,800,815	169	255	34
NUMBER OF TOTAL MILES: (CONVERTED FROM FEET)	40		57		136	89	14	6	342 MILES			

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-3

UPSTREAM COLLECTION AND CONVEYANCE SYSTEM COMPONENT COSTS –
SINGLE COLLECTION SYSTEM LOCATED DOWNSTREAM OF LEWISTON
(ASSUMES A 225,000 CFS DESIGN FLOW WITH A BRIDGE STRUCTURE/
FIXED BARRIER DESIGN)
ANADROMOUS FISH COLLECTION & CONVEYANCE

PRICE LEVEL DATE: 1 OCT 92

COSTS BY FEATURE	ESTIMATED COST (INCLUDES OVERHEAD & PROFIT)
UPSTREAM COLLECTION SYSTEM	
MOB & DEMOB, PREPARATION	$1,421,014
FIXED SCREENS/BARRIERS	$117,876,646
ADULT FISH PASSAGE – DOWNSTREAM	$2,448,454
ADULT FISH PASSAGE – UPSTREAM	$1,518,504
ACCESS ROAD	$135,550
LOW HEAD BOAT PASSAGE	$10,002,467
ACCESS PIER	$1,626,109
FISH ATTRACTION CHAMBER	$2,226,369
FISH SORT, HOLD & LOAD FACILITY, & OFFICE	$9,251,858
MAINTENANCE FACILITY	$768,038
UPSTREAM DEBRIS REMOVAL SYSTEM	$3,066,008
NEW PARK AREA	$2,372,122
TOTAL COST:	$152,713,139
ROUNDED TOTAL – USE:	$152,713,000

TABLE T-3

UPSTREAM COLLECTION AND CONVEYANCE SYSTEM COMPONENT COSTS –
SINGLE COLLECTION SYSTEM LOCATED DOWNSTREAM OF LEWISTON (ASSUMES A 225,000 CFS DESIGN FLOW WITH A BRIDGE STRUCTURE/ FIXED BARRIER DESIGN)
ANADROMOUS FISH COLLECTION & CONVEYANCE

COSTS BY FEATURE	ESTIMATED COST (INCLUDES OVERHEAD & PROFIT)
FISH LIFT FOR MIGRATORY CANAL PRESSURE PIPELINE AND FLOATING PIPELNE SYSTEMS	$1,500,000
TRANSPORT	
FISH BARGE CHAMBERS	$56,321,000
RESTING PONDS	
POND	$148,695,200
LOCAL DRAINAGE DAM UPSTREAM	$24,975
IMPOUNDMENT DAM	$614,140
DIVERSION OF LOCAL RUNOFF	$21,547
LOW LEVEL OUTLET	$22,757
INLET STRUCTURE	$46,356
BAFFLE CHUTE SPILLWAY	$80,971
EVAPORATIVE COOLING SYSTEM	$292,000
LANDSCAPING	$73,000
SIDE CHANNEL SPILLWAY	$228,487
SUBTOTAL:	$150,099,433.00
ROUNDED TOTAL – USE:	$1,550,000.00
SIDE CHANNEL SPILLWAY (One every 4,000 linear feet of open channel)	
INDIVIDUAL COST	$146,000.00

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS
COLUMBIA & SNAKE RIVERS

TABLE T-3

UPSTREAM COLLECTION AND CONVEYANCE SYSTEM COMPONENT COSTS –
SINGLE COLLECTION SYSTEM LOCATED DOWNSTREAM OF LEWISTON
(ASSUMES A 225,000 CFS DESIGN FLOW WITH A BRIDGE STRUCTURE/
FIXED BARRIER DESIGN)
ANADROMOUS FISH COLLECTION & CONVEYANCE

COSTS PER REACH	ESTIMATED COST (INCLUDES OVERHEAD & PROFIT)
INEL PASSAGE THROUGH DAM	
TEMPORARY COFFER DAM	$210,240
DRILLING & CUTTING	$58,400
CONCRETE	$116,800
PIPES	$146,000
GATES, CONNECTORS & MISCELLANEOUS METAL	$89,060
TOTAL:	$620,500
ROUNDED TOTAL -- USE:	$620,000

TABLE T-3

UPSTREAM COLLECTION AND CONVEYANCE SYSTEM COMPONENT COSTS –
SINGLE COLLECTION SYSTEM LOCATED DOWNSTREAM OF LEWISTON
(ASSUMES A 225,000 CFS DESIGN FLOW WITH A BRIDGE STRUCTURE/
FIXED BARRIER DESIGN)
ANADROMOUS FISH COLLECTION & CONVEYANCE

COSTS PER FOOT	6 FOOT DIAMETER PIPE (INCLUDES OVERHEAD & PROFIT)	8 FOOT DIAMETER PIPE (INCLUDES OVERHEAD & PROFIT)	12 FOOT DIAMETER PIPE (INCLUDES OVERHEAD & PROFIT)
BURRIED PRESSURE PIPE			
ROCK EXCAVATION	$2.03	$2.66	$3.84
COMMON EXCAVATION	$8.38	$10.98	$15.84
BACKFILL SAND BEDDING	$9.48	$12.41	$17.91
PIPE (PER EACH DIAMETER AS SHOWN)	$622.18	$705.94	$1,403.89
MANHOLE COST/LENGTH	$77.57	$77.57	$77.57
MISCELLANEOUS	$10.66	$13.96	$20.15
SUBTOTAL:	$730.30	$823.52	$1,539.20
ROUNDED TOTAL COST	$730.00	$820.00	$1,540.00

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-3

UPSTREAM COLLECTION AND CONVEYANCE SYSTEM COMPONENT COSTS –
SINGLE COLLECTION SYSTEM LOCATED DOWNSTREAM OF LEWISTON
(ASSUMES A 225,000 CFS DESIGN FLOW WITH A BRIDGE STRUCTURE/
FIXED BARRIER DESIGN)

ANADROMOUS FISH COLLECTION & CONVEYANCE

COSTS PER FOOT	TYPE I OPEN CHANNEL (INCLUDES OVERHEAD & PROFIT)	TYPE II OPEN CHANNEL (INCLUDES OVERHEAD & PROFIT)	TYPE III OPEN CHANNEL (INCLUDES OVERHEAD & PROFIT)
ROCK EXCAVATION	$2.72	$48.78	$2.98
COMMON EXCAVATION	$7.14	$1.20	$1.20
CHANNEL ROCK	$10.23	$10.23	$10.23
CRUSHED ROCK	$9.26	$15.99	$9.26
REINFORCED CONCRETE	$122.28	$122.28	$122.28
SHOTCRETE	$56.60	$228.37	$56.60
ROAD SURFACING	$0.00	$11.20	$0.00
STEEL GUIDE RAIL	$0.00	$118.38	$0.00
MISCELLANEOUS	$2.01	$1.04	$38.57
ROADS	$14.21	$0.00	$0.00
FENCING	$59.51	$59.51	$59.51
TOTAL COST PER FOOT:	$283.96	$616.98	$300.63
ROUNDED COST PER FOOT – USE:	$280.00	$620.00	$300.00

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-3

UPSTREAM COLLECTION AND CONVEYANCE SYSTEM COMPONENT COSTS –
SINGLE COLLECTION SYSTEM LOCATED DOWNSTREAM OF LEWISTON (ASSUMES A 225,000 CFS DESIGN FLOW WITH A BRIDGE STRUCTURE/ FIXED BARRIER DESIGN)
ANADROMOUS FISH COLLECTION & CONVEYANCE

COSTS PER FOOT	TYPE IA OPEN CHANNEL (INCLUDES OVERHEAD & PROFIT)	TYPE IIA OPEN CHANNEL (INCLUDES OVERHEAD & PROFIT)	TYPE IIIA OPEN CHANNEL (INCLUDES OVERHEAD & PROFIT)
ROCK EXCAVATION	$5.42	$100.27	$14.91
COMMON EXCAVATION	$13.10	$1.20	$1.20
CHANNEL ROCK	$10.23	$10.23	$10.23
CRUSHED ROCK	$20.19	$20.19	$20.19
REINFORCED CONCRETE	$173.94	$173.94	$173.94
SHOTCRETE	$56.60	$248.24	$56.60
ROAD SURFACING	$0.00	$11.20	$0.00
STEEL GUIDE RAIL	$0.00	$118.38	$0.00
MISCELLANEOUS	$7.59	$4.83	$11.75
ROADS	$13.77	$0.00	$13.77
FENCING	$54.95	$54.95	$54.95
SUBTOTAL:	$355.79	$743.43	$357.54
ROUNDED COST PER FOOT – USE:	$360.00	$740.00	$300.00

NOTE: TYPES IA THROUGH IIIA ARE USED FOR THE JOHN DAY RESERVOIR REACH, TO ACCOMMODATE THE LARGER REQUIRED CROSS SECTIONS

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-4

REAL ESTATE QUANTITIES FOR ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES SINGLE COLLECTION SYSTEM DOWNSTREAM OF LEWISTON)

	NO. OF LF	= NO. OF ACRES
1. LOWER GRANITE DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
TUNNELS / FLUMES – OPEN GRAZING LANDS	73,050	58.70
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – RECREATION / PROJECT LANDS	43,350	36.00
FLUMES – PROJECT LANDS	900	0.72
2. LITTLE GOOSE DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
TUNNELS / FLUMES – OPEN GRAZING LANDS	59,500	47.80
OPEN CANALS – OPEN GRAZING LANDS	5,300	4.30
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT LANDS	130,350	105.00
3. LOWER MONUMENTAL DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – INDUSTIRAL / PORT LANDS	35,400	28.00
TUNNELS – OPEN GRAZING LANDS	33,150	26.70
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT LANDS	81,500	65.50
FLUMES – PROJECT LANDS	2,500	2.00
4. ICE HARBOR DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – INDUSTRIAL/PORT LANDS	26,500	21.30
OPEN CANALS – IRRIGATED CROP LANDS	12,200	9.80
OPEN CANALS – IRRIGATED FRUIT ORCHARDS	17,800	14.30
TUNNELS / FLUMES – IRRIGATED CROP LANDS	30,600	25.00
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT / WILDLIFE LANDS	70,650	57.00
TUNNELS / FLUMES – PROJECT / WILDLIFE LANDS	3,500	2.80

TABLE T-4

REAL ESTATE QUANTITIES FOR ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES SINGLE COLLECTION SYSTEM DOWNSTREAM OF LEWISTON)

	NO. OF LF	= NO. OF ACRES
5. MCNARY DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – INDUSTRIAL / PORT LANDS	86,700	70.00
OPEN CANALS – IRRIGATED CROP LANDS	15,000	12.00
TUNNELS / FLUMES – IRRIGATED CROP LANDS	11,850	9.50
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT / WILDLIFE LANDS	105,700	85.00
6. JOHN DAY DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – IRRIGATED CROP LANDS	80,600	65.00
OPEN CANALS – INDUSTRIAL / PORT LANDS	50,400	40.00
OPEN CANALS – RESIDENTIAL / RURAL LANDS	32,300	26.00
TUNNELS / FLUMES – RURAL FARM LANDS	21,000	17.00
TUNNELS / FLUMES – RESIDENTIAL / RURAL LANDS	4,850	4.00
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT / WILDLIFE LANDS	182,000	146.00
TUNNELS / FLUMES – PROJECT / WILDLIFE LANDS	4,800	4.00
7. THE DALLES DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – INDUSTRIAL LANDS	46,300	37.00
OPEN CANALS – IRRIGATED FARM LANDS	66,500	53.40
TUNNELS / FLUMES – INDUSTRIAL LANDS	4,600	3.70
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT / WILDLIFE LANDSLANDS	7,900	6.30
TUNNELS / FLUMES – PROJECT / WILDLIFE LANDS	1,100	0.90

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-4

REAL ESTATE QUANTITIES FOR ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES SINGLE COLLECTION SYSTEM DOWNSTREAM OF LEWISTON)

	NO. OF LF	NO. OF ACRES
8. BONNEVILLE DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – INDUSTRIAL / COMMERCIAL LANDS	28,500	23.00
OPEN CANALS – POTENTIAL INDUSTRIAL LANDS	17,300	14.00
OPEN CANALS – IRRIGATED FARM LANDS	64,500	52.00
TUNNELS / FLUMES – IRRIGATED FARM LANDS	25,350	20.00
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT / WILDLIFE LANDSLANDS	96,500	77.50
TUNNELS / FLUMES – PROJECT / WILDLIFE LANDS	500	0.40

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-5

REAL ESTATE COSTS FOR ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES SINGLE COLLECTION SYSTEM DOWNSTREAM OF LEWISTON)

	NO. OF ACRES:	LF:	COST:
1. LOWER GRANITE DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
TUNNELS / FLUMES	58.70	73,050	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	36.00	45,350	
FLUMES	0.72	900	
C. ESTIMATED VALUE OF PRIVATE LANDS			
TUNNELS / FLUMES			$29,350
D. ESTIMATED ADMINISTRATIVE COSTS			$10,000
TOTAL:			$39,350
2. LITTLE GOOSE DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	4.30	5,300	
TUNNELS / FLUMES	47.80	59,500	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	105.00	130,350	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$2,000
TUNNELS / FLUMES			$11,950
SUBTOTAL:			$13,950
D. ESTIMATED ADMINISTRATIVE COSTS			$15,000
TOTAL:			$28,950

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-5

REAL ESTATE COSTS FOR ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES SINGLE COLLECTION SYSTEM DOWNSTREAM OF LEWISTON)

	NO. OF ACRES:	LF:	COST:
3. LOWER MONUMENTAL DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	28.00	35,400	
TUNNELS / FLUMES	26.70	33,150	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	65.50	81,500	
FLUMES	2.00	2,500	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$84,000
TUNNELS / FLUMES			$5,340
SUBTOTAL:			$89,340
D. ESTIMATED ADMINISTRATIVE COSTS			$15,000
TOTAL:			$104,340
4. ICE HARBOR DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	45.40	56,500	
TUNNELS / FLUMES	25.00	30,600	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	57.00	70,650	
TUNNELS / FLUMES	2.80	3,500	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$187,300
TUNNELS / FLUMES			$94,000
SUBTOTAL:			$281,300
D. ESTIMATED ADMINISTRATIVE COSTS			$25,000
TOTAL:			$306,300

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-5

REAL ESTATE COSTS FOR ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES SINGLE COLLECTION SYSTEM DOWNSTREAM OF LEWISTON)

	NO. OF ACRES:	LF:	COST:
5. MCNARY DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	82.00	101,700	
TUNNELS / FLUMES	9.50	11,850	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	85.00	105,700	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$233,700
TUNNELS / FLUMES			$46,500
SUBTOTAL:			$280,200
D. ESTIMATED ADMINISTRATIVE COSTS			$75,000
TOTAL:			$355,200
6. JOHN DAY DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	131.00	163,300	
TUNNELS / FLUMES	21.00	25,850	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	146.00	182,000	
TUNNELS / FLUMES	4.00	4,800	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$628,800
TUNNELS / FLUMES			$168,000
SUBTOTAL:			$796,800
D. ESTIMATED ADMINISTRATIVE COSTS			$75,000
TOTAL:			$871,800

TABLE T-5

REAL ESTATE COSTS FOR ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES SINGLE COLLECTION SYSTEM DOWNSTREAM OF LEWISTON)

	NO. OF ACRES:	LF:	COST:
7. THE DALLES DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	90.40	112,800	
TUNNELS / FLUMES	3.70	4,600	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	6.30	7,900	
FLUMES	0.90	1,100	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$418,100
TUNNELS / FLUMES			$18,500
SUBTOTAL:			$436,600
D. ESTIMATED ADMINISTRATIVE COSTS			$300,000
TOTAL:			$736,600
8. BONNEVILLE DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	89.00	110,300	
TUNNELS / FLUMES	20.00	23,350	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	77.50	96,500	
FLUMES	0.40	500	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$293,700
TUNNELS / FLUMES			$70,000
SUBTOTAL:			$363,700
D. ESTIMATED ADMINISTRATIVE COSTS			$250,000
TOTAL:			$613,700

TABLE T-5

REAL ESTATE COSTS FOR ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES SINGLE COLLECTION SYSTEM DOWNSTREAM OF LEWISTON)

	NO. OF ACRES:	LF:	COST:
9. ADMINISTRATIVE COSTS FOR GOVERNMENT OWNED LANDS (OTHER THAN COE)			$100,000
TOTAL ESTIMATED REAL ESTATE COSTS:			$3,156,240
CONTINGENCY - USE 20%			$631,250
			$3,787,490
		ROUNDED:	$4,000,000

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-6

REAL ESTATE QUANTITIES FOR VARIATIONS OF ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES DUAL COLLECTION SYSTEMS UPSTREAM OF LEWISTON)

	NO. OF LF	= NO. OF ACRES
1. LOWER GRANITE DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
TUNNELS / FLUMES – OPEN GRAZING LANDS	88,000	70.70
TUNNELS / FLUMES – RESIDENTIAL LANDS	43,550	35.00
OPEN CANALS – RESIDENTIAL LANDS	25,250	20.00
TUNNELS / FLUMES – RURAL FARM LANDS	24,650	19.80
OPEN CANALS – RURAL FARM LANDS	11,500	9.20
OPEN CANALS – RECREATIONAL LANDS	10,000	8.00
OPEN CANALS – OPEN GRAZING LANDS	8,500	6.80
TUNNELS / FLUMES – RURAL RESIDENTIAL LANDS	1,950	1.60
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – RECREATIONAL / PROJECT LANDS	58,850	47.20
FLUMES – RECREATIONAL / PROJECT LANDS	900	0.72
2. LITTLE GOOSE DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
TUNNELS / FLUMES – OPEN GRAZING LANDS	59,500	47.80
OPEN CANALS – OPEN GRAZING LANDS	5,300	4.30
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT LANDS	130,350	105.00
3. LOWER MONUMENTAL DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – INDUSTIRAL / PORT LANDS	35,400	28.00
TUNNELS – OPEN GRAZING LANDS	33,150	26.70
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT LANDS	81,500	66.50
FLUMES – PROJECT LANDS	2,500	2.00

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-6

REAL ESTATE QUANTITIES FOR VARIATIONS OF ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
ASSUMING DUAL COLLECTION SYSTEMS LOCATED UPSTREAM OF LEWISTON

	NO. OF LF	NO. OF ACRES
4. ICE HARBOR DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – INDUSTRIAL/PORT LANDS	26,500	21.30
OPEN CANALS – IRRIGATED CROP LANDS	12,200	9.80
OPEN CANALS – IRRIGATED FRUIT ORCHARDS	17,800	14.30
TUNNELS / FLUMES – IRRIGATED CROP LANDS	30,600	25.00
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT / WILDLIFE LANDS	70,650	57.00
TUNNELS / FLUMES – PROJECT / WILDLIFE LANDS	3,500	2.80
5. MCNARY DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – INDUSTRIAL / PORT LANDS	86,700	70.00
OPEN CANALS – IRRIGATED CROP LANDS	15,000	12.00
TUNNELS / FLUMES – IRRIGATED CROP LANDS	11,850	9.50
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT / WILDLIFE LANDS	105,700	85.00
6. JOHN DAY DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – IRRIGATED CROP LANDS	80,600	65.00
OPEN CANALS – INDUSTRIAL / PORT LANDS	50,400	40.00
OPEN CANALS – RESIDENTIAL / RURAL LANDS	32,300	26.00
TUNNELS / FLUMES – RURAL FARM LANDS	21,000	17.00
TUNNELS / FLUMES – RESIDENTIAL / RURAL LANDS	4,850	4.00
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT / WILDLIFE LANDS	182,000	146.00
TUNNELS / FLUMES – PROJECT / WILDLIFE LANDS	4,800	4.00

TABLE T-6

REAL ESTATE QUANTITIES FOR VARIATIONS OF ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES DUAL COLLECTION SYSTEMS UPSTREAM OF LEWISTON)

	NO. OF LF	= NO. OF ACRES
7. THE DALLES DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – INDUSTRIAL LANDS	46,300	37.00
OPEN CANALS – IRRIGATED FARM LANDS	66,500	53.40
TUNNELS / FLUMES – INDUSTRIAL LANDS	4,600	3.70
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT / WILDLIFE LANDS	7,900	6.30
TUNNELS / FLUMES – PROJECT / WILDLIFE LANDS	1,100	0.90
8. BONNEVILLE DAM PROJECT:		
A. PRIVATELY OWNED LANDS:		
OPEN CANALS – INDUSTRIAL / COMMERCIAL LANDS	28,500	23.00
OPEN CANALS – POTENTIAL INDUSTRIAL LANDS	17,300	14.00
OPEN CANALS – IRRIGATED FARM LANDS	64,500	52.00
TUNNELS / FLUMES – IRRIGATED FARM LANDS	25,350	20.00
B. GOVERNMENT OWNED LANDS:		
OPEN CANALS – PROJECT / WILDLIFE LANDSLANDS	96,500	77.50
TUNNELS / FLUMES – PROJECT / WILDLIFE LANDS	500	0.40

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-7

REAL ESTATE COSTS FOR VARIATIONS OF ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES DUAL COLLECTION SYSTEMS UPSTREAM OF LEWISTON)

	NO. OF ACRES:	LF:	COST:
1. LOWER GRANITE DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	44.00	55,250	
TUNNELS / FLUMES	127.00	158,150	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	47.20	58,850	
FLUMES	0.72	900	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$82,500
TUNNELS / FLUMES			$158,750
SUBTOTAL:			$241,250
D. ESTIMATED ADMINISTRATIVE COSTS			$600,000
TOTAL:			$841,250
2. LITTLE GOOSE DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	4.30	5,300	
TUNNELS / FLUMES	47.80	59,500	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	105.00	130,350	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$2,000
TUNNELS / FLUMES			$11,950
SUBTOTAL:			$13,950
D. ESTIMATED ADMINISTRATIVE COSTS			$15,000
TOTAL:			$28,950

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-7

REAL ESTATE COSTS FOR VARIATIONS OF ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES DUAL COLLECTION SYSTEMS UPSTREAM OF LEWISTON)

	NO. OF ACRES:	LF:	COST:
3. LOWER MONUMENTAL DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	28.00	35,400	
TUNNELS / FLUMES	26.70	33,150	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	65.50	81,500	
FLUMES	2.00	2,500	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$84,000
TUNNELS / FLUMES			$5,340
SUBTOTAL:			$89,340
D. ESTIMATED ADMINISTRATIVE COSTS			$5,000
TOTAL:			$94,340
4. ICE HARBOR DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	45.40	56,500	
TUNNELS / FLUMES	25.00	30,600	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	57.00	70,650	
TUNNELS / FLUMES	2.80	3,500	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$187,300
TUNNELS / FLUMES			$94,000
SUBTOTAL:			$281,300
D. ESTIMATED ADMINISTRATIVE COSTS			$25,000
TOTAL:			$306,300

TABLE T-7

REAL ESTATE COSTS FOR VARIATIONS OF ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES DUAL COLLECTION SYSTEMS UPSTREAM OF LEWISTON)

	NO. OF ACRES:	LF:	COST:
5. MCNARY DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	82.00	101,700	
TUNNELS / FLUMES	9.50	11,850	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	85.00	105,700	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$233,700
TUNNELS / FLUMES			$46,500
SUBTOTAL:			$280,200
D. ESTIMATED ADMINISTRATIVE COSTS			$75,000
TOTAL:			$355,200
6. JOHN DAY DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	131.00	163,300	
TUNNELS / FLUMES	21.00	25,850	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	146.00	182,000	
TUNNELS / FLUMES	4.00	4,800	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$628,800
TUNNELS / FLUMES			$168,000
SUBTOTAL:			$796,800
D. ESTIMATED ADMINISTRATIVE COSTS			$75,000
TOTAL:			$871,800

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-7

REAL ESTATE COSTS FOR VARIATIONS OF ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES DUAL COLLECTION SYSTEMS UPSTREAM OF LEWISTON)

	NO. OF ACRES:	LF:	COST:
7. THE DALLES DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	90.40	112,800	
TUNNELS / FLUMES	3.70	4,600	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	6.30	7,900	
FLUMES	0.90	1,100	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$418,100
TUNNELS / FLUMES			$18,500
SUBTOTAL:			$436,600
D. ESTIMATED ADMINISTRATIVE COSTS			$300,000
TOTAL:			$736,600
8. BONNEVILLE DAM PROJECT:			
A. PRIVATELY OWNED LANDS:			
OPEN CANALS	89.00	110,300	
TUNNELS / FLUMES	20.00	23,350	
B. GOVERNMENT OWNED LANDS			
OPEN CANALS	77.50	96,500	
FLUMES	0.40	500	
C. ESTIMATED VALUE OF PRIVATE LANDS			
OPEN CANALS			$293,700
TUNNELS / FLUMES			$70,000
SUBTOTAL:			$363,700
D. ESTIMATED ADMINISTRATIVE COSTS			$250,000
TOTAL:			$613,700

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-7

REAL ESTATE COSTS FOR VARIATIONS OF ALTERNATIVES 1 AND 2
MIGRATORY CANAL OR PRESSURE PIPELINE SYSTEMS
(ASSUMES DUAL COLLECTION SYSTEMS UPSTREAM OF LEWISTON)

	NO. OF ACRES:	LF:	COST:
9. ADMINISTRATIVE COSTS FOR GOVERNMENT OWNED LANDS (OTHER THAN COE)			$100,000
TOTAL ESTIMATED REAL ESTATE COSTS:			$3,948,140
CONTINGENCY – USE 20%			$789,600
			$4,737,740
	ROUNDED:		$5,000,000

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-8(A)

TOTAL COSTS – ALTERNATIVE 1:
SINGLE UPSTREAM COLLECTION FACILITY
(LOW VELOCITY BRIDGE STRUCTURE [Q=100,000 CFS]) WITH MIGRATORY CANAL CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/-)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$148,000,000	$37,000,000	25%	$185,000,000	OCT 2000	28.6%	$190,330,000	$47,580,000	$237,910,000
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$105,994,500	$42,400,000	40%	$148,394,500	OCT 2000	28.6%	$136,310,000	$54,530,000	$190,840,000
09.01.00	LOWER GRANITE REACH	$336,000,000	$117,600,000	35%	$453,600,000	OCT 2000	28.6%	$432,100,000	$151,230,000	$583,330,000
09.02.00	LITTLE GOOSE REACH	$390,000,000	$136,500,000	35%	$526,500,000	OCT 2000	28.6%	$501,540,000	$175,540,000	$677,080,000
09.03.00	LOWER MONUMENTAL REACH	$375,000,000	$131,250,000	35%	$506,250,000	OCT 2000	13.4%	$425,250,000	$148,840,000	$574,090,000
09.04.00	ICE HARBOR REACH	$322,000,000	$112,700,000	35%	$434,700,000	OCT 2000	28.6%	$414,090,000	$144,930,000	$559,020,000
09.05.00	MCNARY REACH	$225,000,000	$78,750,000	35%	$303,750,000	OCT 2000	28.6%	$289,350,000	$101,270,000	$390,620,000
09.06.00	JOHN DAY REACH	$381,000,000	$133,350,000	35%	$514,350,000	OCT 2000	28.6%	$489,970,000	$171,490,000	$661,460,000
09.07.00	THE DALLES REACH	$174,000,000	$60,900,000	35%	$234,900,000	OCT 2000	28.6%	$223,760,000	$78,320,000	$302,080,000
09.08.00	BONNEVILLE REACH	$354,000,000	$123,900,000	35%	$477,900,000	OCT 2000	28.6%	$455,240,000	$159,340,000	$614,580,000
18.00.00	CULTURAL RESOURCE PRESERVATION	$30,000,000	$7,500,000	25%	$37,500,000	OCT 1997	17.0%	$35,100,000	$8,780,000	$43,880,000
20.00.00	PERMANENT OPERATING EQUIPMENT	$5,000,000	$1,250,000	25%	$6,250,000	OCT 2001	32.7%	$6,640,000	$1,660,000	$8,300,000
	TOTAL CONSTRUCTION COST	$2,845,994,500	$983,100,000		$3,829,094,500			$3,599,680,000	$1,243,510,000	$4,843,190,000
01.00.00	LANDS AND DAMAGES	$3,300,000	$660,000	20%	$3,960,000	OCT 1997	17.0%	$3,860,000	$770,000	$4,630,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$220,000,000	$55,000,000	25%	$275,000,000	OCT 1995	21.5%	$267,300,000	$66,830,000	$334,130,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$126,000,000	$18,900,000	15%	$144,900,000	OCT 1999	51.6%	$191,020,000	$28,650,000	$219,670,000
	TOTAL PROJECT COST:	$3,195,294,500	$1,057,660,000		$4,252,954,500			$4,061,860,000	$1,339,760,000	$5,401,620,000

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-8(B)

TOTAL COSTS – ALTERNATIVE 1:
SINGLE UPSTREAM COLLECTION FACILITY
(LOW VELOCITY BRIDGE STRUCTURE [Q=160,000 CFS]) WITH MIGRATORY CANAL CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/-)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$148,000,000	$37,000,000	25%	$185,000,000	OCT 2000	28.6%	$190,330,000	$47,580,000	$237,910,000
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$122,975,000	$49,190,000	40%	$172,165,000	APR 2000	31.7%	$161,960,000	$64,780,000	$226,740,000
09.01.00	LOWER GRANITE REACH	$336,000,000	$117,600,000	35%	$453,600,000	OCT 2000	28.6%	$432,100,000	$151,230,000	$583,330,000
09.02.00	LITTLE GOOSE REACH	$390,000,000	$136,500,000	35%	$526,500,000	OCT 2000	28.6%	$501,540,000	$175,540,000	$677,080,000
09.03.00	LOWER MONUMENTAL REACH	$375,000,000	$131,250,000	35%	$506,250,000	OCT 2000	13.4%	$425,250,000	$148,840,000	$574,090,000
09.04.00	ICE HARBOR REACH	$322,000,000	$112,700,000	35%	$434,700,000	OCT 2000	28.6%	$414,090,000	$144,930,000	$559,020,000
09.05.00	MCNARY REACH	$225,000,000	$78,750,000	35%	$303,750,000	OCT 2000	28.6%	$289,350,000	$101,270,000	$390,620,000
09.06.00	JOHN DAY REACH	$381,000,000	$133,350,000	35%	$514,350,000	OCT 2000	28.6%	$489,970,000	$171,490,000	$661,460,000
09.07.00	THE DALLES REACH	$174,000,000	$60,900,000	35%	$234,900,000	OCT 2000	28.6%	$223,760,000	$78,320,000	$302,080,000
09.08.00	BONNEVILLE REACH	$354,000,000	$123,900,000	35%	$477,900,000	OCT 2000	28.6%	$455,240,000	$159,340,000	$614,580,000
18.00.00	CULTURAL RESOURCE PRESERVATION	$30,000,000	$7,500,000	25%	$37,500,000	OCT 1997	17.0%	$35,100,000	$8,780,000	$43,880,000
20.00.00	PERMANENT OPERATING EQUIPMENT	$5,000,000	$1,250,000	25%	$6,250,000	OCT 2001	32.7%	$6,640,000	$1,660,000	$8,300,000
	TOTAL CONSTRUCTION COST	$2,862,975,000	$989,890,000		$3,852,865,000			$3,625,330,000	$1,253,760,000	$4,879,090,000
01.00.00	LANDS AND DAMAGES	$3,300,000	$660,000	20%	$3,960,000	OCT 1997	17.0%	$3,860,000	$770,000	$4,630,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$220,000,000	$55,000,000	25%	$275,000,000	OCT 1995	21.5%	$267,300,000	$66,830,000	$334,130,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$126,000,000	$18,900,000	15%	$144,900,000	OCT 1999	51.6%	$191,020,000	$28,650,000	$219,670,000
	TOTAL PROJECT COST:	$3,212,275,000	$1,064,450,000		$4,276,725,000			$4,087,510,000	$1,350,010,000	$5,437,520,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-8(C)

TOTAL COSTS -- ALTERNATIVE 1:
SINGLE UPSTREAM COLLECTION FACILITY
(LOW VELOCITY BRIDGE STRUCTURE [Q=225,000 CFS]) WITH MIGRATORY CANAL CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST: 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/-)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$148,000,000	$37,000,000	25%	$185,000,000	OCT 2000	28.6%	$190,330,000	$47,580,000	$237,910,000
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$154,213,000	$61,690,000	40%	$215,903,000	APR 2000	30.7%	$201,560,000	$80,630,000	$282,190,000
09.01.00	LOWER GRANITE REACH	$336,000,000	$117,600,000	35%	$453,600,000	OCT 2000	28.6%	$432,100,000	$151,230,000	$583,330,000
09.02.00	LITTLE GOOSE REACH	$390,000,000	$136,500,000	35%	$526,500,000	OCT 2000	28.6%	$501,540,000	$175,540,000	$677,080,000
09.03.00	LOWER MONUMENTAL REACH	$375,000,000	$131,250,000	35%	$506,250,000	OCT 2000	13.4%	$425,250,000	$148,840,000	$574,090,000
09.04.00	ICE HARBOR REACH	$322,000,000	$112,700,000	35%	$434,700,000	OCT 2000	28.6%	$414,090,000	$144,930,000	$559,020,000
09.05.00	MCNARY REACH	$225,000,000	$78,750,000	35%	$303,750,000	OCT 2000	28.6%	$289,350,000	$101,270,000	$390,620,000
09.06.00	JOHN DAY REACH	$381,000,000	$133,350,000	35%	$514,350,000	OCT 2000	28.6%	$489,970,000	$171,490,000	$661,460,000
09.07.00	THE DALLES REACH	$174,000,000	$60,900,000	35%	$234,900,000	OCT 2000	28.6%	$223,760,000	$78,320,000	$302,080,000
09.08.00	BONNEVILLE REACH	$354,000,000	$123,900,000	35%	$477,900,000	OCT 2000	28.6%	$455,240,000	$159,340,000	$614,580,000
18.00.00	CULTURAL RESOURCE PRESERVATION	$30,000,000	$7,500,000	25%	$37,500,000	OCT 1997	17.0%	$35,100,000	$8,780,000	$43,880,000
20.00.00	PERMANENT OPERATING EQUIPMENT	$5,000,000	$1,250,000	25%	$6,250,000	OCT 2001	32.7%	$6,640,000	$1,660,000	$8,300,000
	TOTAL CONSTRUCTION COST	$2,894,213,000	$1,002,390,000		$3,896,603,000			$3,664,930,000	$1,269,610,000	$4,934,540,000
01.00.00	LANDS AND DAMAGES	$3,300,000	$660,000	20%	$3,960,000	OCT 1997	17.0%	$3,860,000	$770,000	$4,630,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$220,000,000	$55,000,000	25%	$275,000,000	OCT 1995	21.5%	$267,300,000	$66,830,000	$334,130,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$126,000,000	$18,900,000	15%	$144,900,000	OCT 1999	51.6%	$191,020,000	$28,650,000	$219,670,000
	TOTAL PROJECT COST:	$3,243,513,000	$1,076,950,000		$4,320,463,000			$4,127,110,000	$1,365,860,000	$5,492,970,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-9(A)

TOTAL COSTS – ALTERNATIVE 2:
SINGLE UPSTREAM COLLECTION FACILTY
(LOW VELOCITY BRIDGE STRUCTURE [Q=100,000 CFS]) WITH PRESSURE PIPELINE CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/-)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$129,000,000	$32,250,000	25%	$161,250,000	OCT 2000	28.6%	$165,890,000	$41,470,000	$207,360,000
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$105,994,500	$42,400,000	40%	$148,394,500	OCT 2000	28.6%	$136,310,000	$54,530,000	$190,840,000
09.01.00	LOWER GRANITE REACH	$159,000,000	$79,500,000	50%	$238,500,000	OCT 2000	28.6%	$204,470,000	$102,240,000	$306,710,000
09.02.00	LITTLE GOOSE REACH	$216,000,000	$108,000,000	50%	$324,000,000	OCT 2000	28.6%	$277,780,000	$138,890,000	$416,670,000
09.03.00	LOWER MONUMENTAL REACH	$185,000,000	$92,500,000	50%	$277,500,000	OCT 1996	13.4%	$209,790,000	$104,900,000	$314,690,000
09.04.00	ICE HARBOR REACH	$193,000,000	$96,500,000	50%	$289,500,000	OCT 2000	28.6%	$248,200,000	$124,100,000	$372,300,000
09.05.00	MCNARY REACH	$250,000,000	$125,000,000	50%	$375,000,000	OCT 2000	28.6%	$321,500,000	$160,750,000	$482,250,000
09.06.00	JOHN DAY REACH	$736,000,000	$368,000,000	50%	$1,104,000,000	OCT 2000	28.6%	$946,500,000	$473,250,000	$1,419,750,000
09.07.00	THE DALLES REACH	$148,000,000	$74,000,000	50%	$222,000,000	OCT 2000	28.6%	$190,330,000	$95,160,000	$285,490,000
09.08.00	BONNEVILLE REACH	$287,000,000	$143,500,000	50%	$430,500,000	OCT 2000	28.6%	$369,080,000	$184,540,000	$553,620,000
18.00.00	CULTURAL RESOURCE PRESERVATION	$26,000,000	$6,500,000	25%	$32,500,000	OCT 1997	17.0%	$30,420,000	$7,610,000	$38,030,000
20.00.00	PERMANENT OPERATING EQUIPMENT	$5,000,000	$1,250,000	25%	$6,250,000	OCT 2001	32.7%	$6,640,000	$1,660,000	$8,300,000
	TOTAL CONSTRUCTION COST	$2,439,994,500	$1,169,400,000		$3,609,394,500			$3,106,910,000	$1,489,100,000	$4,596,010,000
01.00.00	LANDS AND DAMAGES	$3,300,000	$830,000	25%	$4,130,000	OCT 1997	17.0%	$3,860,000	$970,000	$4,830,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$191,000,000	$47,750,000	25%	$238,750,000	OCT 1995	21.5%	$232,070,000	$58,020,000	$290,090,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$109,000,000	$16,350,000	15%	$125,350,000	OCT 1999	51.6%	$165,240,000	$24,790,000	$190,030,000
	TOTAL PROJECT COST:	$2,743,294,500	$1,234,330,000		$3,977,624,500			$3,508,080,000	$1,572,880,000	$5,080,960,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-9(B)

TOTAL COSTS – ALTERNATIVE 2:
SINGLE UPSTREAM COLLECTION FACILTY
(LOW VELOCITY BRIDGE STRUCTURE [Q=160,000 CFS]) WITH PRESSURE PIPELINE CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/-)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$129,000,000	$32,250,000	25%	$161,250,000	OCT 2000	28.6%	$165,890,000	$41,470,000	$207,360,000
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$122,975,000	$49,190,000	40%	$172,165,000	APR 2000	31.7%	$161,960,000	$64,780,000	$226,740,000
09.01.00	LOWER GRANITE REACH	$159,000,000	$79,500,000	50%	$238,500,000	OCT 2000	28.6%	$204,470,000	$102,240,000	$306,710,000
09.02.00	LITTLE GOOSE REACH	$216,000,000	$108,000,000	50%	$324,000,000	OCT 2000	28.6%	$277,780,000	$138,890,000	$416,670,000
09.03.00	LOWER MONUMENTAL REACH	$185,000,000	$92,500,000	50%	$277,500,000	OCT 1996	13.4%	$209,790,000	$104,900,000	$314,690,000
09.04.00	ICE HARBOR REACH	$193,000,000	$96,500,000	50%	$289,500,000	OCT 2000	28.6%	$248,200,000	$124,100,000	$372,300,000
09.05.00	MCNARY REACH	$250,000,000	$125,000,000	50%	$375,000,000	OCT 2000	28.6%	$321,500,000	$160,750,000	$482,250,000
09.06.00	JOHN DAY REACH	$736,000,000	$368,000,000	50%	$1,104,000,000	OCT 2000	28.6%	$946,500,000	$473,250,000	$1,419,750,000
09.07.00	THE DALLES REACH	$148,000,000	$74,000,000	50%	$222,000,000	OCT 2000	28.6%	$190,330,000	$95,160,000	$285,490,000
09.08.00	BONNEVILLE REACH	$287,000,000	$143,500,000	50%	$430,500,000	OCT 2000	28.6%	$369,080,000	$184,540,000	$553,620,000
18.00.00	CULTURAL RESOURCE PRESERVATION	$26,000,000	$6,500,000	25%	$32,500,000	OCT 1997	17.0%	$30,420,000	$7,610,000	$38,030,000
20.00.00	PERMANENT OPERATING EQUIPMENT	$5,000,000	$1,250,000	25%	$6,250,000	OCT 2001	32.7%	$6,640,000	$1,660,000	$8,300,000
	TOTAL CONSTRUCTION COST	$2,456,975,000	$1,176,190,000		$3,633,165,000			$3,132,560,000	$1,499,350,000	$4,631,910,000
01.00.00	LANDS AND DAMAGES	$3,300,000	$830,000	25%	$4,130,000	OCT 1997	17.0%	$3,860,000	$970,000	$4,830,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$191,000,000	$47,750,000	25%	$238,750,000	OCT 1995	21.5%	$232,070,000	$58,020,000	$290,090,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$109,000,000	$16,350,000	15%	$125,350,000	OCT 1999	51.6%	$165,240,000	$24,790,000	$190,030,000
	TOTAL PROJECT COST:	$2,760,275,000	$1,241,120,000		$4,001,395,000			$3,533,730,000	$1,583,130,000	$5,116,860,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-9(C)

TOTAL COSTS – ALTERNATIVE 2:
SINGLE UPSTREAM COLLECTION FACILTY
(LOW VELOCITY BRIDGE STRUCTURE [Q=225,000 CFS]) WITH PRESSURE PIPELINE CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/-)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$129,000,000	$32,250,000	25%	$161,250,000	OCT 2000	28.6%	$165,890,000	$41,470,000	$207,360,000
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$154,213,000	$61,690,000	40%	$215,903,000	APR 2000	30.7%	$201,560,000	$80,630,000	$282,190,000
09.01.00	LOWER GRANITE REACH	$159,000,000	$79,500,000	50%	$238,500,000	OCT 2000	28.6%	$204,470,000	$102,240,000	$306,710,000
09.02.00	LITTLE GOOSE REACH	$216,000,000	$108,000,000	50%	$324,000,000	OCT 2000	28.6%	$277,780,000	$138,890,000	$416,670,000
09.03.00	LOWER MONUMENTAL REACH	$185,000,000	$92,500,000	50%	$277,500,000	OCT 1996	13.4%	$209,790,000	$104,900,000	$314,690,000
09.04.00	ICE HARBOR REACH	$193,000,000	$96,500,000	50%	$289,500,000	OCT 2000	28.6%	$248,200,000	$124,100,000	$372,300,000
09.05.00	MCNARY REACH	$250,000,000	$125,000,000	50%	$375,000,000	OCT 2000	28.6%	$321,500,000	$160,750,000	$482,250,000
09.06.00	JOHN DAY REACH	$736,000,000	$368,000,000	50%	$1,104,000,000	OCT 2000	28.6%	$946,500,000	$473,250,000	$1,419,750,000
09.07.00	THE DALLES REACH	$148,000,000	$74,000,000	50%	$222,000,000	OCT 2000	28.6%	$190,330,000	$95,160,000	$285,490,000
09.08.00	BONNEVILLE REACH	$287,000,000	$143,500,000	50%	$430,500,000	OCT 2000	28.6%	$369,080,000	$184,540,000	$553,620,000
18.00.00	CULTURAL RESOURCE PRESERVATION	$26,000,000	$6,500,000	25%	$32,500,000	OCT 1997	17.0%	$30,420,000	$7,610,000	$38,030,000
20.00.00	PERMANENT OPERATING EQUIPMENT	$5,000,000	$1,250,000	25%	$6,250,000	OCT 2001	32.7%	$6,640,000	$1,660,000	$8,300,000
	TOTAL CONSTRUCTION COST	$2,488,213,000	$1,188,690,000		$3,676,903,000			$3,172,160,000	$1,515,200,000	$4,687,360,000
01.00.00	LANDS AND DAMAGES	$3,300,000	$830,000	25%	$4,130,000	OCT 1997	17.0%	$3,860,000	$970,000	$4,830,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$191,000,000	$47,750,000	25%	$238,750,000	OCT 1995	21.5%	$232,070,000	$58,020,000	$290,090,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$109,000,000	$16,350,000	15%	$125,350,000	OCT 1999	51.6%	$165,240,000	$24,790,000	$190,030,000
	TOTAL PROJECT COST:	$2,791,513,000	$1,253,620,000		$4,045,133,000			$3,573,330,000	$1,598,980,000	$5,172,310,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-10(A)

TOTAL – ALTERNATIVE 3:
SINGLE UPSTREAM COLLECTION FACILITY
(LOW VELOCITY BRIDGE STRUCTURE [Q= 100,000 CFS]) WITH TRANSPORT CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST: 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/-)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$0								
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$133,405,000	$53,362,000	40%	$186,767,000	1Q 00	28.6%	$171,559,000	$68,623,000	$240,182,000
09.01.00	LOWER GRANITE REACH	$0								
09.02.00	LITTLE GOOSE REACH	$0								
09.03.00	LOWER MONUMENTAL REACH	$0								
09.04.00	ICE HARBOR REACH	$0								
09.05.00	MCNARY REACH	$0								
09.06.00	JOHN DAY REACH	$0								
09.07.00	THE DALLES REACH	$0								
09.08.00	BONNEVILLE REACH	$0								
18.00.00	CULTURAL RESOURCE PRESERVATION	$0	(INCLUDED IN ESTIMATED COST AND CONTINGENCY)							
20.00.00	PERMANENT OPERATING EQUIPMENT	$0	(INCLUDED IN ESTIMATED COST AND CONTINGENCY)							
	TOTAL CONSTRUCTION COST	$133,405,000	$53,362,000		$186,767,000			$171,559,000	$68,623,000	$240,182,000
01.00.00	LANDS AND DAMAGES	$800,000	$160,000	20%	$960,000	OCT 1995	9.9%	$880,000	$180,000	$1,060,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$36,000,000	$9,000,000	25%	$45,000,000	OCT 1994	13.9%	$41,000,000	$10,250,000	$51,250,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$21,000,000	$3,150,000	15%	$24,150,000	OCT 1998	42.1%	$29,840,000	$4,480,000	$34,320,000
	TOTAL PROJECT COST:	$191,205,000	$65,672,000		$256,877,000			$243,279,000	$83,533,000	$326,812,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-10(B)

TOTAL – ALTERNATIVE 3:
SINGLE UPSTREAM COLLECTION FACILITY
(LOW VELOCITY BRIDGE STRUCTURE [Q= 160,000 CFS]) WITH TRANSPORT CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST: 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/-)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$0								
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$177,796,000	$71,118,000	40%	$248,914,000	3Q 00	31.7%	$234,157,000	$93,663,000	$327,820,000
09.01.00	LOWER GRANITE REACH	$0								
09.02.00	LITTLE GOOSE REACH	$0								
09.03.00	LOWER MONUMENTAL REACH	$0								
09.04.00	ICE HARBOR REACH	$0								
09.05.00	MCNARY REACH	$0								
09.06.00	JOHN DAY REACH	$0								
09.07.00	THE DALLES REACH	$0								
09.08.00	BONNEVILLE REACH	$0								
18.00.00	CULTURAL RESOURCE PRESERVATION	$0	(INCLUDED IN ESTIMATED COST AND CONTINGENCY)							
20.00.00	PERMANENT OPERATING EQUIPMENT	$0	(INCLUDED IN ESTIMATED COST AND CONTINGENCY)							
	TOTAL CONSTRUCTION COST	$177,796,000	$71,118,000		$248,914,000			$234,157,000	$93,663,000	$327,820,000
01.00.00	LANDS AND DAMAGES	$800,000	$160,000	20%	$960,000	OCT 1995	9.9%	$880,000	$180,000	$1,060,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$36,000,000	$9,000,000	25%	$45,000,000	OCT 1994	13.9%	$41,000,000	$10,250,000	$51,250,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$21,000,000	$3,150,000	15%	$24,150,000	OCT 1998	42.1%	$29,840,000	$4,480,000	$34,320,000
	TOTAL PROJECT COST:	$235,596,000	$83,428,000		$319,024,000			$305,877,000	$108,573,000	$414,450,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-10(C)

TOTAL – ALTERNATIVE 3:
SINGLE UPSTREAM COLLECTION FACILITY
(LOW VELOCITY BRIDGE STRUCTURE [Q= 225,000 CFS]) WITH TRANSPORT CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST: 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/-)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$0								
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$209,034,319	$83,610,000	40%	$292,644,319	3Q 00	30.7%	$273,208,000	$109,137,000	$382,345,000
09.01.00	LOWER GRANITE REACH	$0								
09.02.00	LITTLE GOOSE REACH	$0								
09.03.00	LOWER MONUMENTAL REACH	$0								
09.04.00	ICE HARBOR REACH	$0								
09.05.00	MCNARY REACH	$0								
09.06.00	JOHN DAY REACH	$0								
09.07.00	THE DALLES REACH	$0								
09.08.00	BONNEVILLE REACH	$0								
18.00.00	CULTURAL RESOURCE PRESERVATION	$0	(INCLUDED IN ESTIMATED COST AND CONTINGENCY)							
20.00.00	PERMANENT OPERATING EQUIPMENT	$0	(INCLUDED IN ESTIMATED COST AND CONTINGENCY)							
	TOTAL CONSTRUCTION COST	$209,034,319	$83,610,000		$292,644,319			$273,208,000	$109,137,000	$382,345,000
01.00.00	LANDS AND DAMAGES	$800,000	$160,000	20%	$960,000	OCT 1995	9.9%	$880,000	$180,000	$1,060,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$36,000,000	$9,000,000	25%	$45,000,000	OCT 1994	13.9%	$41,000,000	$10,250,000	$51,250,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$21,000,000	$3,150,000	15%	$24,150,000	OCT 1998	42.1%	$29,840,000	$4,480,000	$34,320,000
	TOTAL PROJECT COST:	$266,834,319	$95,920,000		$362,754,319			$344,928,000	$124,047,000	$468,975,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-11(A)

TOTAL -- ALTERNATIVE 4:
SINGLE UPSTREAM COLLECTION FACILITY
(LOW VELOCITY BRIDGE STRUCTURE [Q=100,000 CFS]) WITH FLOATING PIPELINE CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/-)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$20,000,000	$5,000,000	25%	$25,000,000	OCT 1997	17.0%	$23,400,000	$5,850,000	$29,250,000
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$105,994,500	$42,400,000	40%	$148,394,500	OCT 2000	28.6%	$136,310,000	$54,530,000	$190,840,000
09.01.00	LOWER GRANITE REACH	$36,900,000	$18,450,000	50%	$55,350,000	OCT 1996	13.4%	$41,840,000	$20,920,000	$62,760,000
09.02.00	LITTLE GOOSE REACH	$34,700,000	$17,350,000	50%	$52,050,000	OCT 1996	13.4%	$39,350,000	$19,670,000	$59,020,000
09.03.00	LOWER MONUMENTAL REACH	$57,400,000	$28,700,000	50%	$86,100,000	OCT 1996	13.4%	$65,090,000	$32,550,000	$97,640,000
09.04.00	ICE HARBOR REACH	$29,800,000	$14,900,000	50%	$44,700,000	OCT 1996	13.4%	$33,790,000	$16,900,000	$50,690,000
09.05.00	MCNARY REACH	$39,700,000	$19,850,000	50%	$59,550,000	OCT 1996	13.4%	$45,020,000	$22,510,000	$67,530,000
09.06.00	JOHN DAY REACH	$70,700,000	$35,350,000	50%	$106,050,000	OCT 1996	13.4%	$80,170,000	$40,090,000	$120,260,000
09.07.00	THE DALLES REACH	$22,600,000	$11,300,000	50%	$33,900,000	OCT 1996	13.4%	$25,630,000	$12,810,000	$38,440,000
09.08.00	BONNEVILLE REACH	$42,200,000	$21,100,000	50%	$63,300,000	OCT 1996	13.4%	$47,850,000	$23,930,000	$71,780,000
18.00.00	CULTURAL RESOURCE PRESERVATION	$4,000,000	$1,000,000	25%	$5,000,000	OCT 1995	9.9%	$4,400,000	$1,100,000	$5,500,000
20.00.00	PERMANENT OPERATING EQUIPMENT	$5,000,000	$1,250,000	25%	$6,250,000	OCT 1997	17.0%	$5,850,000	$1,460,000	$7,310,000
	TOTAL CONSTRUCTION COST	$468,994,500	$216,650,000		$685,644,500			$548,700,000	$252,320,000	$801,020,000
01.00.00	LANDS AND DAMAGES	$800,000	$160,000	20%	$960,000	OCT 1995	9.9%	$880,000	$180,000	$1,060,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$53,000,000	$13,250,000	25%	$66,250,000	OCT 1994	13.9%	$60,370,000	$15,090,000	$75,460,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$31,000,000	$4,650,000	15%	$35,650,000	OCT 1996	29.6%	$40,180,000	$6,030,000	$46,210,000
	TOTAL PROJECT COST:	$553,794,500	$234,710,000		$788,504,500			$650,130,000	$273,620,000	$923,750,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-11(B)

TOTAL – ALTERNATIVE 4:
SINGLE UPSTREAM COLLECTION FACILITY
(LOW VELOCITY BRIDGE STRUCTURE [Q=160,000 CFS]) WITH FLOATING PIPELINE CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST: 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/-)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$20,000,000	$5,000,000	25%	$25,000,000	OCT 1997	17.0%	$23,400,000	$5,850,000	$29,250,000
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$122,975,000	$49,190,000	40%	$172,165,000	APR 2000	31.7%	$161,960,000	$64,780,000	$226,740,000
09.01.00	LOWER GRANITE REACH	$36,900,000	$18,450,000	50%	$55,350,000	OCT 1996	13.4%	$41,840,000	$20,920,000	$62,760,000
09.02.00	LITTLE GOOSE REACH	$34,700,000	$17,350,000	50%	$52,050,000	OCT 1996	13.4%	$39,350,000	$19,670,000	$59,020,000
09.03.00	LOWER MONUMENTAL REACH	$57,400,000	$28,700,000	50%	$86,100,000	OCT 1996	13.4%	$65,090,000	$32,550,000	$97,640,000
09.04.00	ICE HARBOR REACH	$29,800,000	$14,900,000	50%	$44,700,000	OCT 1996	13.4%	$33,790,000	$16,900,000	$50,690,000
09.05.00	MCNARY REACH	$39,700,000	$19,850,000	50%	$59,550,000	OCT 1996	13.4%	$45,020,000	$22,510,000	$67,530,000
09.06.00	JOHN DAY REACH	$70,700,000	$35,350,000	50%	$106,050,000	OCT 1996	13.4%	$80,170,000	$40,090,000	$120,260,000
09.07.00	THE DALLES REACH	$22,600,000	$11,300,000	50%	$33,900,000	OCT 1996	13.4%	$25,630,000	$12,810,000	$38,440,000
09.08.00	BONNEVILLE REACH	$42,200,000	$21,100,000	50%	$63,300,000	OCT 1996	13.4%	$47,850,000	$23,930,000	$71,780,000
18.00.00	CULTURAL RESOURCE PRESERVATION	$4,000,000	$1,000,000	25%	$5,000,000	OCT 1995	9.9%	$4,400,000	$1,100,000	$5,500,000
20.00.00	PERMANENT OPERATING EQUIPMENT	$5,000,000	$1,250,000	25%	$6,250,000	OCT 1997	17.0%	$5,850,000	$1,460,000	$7,310,000
	TOTAL CONSTRUCTION COST	$485,975,000	$223,440,000		$709,415,000			$574,350,000	$262,570,000	$836,920,000
01.00.00	LANDS AND DAMAGES	$800,000	$160,000	20%	$960,000	OCT 1995	9.9%	$880,000	$180,000	$1,060,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$53,000,000	$13,250,000	25%	$66,250,000	OCT 1994	13.9%	$60,370,000	$15,090,000	$75,460,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$31,000,000	$4,650,000	15%	$35,650,000	OCT 1996	29.6%	$40,180,000	$6,030,000	$46,210,000
	TOTAL PROJECT COST:	$570,775,000	$241,500,000		$812,275,000			$675,780,000	$283,870,000	$959,650,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-11(C)

TOTAL – ALTERNATIVE 4:
SINGLE UPSTREAM COLLECTION FACILITY
(LOW VELOCITY BRIDGE STRUCTURE [Q=225,000 CFS]) WITH FLOATING PIPELINE CONVEYANCE SYSTEM

ACCOUNT CODE	ITEM DESCRIPTION	ESTIMATED COST: 1 OCT 92	CONTINGENCY AMOUNT ($)	%	TOTAL ESTIMATED COST 1 OCT 92	BUDGET MID-POINT OF CONSTRUCTION	OMB % INFLATION (+/–)	INFLATED COST AMOUNT	INFLATED CONTINGENCY AMOUNT	FULLY FUNDED COSTS
06.00.00	FISH AND WILDLIFE FACILITIES	$20,000,000	$5,000,000	25%	$25,000,000	OCT 1997	17.0%	$23,400,000	$5,850,000	$29,250,000
	CHANNELS AND CANALS									
09.00.00	UPSTREAM COLLECTION FACILITY	$154,213,000	$61,690,000	40%	$215,903,000	APR 2000	30.7%	$201,560,000	$80,630,000	$282,190,000
09.01.00	LOWER GRANITE REACH	$36,900,000	$18,450,000	50%	$55,350,000	OCT 1996	13.4%	$41,840,000	$20,920,000	$62,760,000
09.02.00	LITTLE GOOSE REACH	$34,700,000	$17,350,000	50%	$52,050,000	OCT 1996	13.4%	$39,350,000	$19,670,000	$59,020,000
09.03.00	LOWER MONUMENTAL REACH	$57,400,000	$28,700,000	50%	$86,100,000	OCT 1996	13.4%	$65,090,000	$32,550,000	$97,640,000
09.04.00	ICE HARBOR REACH	$29,800,000	$14,900,000	50%	$44,700,000	OCT 1996	13.4%	$33,790,000	$16,900,000	$50,690,000
09.05.00	MCNARY REACH	$39,700,000	$19,850,000	50%	$59,550,000	OCT 1996	13.4%	$45,020,000	$22,510,000	$67,530,000
09.06.00	JOHN DAY REACH	$70,700,000	$35,350,000	50%	$106,050,000	OCT 1996	13.4%	$80,170,000	$40,090,000	$120,260,000
09.07.00	THE DALLES REACH	$22,600,000	$11,300,000	50%	$33,900,000	OCT 1996	13.4%	$25,630,000	$12,810,000	$38,440,000
09.08.00	BONNEVILLE REACH	$42,200,000	$21,100,000	50%	$63,300,000	OCT 1996	13.4%	$47,850,000	$23,930,000	$71,780,000
18.00.00	CULTURAL RESOURCE PRESERVATION	$4,000,000	$1,000,000	25%	$5,000,000	OCT 1995	9.9%	$4,400,000	$1,100,000	$5,500,000
20.00.00	PERMANENT OPERATING EQUIPMENT	$5,000,000	$1,250,000	25%	$6,250,000	OCT 1997	17.0%	$5,850,000	$1,460,000	$7,310,000
	TOTAL CONSTRUCTION COST	$517,213,000	$235,940,000		$753,153,000			$613,950,000	$278,420,000	$892,370,000
01.00.00	LANDS AND DAMAGES	$800,000	$160,000	20%	$960,000	OCT 1995	9.9%	$880,000	$180,000	$1,060,000
30.00.00	PLANNING, ENGINEERING & DESIGN	$53,000,000	$13,250,000	25%	$66,250,000	OCT 1994	13.9%	$60,370,000	$15,090,000	$75,460,000
31.00.00	CONSTRUCTION MANAGEMENT (S&I)	$31,000,000	$4,650,000	15%	$35,650,000	OCT 1996	29.6%	$40,180,000	$6,030,000	$46,210,000
	TOTAL PROJECT COST:	$602,013,000	$254,000,000		$856,013,000			$715,380,000	$299,720,000	$1,015,100,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS
COLUMBIA & SNAKE RIVERS

TABLE T-12

SUMMARY OPERATION AND MAINTENANCE COSTS
ALTERNATIVES 1 – 4

TOTAL ANNUAL O&M COSTS:

ALTERNATIVE 1: MIGRATORY CANAL & SINGLE COLLECTION, SORTING, LIFT FACILITIES			
A. SILCOTT COLLECTOR FACILITIES	$3,657,000		
B. CANAL & RESTING PONDS	$5,792,000		
TOTAL O&M ALTERNATIVE 1:	$9,449,000	ROUNDED:	$9,500,000
ALTERNATIVE 2: PRESSURE PIPELINE & SINGLE COLLECTION, SORTING, LIFT FACILITIES			
A. SILCOTT COLLECTOR FACILITIES	$3,657,000		
B. CANAL & RESTING PONDS	$5,792,000		
TOTAL O&M ALTERNATIVE 2:	$9,449,000	ROUNDED:	$9,500,000
ALTERNATIVE 3: BARGE TRANSPORT & SINGLE COLLECTION SORTING, HANDLING FACILITIES			
A. SILCOTT COLLECTOR FACILITIES	$3,347,000		
B. BARGE FLEET OM&R	$1,725,000		
TOTAL O&M ALTERNATIVE 3:	$5,072,000	ROUNDED:	$5,100,000
ALTERNATIVE 4: FLOATING PIPELINE/PUMP SYSTEM & SINGLE COLLECTION, SORTING FACILITIES			
A. SILCOTT COLLECTOR FACILITIES	$3,347,000		
B. FLOATING PIPELINE/PUMPS/PONDS	$28,426,000		
TOTAL O&M ALTERNATIVE 4:	$31,773,000	ROUNDED:	$32,000,000

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-13

DETAILED OPERATION AND MAINTENANCE COSTS
ALTERNATIVES 1 – 4

GENERAL:	MANPOWER RATE:
ANNUAL SALARY (AVERAGE)	$30,000.00
OVERHEAD RATE	$236.00
WORK DAYS PER YEAR	$236.00
EFFECTIVE MANHOUR RATE	$32.00

COLLECTORS:

SILCOTT COLLECTOR, FISH LIFT, AND 200 CFS PUMPING

MAJOR MAINTENANCE & REHABILITATION COSTS:	
DEBRIS BOOM	$30,000
REPLACE SCREENS (5 YEAR LIFE)	$1,820,000
NAVIGATION LOCK REHAB	$125,000
FISH LIFT	$5,000
PUMPS	$40,000
TOTAL:	$2,020,000

OPERATIONAL MANPOWER REQUIREMENTS

ACTIVITY	NUMBER OF PEOPLE	MANHOURS PER WEEK	MANWEEKS PER YEAR	MANHOURS PER YEAR	
LOCK OPERATOR	1	168	52	8,736	
DEBRIS COLLECTION & BOAT PASSAGE	2	240	26	6,240	
RAKE DEBRIS FROM SCREENS	6	495	26	12,870	
VISITOR CENTER & OFFICE	2	100	52	5,200	
SHOP	2	80	26	2,080	
SORTING FACILITY & FISH LIFT	1	168	2	336	
TOTAL:				35,462	
TOTAL OPERATIONAL MAN POWER COST PER YEAR:	(MANHOURS PER YEAR * $32/HOUR)				$1,134,784

SUMMARY OF OPERATION & MAINTENANCE COSTS:	
MAJOR MAINTENANCE AND REHAB	$2,020,000
MANPOWER COSTS (PER YEAR)	$1,264,000
MINOR MAINTENANCE & MATERIALS (5% OF MANPOWER)	$63,200
SUBTOTAL OF O&M COSTS FOR SILCOTT COLLECTOR/BARGE & FLOATING PIPE ALTERNATIVES	$3,347,200
PUMPING COSTS	$300,000
LIFT ENERGY COSTS	$10,000
	$310,000
TOTAL O&M COSTS:	$3,657,200

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-13

DETAILED OPERATION AND MAINTENANCE COSTS
ALTERNATIVES 1 – 4

COLLECTORS:						
UPSTREAM ALTERNATIVE COLLECTORS AND FISH LIFTS						
MAJOR MAINTENANCE & REHABILITATION COSTS:						
DEBRIS BOOM					$60,000	
REPLACE SCREENS (5 YEAR LIFE)					$1,038,000	
FISH LIFT					$5,000	
TOTAL MAJOR MAINTENANCE & REHABILITATION COSTS:					$1,103,000	
OPERATIONAL MANPOWER REQUIREMENTS						
ACTIVITY	NUMBER OF PEOPLE	MANHOURS PER WEEK	MANWEEKS PER YEAR	MANHOURS PER YEAR		
DEBRIS COLLECTION	1	72	26	1,872		
RAKE DEBRIS FROM SCREENS	4	332	26	8,632		
VISITOR CENTER & OFFICE	1	40	52	2,080		
SHOP	2	80	26	2,080		
SORTING FACILITY & FISH LIFT	1	168	26	4,368		
TOTAL:			156	19,032		
TOTAL OPERATIONAL MAN POWER COSTS FOR EACH COLLECTOR (MANHOURS PER YEAR * $32/HOUR)						$609,024
SUMMARY OF O&M COSTS FOR BOTH ALTERNATE COLLECTORS:						
MAJOR MAINTENANCE AND REHAB			$2,206,000			
MANPOWER COSTS			$1,218,000			
MINOR MAINTENANCE AND MATERIALS			$120,000			
TOTAL O&M COSTS FOR UPSTREAM COLLECTORS USED WITH BARGE & FLOATING ALTERNATIVES				$3,544,000		
LIFT ENERGY COSTS 180' AT 10 MILES RAPIDS LIFT			$20,000			
PUMPING COSTS AT CLEARWATER COLLECTOR			$300,000			
PUMPING COSTS AT TEN MILE RAPIDS COLLECTOR			$616,000			
SUBTOTAL:				$936,000		
TOTAL O&M COSTS FOR UPSTREAM COLLECTORS USED WITH CANAL & PRESSURE PIPE ALTERNATIVES:						$4,480,000

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UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-13

DETAILED OPERATION AND MAINTENANCE COSTS
ALTERNATIVES 1 – 4

CANAL AND RESTING PONDS: (Typical 10 mile canal or pipeline segment with resting pond)

OPERATIONAL MANPOWER REQUIREMENTS

ACTIVITY	MANHOURS PER WEEK	MANWEEKS PER YEAR	MANHOURS PER YEAR
MONITOR CANAL & POND	28	26	728
FEED FISH	4	26	104
MINOR REPAIRS & MAINTENANCE			100
TOTAL:			932

TOTAL OPERATIONAL MANPOWER COSTS PER 10 MILE CANAL/PIPE SEGMENT & POND (MANHOURS/YEAR * $32/HOUR)	$29,824
MINOR MAINTENANCE, TOOLS, AND MATERIALS COSTS (ESTIMATE 5% OF MANPOWER COSTS)	$1,491
MAJOR MAINTENANCE AND REHABILITATION COSTS:	
PUMP, TURBINE, AND MOTOR REPLACEMENT	$8,000
PUMP, TURBINE, AND MOTOR ANNUAL MAINTENANCE	$5,000
EVAPORATIVE COOLING SYSTEM MAINTENANCE	$5,000
LANDSCAPE MAINTAINANCE	$1,000
CANAL REPAIR	$50,000
WATER–UP AND INSPECT IN SPRING	$5,000
DE–WATER AND WINTERIZE IN FALL	$3,000
TOTAL MAJOR MAINTENANCE AND REHABILITATION COSTS:	$77,000
SUMMARY OF O&M COSTS FOR 10 MILE CANAL/PIPE SEGMENT AND RESTING POND:	
MAJOR MAINTENANCE AND REHAB	$77,000
MANPOWER COSTS	$0
MINOR MAINTENANCE, TOOLS, AND MATERIALS	$0
PUMP ENERGY COSTS AT REST PONDS	$62,000
TOTAL O&M COSTS PER SEGMENT:	$139,000

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

COLUMBIA & SNAKE RIVERS

TABLE T-13

DETAILED OPERATION AND MAINTENANCE COSTS
ALTERNATIVES 1 – 4

BARGE FLEET (OPERATION, MAINTENANCE, AND REPLACEMENT)	
BARGE FLEET OPERATION	$720,000
BARGE MAINTENANCE	$600,000
REPLACEMENT	$404,000
TOTAL OM&R COSTS:	$1,724,000
FLOATING PIPELINE AND PUMP SYSTEM (OPERATING, MAINTENANCE, & REPLACEMENT)	
PUMP OVERHAUL	$16,900,000
CLEANING	$1,690,000
POWER	$2,876,000
MATERIALS	$6,960,000
TOTAL OM&R COSTS:	$28,426,000

TABLE T-13

DETAILED OPERATION AND MAINTENANCE COSTS
ALTERNATIVES 1 – 4

MISCELLANEOUS OPERATIONAL COSTS PER REACH:

ACTIVITY	MANHOURS PER WEEK	MAN–WEEKS PER YEAR	MAN HOURS PER YEAR
MONITOR SYSTEM REMOTELY	84	26	2,184
ADDITIONAL MANPOWER REQUIRED AT DAM	20	26	520
TOTAL:			2,704

SUMMARY OF O&M COSTS FOR RESTING PONDS AND CANAL (By number of resting ponds and 10–mile segments)

ALTERNATIVES 1(a) AND 2(a):

REACH	# OF RESTING PONDS	TOTAL MANHOURS:	TOTAL COST:
LOWER GRANITE	3	5500	$596,000
LITTLE GOOSE	4	6432	$767,000
LOWER MONUMENTAL	4	6432	$767,000
ICE HARBOR	3	5500	$596,000
MCNARY	5	7364	$937,000
JOHN DAY	7	9228	$1,277,000
THE DALLES	2	4568	$426,000
BONNEVILLE	2	4568	$426,000
TOTALS:		49,592	$5,792,000

CHARTS

COLUMBIA RIVER SALMON MITIGATION ANALYSIS
UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS
SYSTEM CONFIGURATION STUDY - PHASE I
SCHEDULE AND CONSTRUCTION COST COMPARISONS FOR UPSTREAM COLLECTION SYSTEM CONCEPTS

LOW VELOCITY CONCEPTS

CONCEPT NAME	SCHEDULES IN YEARS (AA+1 … AA+22)	FULLY FUNDED CONSTRUCTION COST
A (1) - FLOATING PLATFORM / MOVING BARRIER SYSTEM (100 KCFS DESIGN)	FDM & P&S — CONSTRUCT — EVALUATION	$ 242 MILLION
A (2) - FLOATING PLATFORM / MOVING BARRIER SYSTEM (160 KCFS DESIGN)	FDM & P&S — CONSTRUCT — EVALUATION	$ 336 MILLION
B (1) - FLOW CONTROL / FIXED BARRIER SYSTEM (100 KCFS DESIGN)	FDM & P&S — CONSTRUCT — EVALUATION	$ 1.2 BILLION
B (2) - FLOW CONTROL / FIXED BARRIER SYSTEM (160 KCFS DESIGN)	FDM & P&S — CONSTRUCT — EVALUATION	$ 1.2 BILLION
C (1) - BRIDGE STRUCTURE / FIXED BARRIER SYSTEM (100 KCFS DESIGN)	FDM & P&S — CONSTRUCT — EVALUATION	$ 240 MILLION
C (2) - BRIDGE STRUCTURE / FIXED BARRIER SYSTEM (160 KCFS DESIGN)	FDM & P&S — CONSTRUCT — EVALUATION	$ 328 MILLION
C (3) - BRIDGE STRUCTURE / FIXED BARRIER SYSTEM (225 KCFS DESIGN)	FDM & P&S — CONSTRUCT — EVALUATION	$ 382 MILLION

HIGH VELOCITY CONCEPTS

CONCEPT NAME	SCHEDULES IN YEARS (AA+1 … AA+22)	FULLY FUNDED CONSTRUCTION COST
D - SKIMMER / SUBMERGED STANDARD SCREEN SYSTEM (100 KCFS AND 160 KCFS DESIGNS)	FDM & P&S — CONSTRUCT — EVALUATION	$ 873 MILLION
E - SKIMMER / EXTENDED SCREEN SYSTEM (100 KCFS AND 160 KCFS DESIGNS)	FDM & P&S — CONSTRUCT — EVALUATION	$ 892 MILLION
F - VERTICAL SLOT-FLOW CONTROL MODULAR INCLINED SCREEN SYSTEM (100 KCFS AND 160 KCFS DESIGNS)	FDM & P&S — CONSTRUCT — EVALUATION	$ 982 MILLION

NOTES:

1. SCHEDULE AND COST DATA IS BASED ON CONCEPTUAL LEVEL DESIGNS ASSUMING A TRANSPORT CONVEYANCE SYSTEM. USE THIS INFORMATION ONLY FOR MAKING RELATIVE COMPARISONS BETWEEN CONCEPTS.
2. SCHEDULES ASSUME PROJECT HAS RECEIVED CONGRESSIONAL AUTHORIZATION.
3. SCHEDULES DO NOT INCLUDE PHASE II OF THE SYSTEM CONFIGURATION STUDY. THIS PART OF THE STUDY WOULD INCLUDE FISHERIES RESEARCH, HYDRAULIC MODEL STUDIES, SITE STUDIES, ETC.
4. IMPLEMENTATION CAN NOT PROCEED UNTIL AUTHORIZATON AND APPROPRIATION (AA) IS RECIEVED. THUS, AA+1 IS THE FIRST YEAR AFTER AUTHORIZATION AND APPROPRIATION.
5. FULLY FUNDED CONSTRUCTION COST DO NOT INCLUDE FUNDS REQUIRED FOR BIOLOGICAL AND ENGINEERING RELATED RESEARCH NEEDS THAT MAY OCCUR DURING FEASIBILITY STUDIES.
6. FDM AND P&S MEANS FEATURE DESIGN MEMORANDUMS AND PLANS AND SPECIFICATIONS, RESPECTIVELY.

COMPUTER AIDED DESIGN & DRAFTING

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

REESE
HAUGEN/LEIGH

SYSTEM CONFIGURATION STUDIES-PHASE I
UPSTREAM COLLECTION AND CONVEYANCE
SCHEDULE AND CONSTRUCTION COST INFORMATION
UPSTREAM COLLECTION SYSTEM CONCEPTS

SCALE AS SHOWN
CHART I

REFERENCE FILES: SCS4UCS.BLK,TB — PEN TABLES: NO — MAIN SCALE: 1/8"=1'-0"

SCS4UCSSCH2.DGN

COLUMBIA RIVER SALMON MITIGATION ANALYSIS

SYSTEM CONFIGURATION STUDY - PHASE I

UPSTREAM COLLECTION AND CONVEYANCE SYSTEMS

SUMMARY SCHEDULE AND COST INFORMATION: ALTERNATIVES 1 - 4

ALTERNATIVE	SCHEDULES IN YEARS																						FULLY FUNDED CONSTRUCTION COST	FULLY FUNDED PROJECT COST
	AA+1	AA+2	AA+3	AA+4	AA+5	AA+6	AA+7	AA+8	AA+9	AA+10	AA+11	AA+12	AA+13	AA+14	AA+15	AA+16	AA+17	AA+18	AA+19	AA+20	AA+21	AA+22		
ALTERNATIVE 1 - SINGLE UPSTREAM COLLECTION WITH MIGRATORY CANAL SYSTEM (SEE NOTES 7 AND 8)	FDM & P&S		CONSTRUCT																	EVALUATION			\$ 4.8 BILLION TO \$ 4.9 BILLION	\$ 5.4 BILLION TO \$ 5.5 BILLION
ALTERNATIVE 2 - SINGLE UPSTREAM COLLECTION WITH PRESSURE PIPELINE SYSTEM (SEE NOTES 7 AND 8)	FDM & P&S		CONSTRUCT																	EVALUATION			\$ 4.6 BILLION TO \$ 4.7 BILLION	\$ 5.1 BILLION TO \$ 5.2 BILLION
ALTERNATIVE 3 - SINGLE UPSTREAM COLLECTION WITH TRANSPORT SYSTEM (SEE NOTE 8)	FDM & P&S		CONSTRUCT																	EVALUATION			\$ 240 MILLION TO \$ 382 MILLION	\$ 327 MILLION TO \$ 469 MILLION
ALTERNATIVE 4 - SINGLE UPSTREAM COLLECTION WITH FLOATING PIPELINE SYSTEM (SEE NOTES 7 AND 8)	FDM & P&S		CONSTRUCT																	EVALUATION			\$ 801 MILLION TO \$ 892 MILLION	\$ 924 MILLION TO \$ 1.0 BILLION

NOTES:

1. SCHEDULE AND COST DATA IS BASED ON CONCEPTUAL LEVEL DESIGNS ASSUMING A COLLECTION SYSTEM USING A BRIDGE STRUCTURE/FIXED BARRIER DESIGN. USE THIS INFORMATION ONLY FOR MAKING RELATIVE COMPARISONS BETWEEN CONCEPTS. RANGE IN COSTS (AND IN THE CASE FOR ALTERNATIVE 3, IN SCHEDULE) REFLECT A VARYING SIZE FOR UPSTREAM COLLECTION FACILITY COMPONENTS ASSUMING A COLLECTION DESIGN FLOW RANGING BETWEEN 100,000 CFS AND 225,000 CFS.
2. SCHEDULES ASSUME PROJECT HAS RECEIVED CONGRESSIONAL AUTHORIZATION.
3. SCHEDULES DO NOT INCLUDE PHASE II OF THE SYSTEM CONFIGURATION STUDY. THIS PART OF THE STUDY WOULD INCLUDE FISHERIES RESEARCH, HYDRAULIC MODEL STUDIES, SITE STUDIES, ETC.
4. IMPLEMENTATION CAN NOT PROCEED UNTIL AUTHORIZATON AND APPROPRIATION (AA) IS RECIEVED. THUS, AA+1 IS THE FIRST YEAR AFTER AUTHORIZATION AND APPROPRIATION.
5. FULLY FUNDED CONSTRUCTION COST DO NOT INCLUDE FUNDS REQUIRED FOR BIOLOGICAL AND ENGINEERING RELATED RESEARCH NEEDS THAT MAY OCCUR DURING FEASIBILITY STUDIES.
6. FDM AND P&S MEANS FEATURE DESIGN MEMORANDUMS AND PLANS AND SPECIFICATIONS, RESPECTIVELY.
7. CONSTRUCTION SCHEDULE SHOWN INCLUDES TIME FOR ADDITIONAL STAGED DESIGN AND LAND AQUISITIONS RELATED TO DIFFERENT REACHES OF THE CONVEYANCE SYSTEM.
8. CONSTRUCTION SCHEDULE RANGES BETWEEN 3 AND 5½ YEARS FOR THE UPSTREAM COLLECTION FACILITY COMPONENT ASSUMING DESIGN FLOWS RANGING BETWEEN 100,000 CFS AND 225,000 CFS, RESPECTIVELY. FOR ALTERNATIVES 1, 2, AND 4, THE UPSTREAM COLLECTION FACILITY COMPONENT DOES NOT DICTATE THE OVERALL LENGTH OF THE CONSTRUCTION SCHEDULE. FOR ALTERNATIVE 1, THE UPSTREAM COLLECTION FACILITY IS THE MAJOR PART OF THE CONSTRUCTION.

COMPUTER AIDED DESIGN & DRAFTING

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

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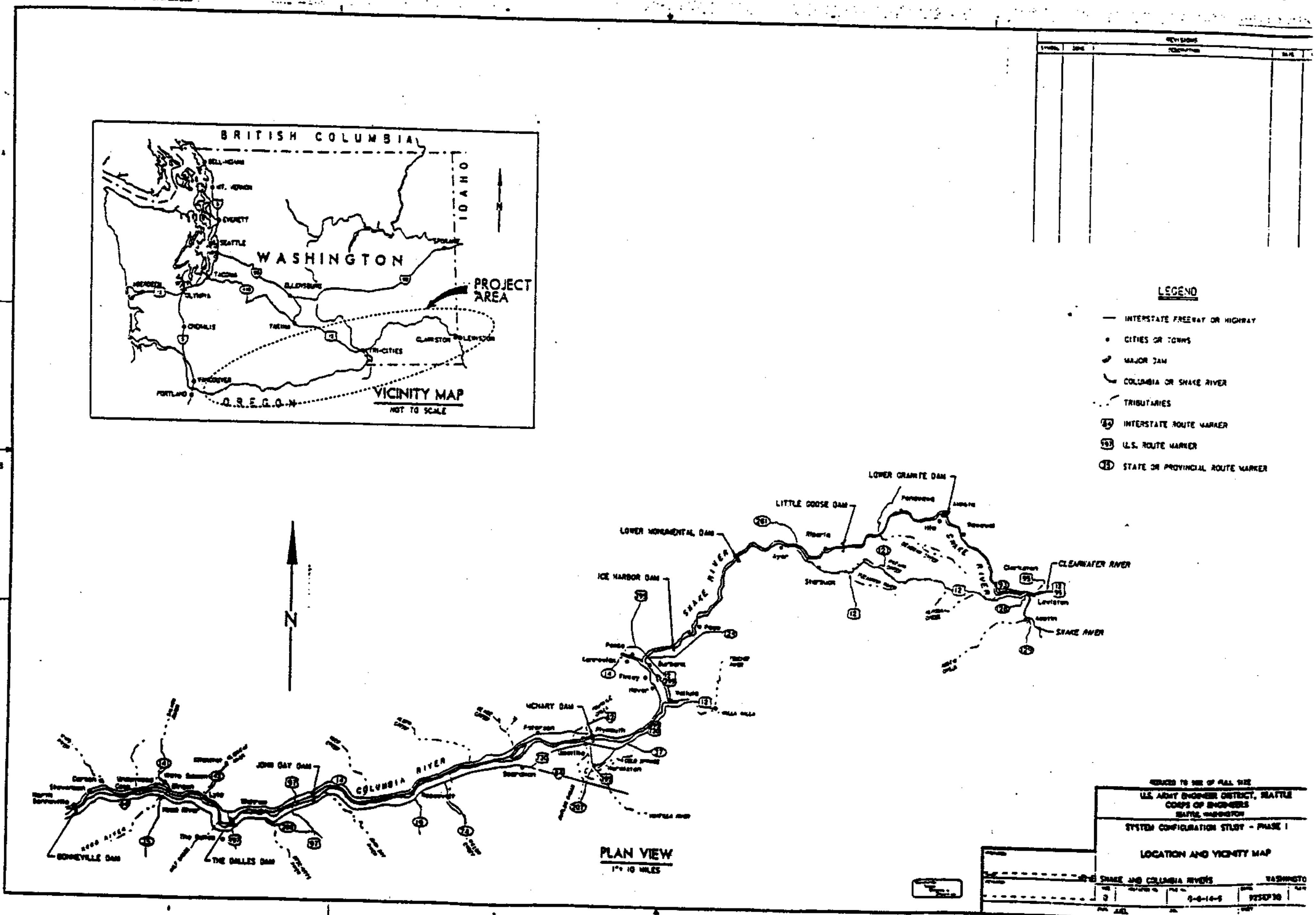
SYSTEM CONFIGURATION STUDIES PHASE I
UPSTREAM COLLECTION AND CONVEYANCE
SUMMARY SCHEDULE AND COST INFORMATION
ALTERNATIVES 1 - 4

SCALE AS SHOWN | DIV. NO.

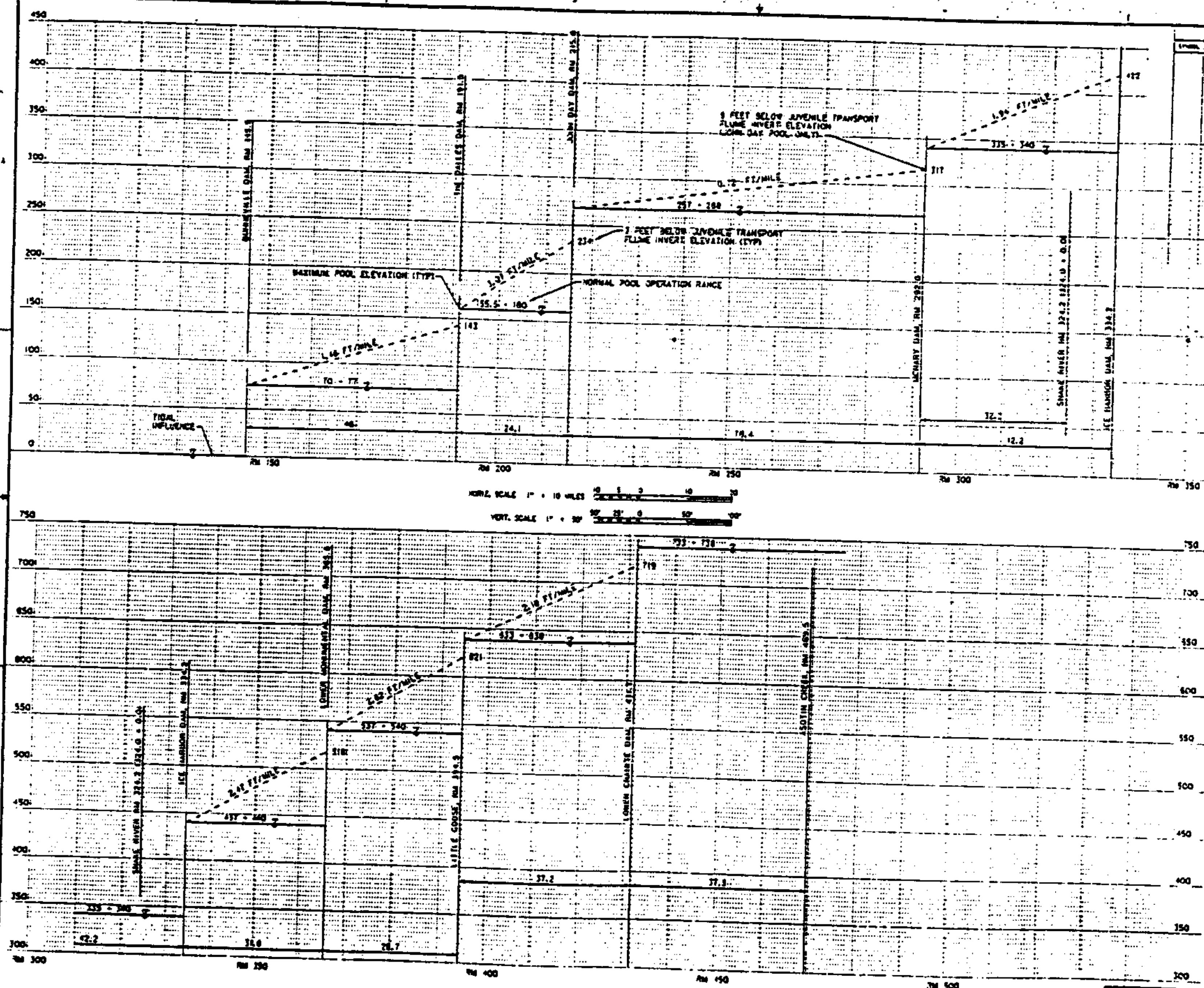
CHART 2

SCSUCS.BLK.TB NO SCSUCSSCHBZ.DC

ENCLOSURES



ENCLOSURE 1-1



NOTES:

1. POOL ELEVATIONS SHOWN REFLECT THE NORMAL OPERATING POOL ELEVATION RANGE RELATIVE TO NGVD DATUM.

REDUCED TO 50% OF FULL SIZE

U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

SYSTEM CONFIGURATION STUDY - PHASE I

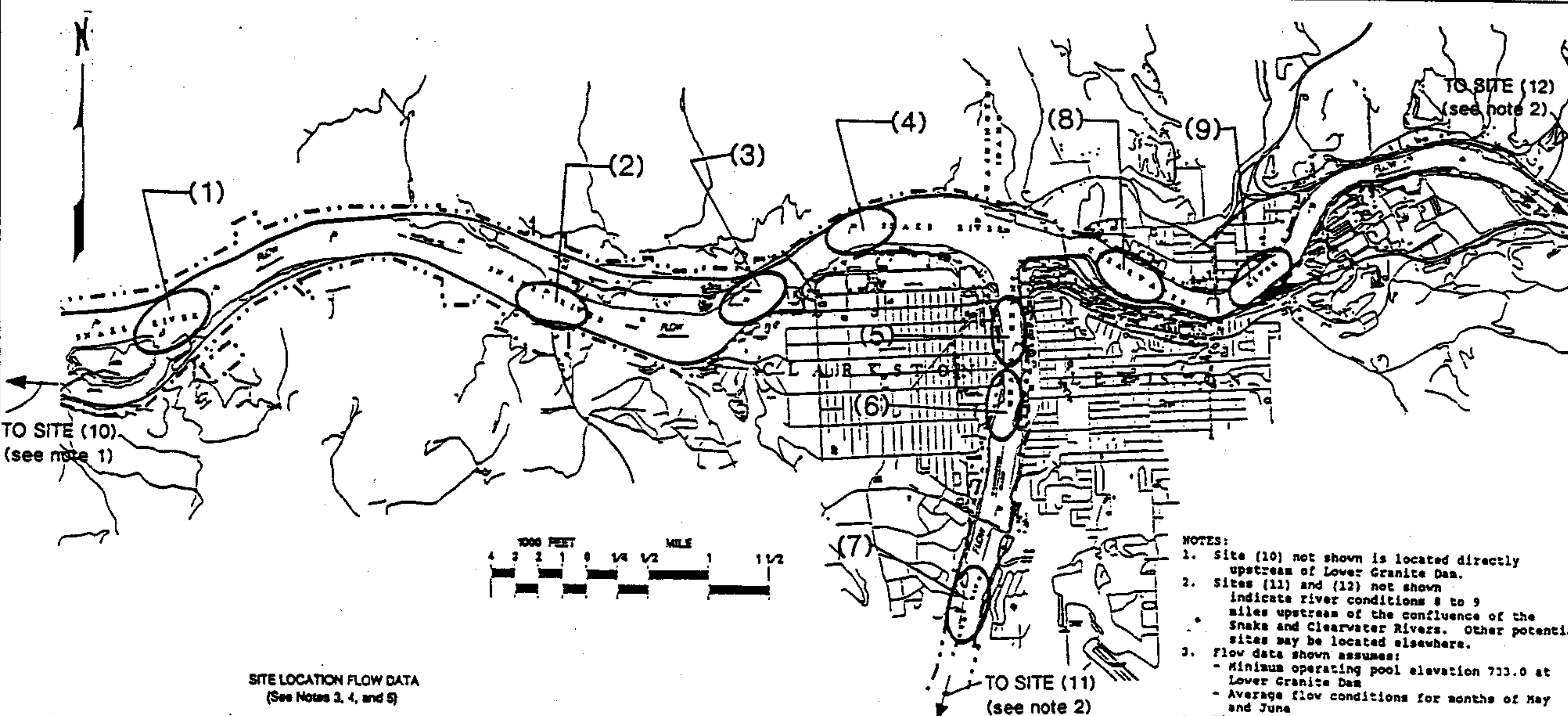
RIVER PROFILE

SNAKE AND COLUMBIA RIVERS — WASHINGTON

92SEP30

FIGURE 1-2

CORPS OF ENGINEERS | SAFETY PAYS | U. S. ARMY



NOTES:
1. Site (10) not shown is located directly upstream of Lower Granite Dam.
2. Sites (11) and (12) not shown indicate river conditions 8 to 9 miles upstream of the confluence of the Snake and Clearwater Rivers. Other potential sites may be located elsewhere.
3. Flow data shown assumes:
   - Minimum operating pool elevation 733.0 at Lower Granite Dam
   - Average flow conditions for months of May and June
4. River geometry and flow analysis based on sedimentation range data.
5. Site location designations:
   SD - Snake River downstream of Lewiston
   SU - Snake River upstream of Lewiston
   CW - Clearwater River upstream of Lewiston

SITE LOCATION FLOW DATA
(See Notes 3, 4, and 5)

Site	River Mile	Water Level (fmsl)	River Discharge (cfs)	Maximum Water Depth (ft)	Average water Velocity (fps)	River Top Width FT	Flow Area (sq ft)
1 (SD)	131.62	733.2	102,000	62.4	1.8	1426	58,286
2 (SD)	135.15	733.4	102,000	55.6	1.8	1455	55,435
3 (SD)	137.17	733.5	102,000	50.0	2.4	1200	42,149
4 (SD)	138.07	733.6	102,000	48.8	2.4	1401	41,803
5 (SU)	139.91	733.9	68,000	35.1	3.1	789	21,656
6 (SU)	140.51	734.0	68,000	40.8	3.0	779	26,667
7 (SU)	142.40	734.7	68,000	40.0	3.4	907	19,767
8 (CW)	1.36	734.0	34,000	19.9	1.7	1278	20,118
9 (CW)	2.58	734.6	34,000	16.1	3.8	849	9,067
10 (SD)	107.43	733.0	102,000	123.3	0.4	3102	275,676
11 (SU)	148.83	748.0	68,000	16.1	6.8	674	10,074
12 (CW)	7.85	759.4	34,000	11.6	7.2	516	4,735

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

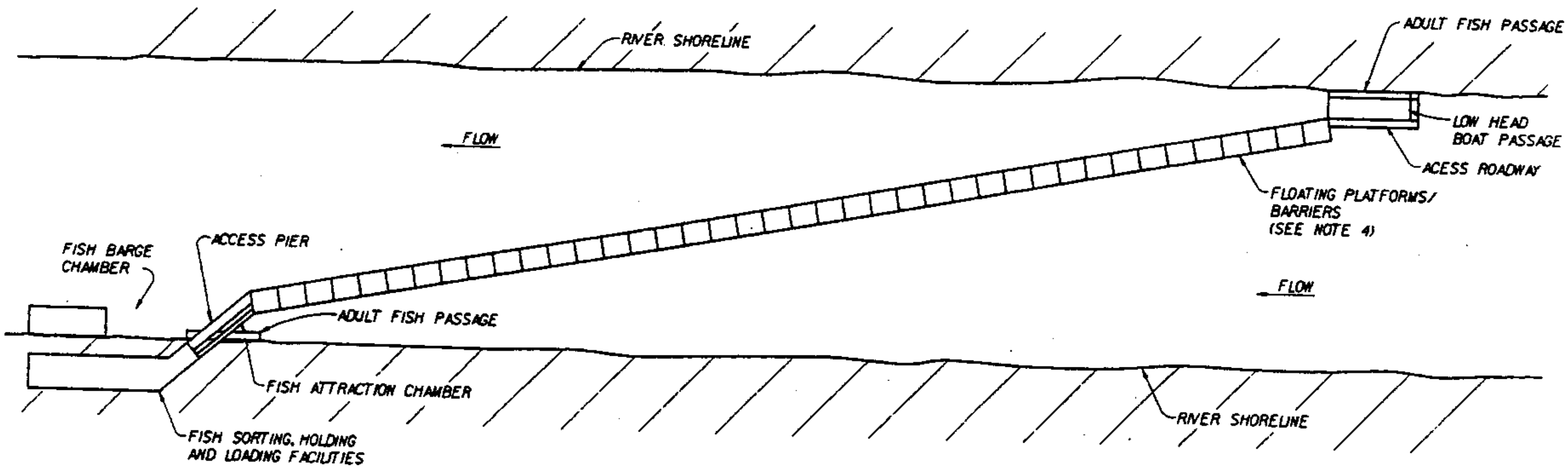
SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS

POTENTIAL SITES FOR UPSTREAM COLLECTION SYSTEM

SCALE AS SHOWN | INV. NO.

ENCLOSURE 2-1

VALUE ENGINEERING PAYS



COMMON SITE PLAN - LOW VELOCITY BARRIERS

Q (DESIGN) = 100,000 CFS
(SEE NOTE 1)

SCALE IN FEET
400' 0 400'

NOTES:

1. LAYOUT SHOWN ASSUMES A VELOCITY THROUGH THE GROSS FLOW AREA OF THE BARRIERS EQUAL TO 0.5 FPS ASSUMING A 60-FOOT WATER DEPTH (50-FOOT POTENTIAL EXPOSED BARRIER DEPTH) AT A RIVER DISCHARGE EQUAL TO 100,000 CFS.
2. UPSTREAM DEBRIS REMOVAL AND RELATED FEATURES NOT SHOWN.
3. CABLE ANCHORS FOR FLOATING PLATFORMS NOT SHOWN.
4. A VERSION OF THIS SITE PLAN USING FIXED STRUCTURES OR FLOATING PLATFORMS COULD BE USED.

COMPUTER AIDED DESIGN & DRAFTING

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

REESE
HAUGEN

SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS
COMMON SITE PLAN FOR LOW VELOCITY BARRIER CONCEPTS
(DESIGN FLOW = 100,000 CFS)

SCALE AS SHOWN

ENCLOS[illegible] 2-2

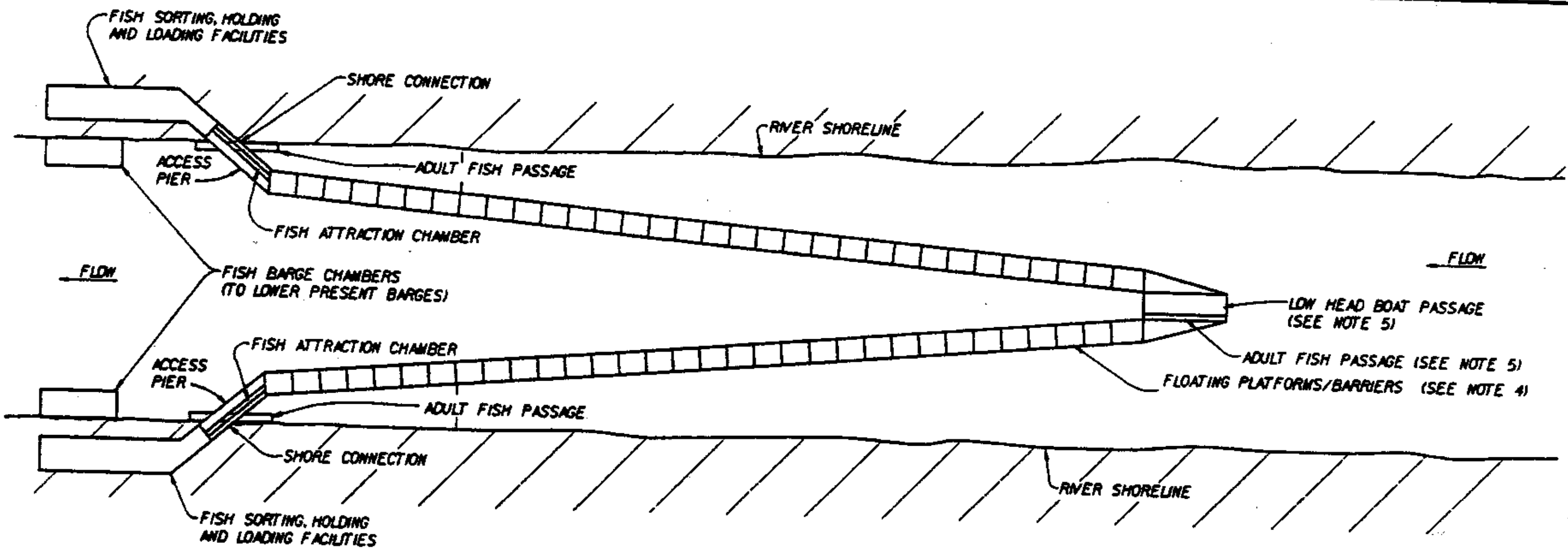
REFERENCE FILES: SCSUCS.BLK.TB
PEN TABLES: NO
SCALE: 1"=400'-0"

CORPS OF ENGINEERS | SAFETY PAYS | U.S. ARMY | VALUE ENGINE[illegible]

CORPS OF ENGINEERS

SAFETY PAYS

U. S. ARMY



COMMON SITE PLAN - LOW VELOCITY BARRIERS

Q (DESIGN) = 160,000 CFS OR 225,000CFS
(SEE NOTE 1 AND 4)

SCALE IN FEET
400' 0 400'

NOTES:

1. LAYOUT SHOWN ASSUMES A VELOCITY THROUGH THE GROSS FLOW AREA OF THE BARRIERS EQUAL TO 0.5 FPS ASSUMING A 60-FOOT WATER DEPTH (50-FOOT POTENTIAL EXPOSED BARRIER DEPTH) AT A RIVER DISCHARGE EQUAL TO 160,000 CFS OR 225,000 CFS.
2. UPSTREAM DEBRIS REMOVAL AND RELATED FEATURES NOT SHOWN.
3. CABLE ANCHORS FOR FLOATING PLATFORMS NOT SHOWN.
4. A VERSION OF THIS SITE PLAN USING FIXED STRUCTURES OR FLOATING PLATFORMS COULD BE USED. THE PRIMARY DIFFERENCE BETWEEN THE 160,000 CFS AND 225,000 CFS WILL BE THE LENGTH BARRIERS REQUIRED.
5. THE LOW HEAD BOAT PASSAGE AND THE ADULT FISH PASSAGE CHAMBER WOULD BE PART OF AN IN-RIVER PIER/ANCHOR SYSTEM FOR THE FLOATING PLATFORMS.

COMPUTER AIDED DESIGN & DRAFTING

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

REESE
HAUGEN

SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS
COMMON SITE PLAN FOR LOW VELOCITY BARRIER CONCEPTS
(DESIGN FLOW = 160,000 CFS AND 225,000 CFS)

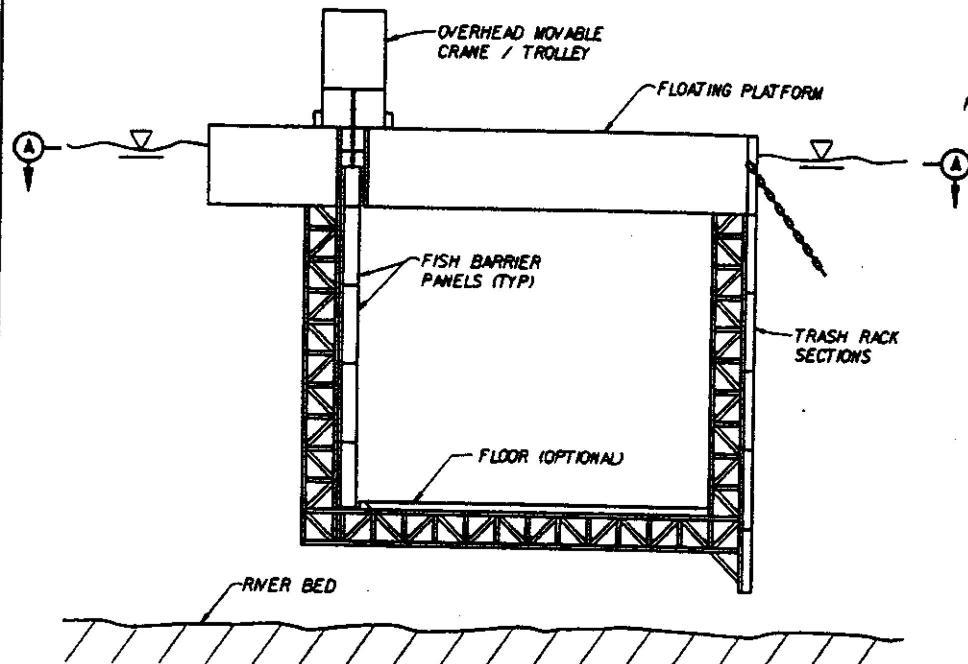
SCALE AS SHOWN | INV. NO.

ENCLOSURE 2-3

400

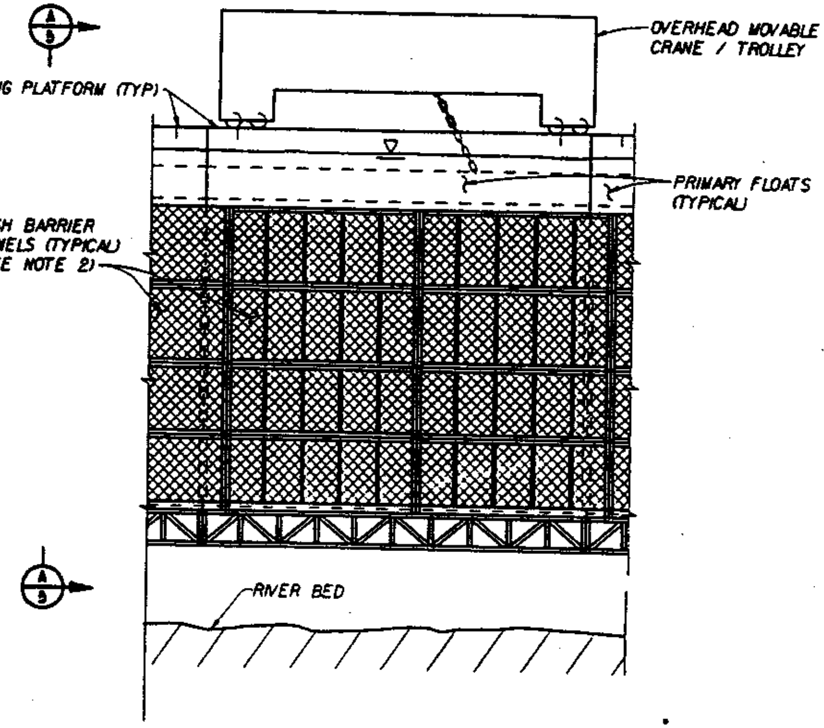
VALUE ENGINEERING PAYS

SCS4UCS.BLK,TB | NO | 1"=400'-0"



FLOATING PLATFORM - SIDE VIEW

SCALE IN FEET 0 10' 20'



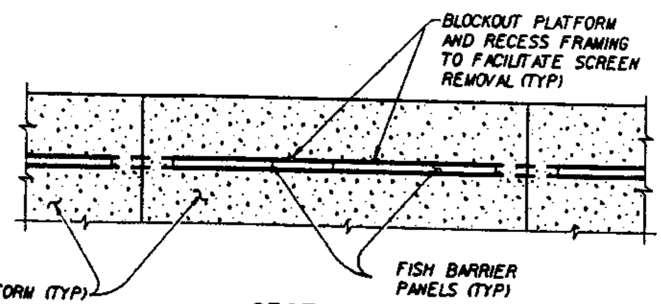
FLOATING PLATFORM - FRONT VIEW

(TRASH RACK NOT SHOWN FOR CLARITY)

SCALE IN FEET 0 10' 20'

NOTES:

1. A SUBSTANTIAL ANCHOR SYSTEM WILL BE REQUIRED TO MAINTAIN THE FLOATING PLATFORM AND RELATED COMPONENTS IN PLACE.
2. BARRIER ARRANGEMENTS AND TYPES CAN BE VARIED AS NEEDED.



SECTION A

SCALE IN FEET 0 20' 40'

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

REESE/BOSS
HAUGEN

SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS

LOW VELOCITY BARRIER SYSTEM
CONCEPT A - FLOATING PLATFORM/MOVING BARRIER SYSTEM - VIEWS

SCALE AS SHOWN | INV. NO.

ENCLOS[illegible]E 2-4

SCSd.SD.BLK.TB
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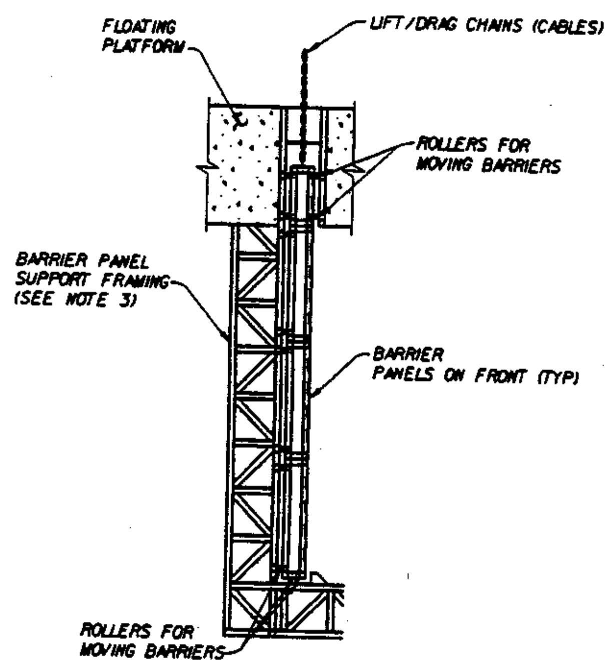
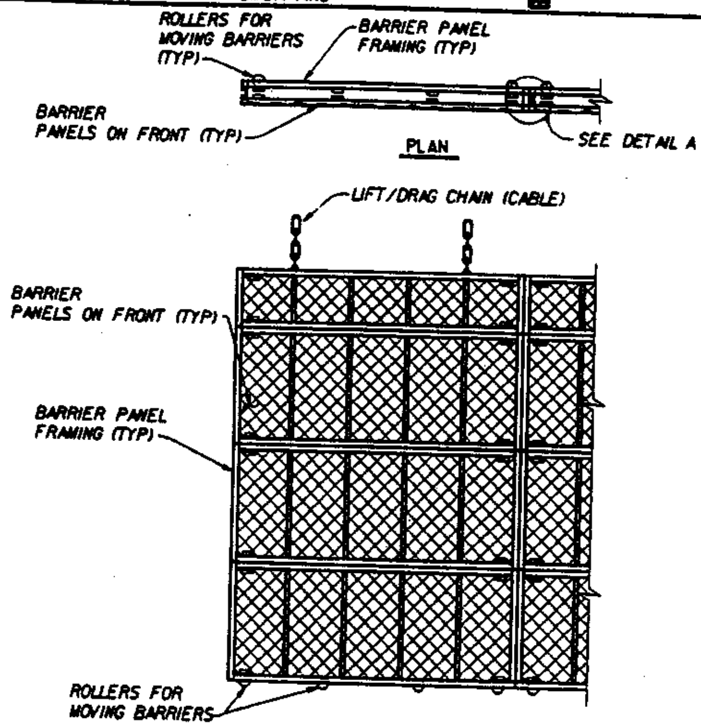
1/8"=1'-0"



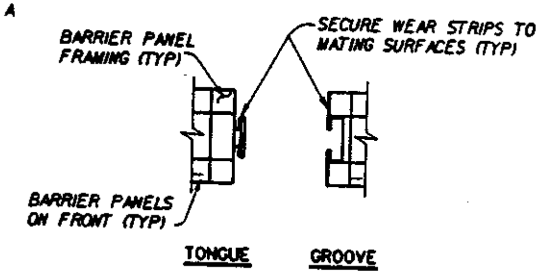
SECTION A
4

(TRASH RACK NOT SHOWN)



FISH DIVERSION BARRIERS (SEE NOTE 2)

(FLOATING PLATFORM, FRAMEWORK AND TRASH RACK NOT SHOWN)



DETAIL A

(ADJACENT PANELS SHOWN DISSASEMBLED)

NOTES:

1. BOLT PANELS TOGETHER (TOP TO BOTTOM) TO FORM 25FT WIDE BY 35FT TALL PANELS.
2. BARRIERS SUCH AS SCREENS LOUVERS, SOUND DEVICES, OR LIGHT DEVICES COULD BE MOUNTED ON THE FRAMEWORK.
3. SUPPORT FRAMING COULD BE MADE FLOATABLE TO FACILITATE CONSTRUCTION AND OPERATION.

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

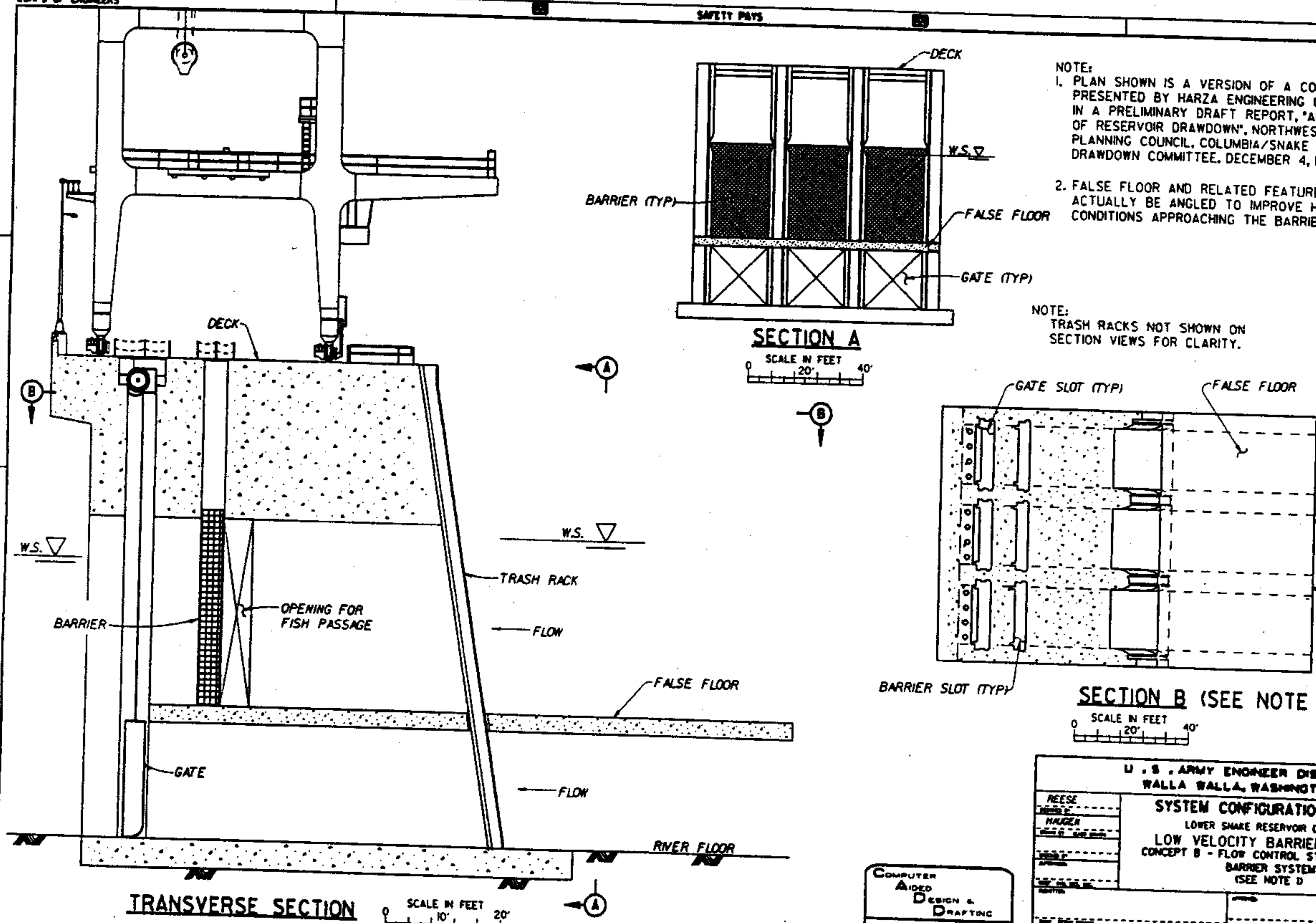
REESE/ROSS
HAUGEN

SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS
LOW VELOCITY BARRIER SYSTEM
CONCEPT A - FLOATING PLATFORM/MOVING BARRIER SYSTEM - DETAILS

SCALE AS SHOWN

ENCLOSURE 2-5

SCSUCS.BLK.TB
NO
3/16"=1'-0"
UCXX03A.DGN



NOTE:
1. PLAN SHOWN IS A VERSION OF A CONCEPT PRESENTED BY HARZA ENGINEERING COMPANY IN A PRELIMINARY DRAFT REPORT, "ANALYSIS OF RESERVOIR DRAWDOWN", NORTHWEST POWER PLANNING COUNCIL, COLUMBIA/SNAKE RIVER DRAWDOWN COMMITTEE, DECEMBER 4, 1992.

2. FALSE FLOOR AND RELATED FEATURES WOULD ACTUALLY BE ANGLED TO IMPROVE HYDRAULIC CONDITIONS APPROACHING THE BARRIER.

NOTE:
TRASH RACKS NOT SHOWN ON SECTION VIEWS FOR CLARITY.

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

SYSTEM CONFIGURATION STUDIES
LOWER SNAKE RESERVOIR DRAWDOWN
LOW VELOCITY BARRIER SYSTEM
CONCEPT B - FLOW CONTROL STRUCTURE/FIXED BARRIER SYSTEM
(SEE NOTE 1)

REESE
HAUGER

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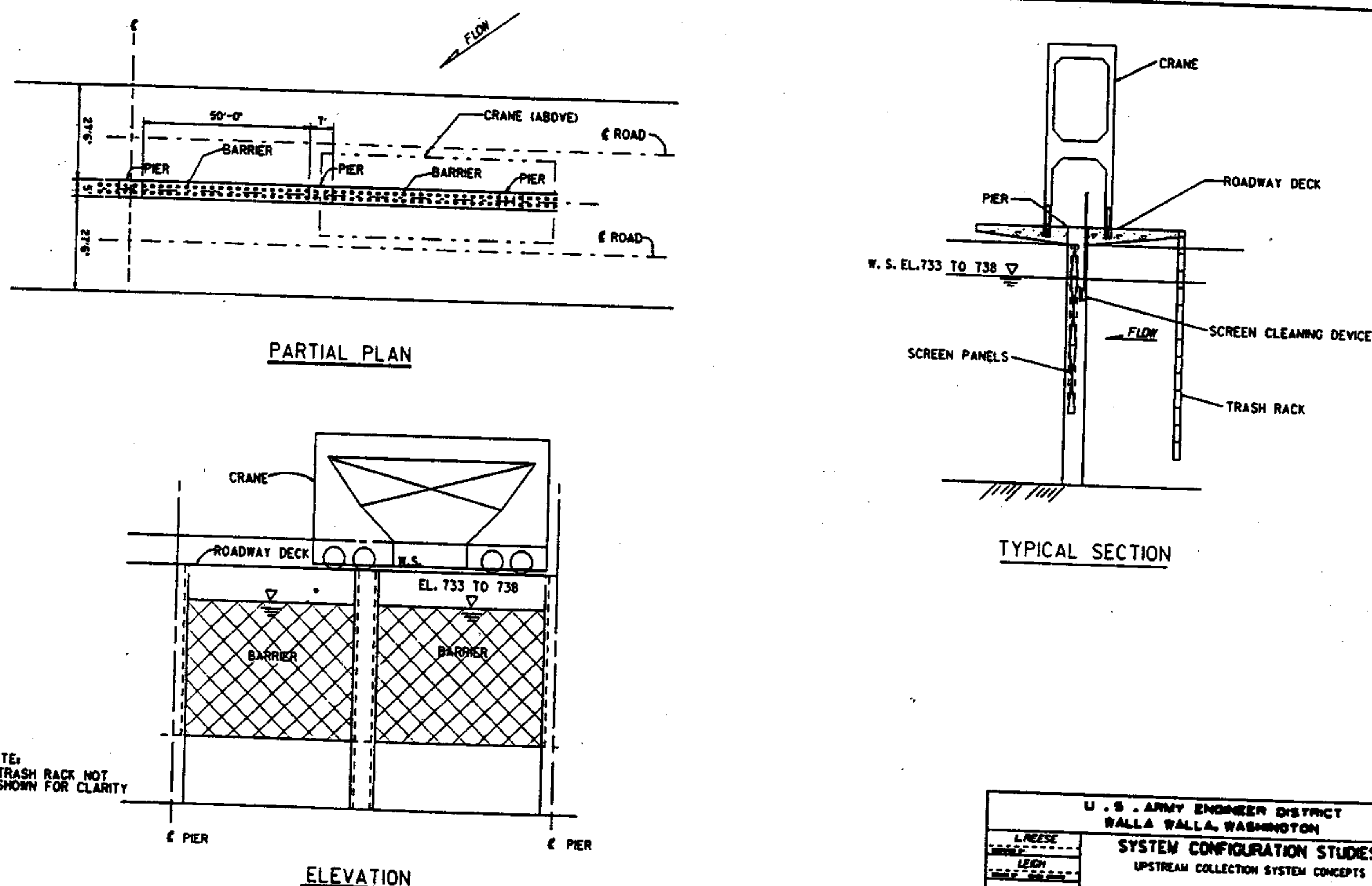
SCALE AS SHOWN

ENCLOSURE 2-6

REFERENCE FILES: SCS&UCS.BLK.TB
PEN TABLES: NO
SCALE: 1/8"=1'-0"



NOTE:
TRASH RACK NOT SHOWN FOR CLARITY

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U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

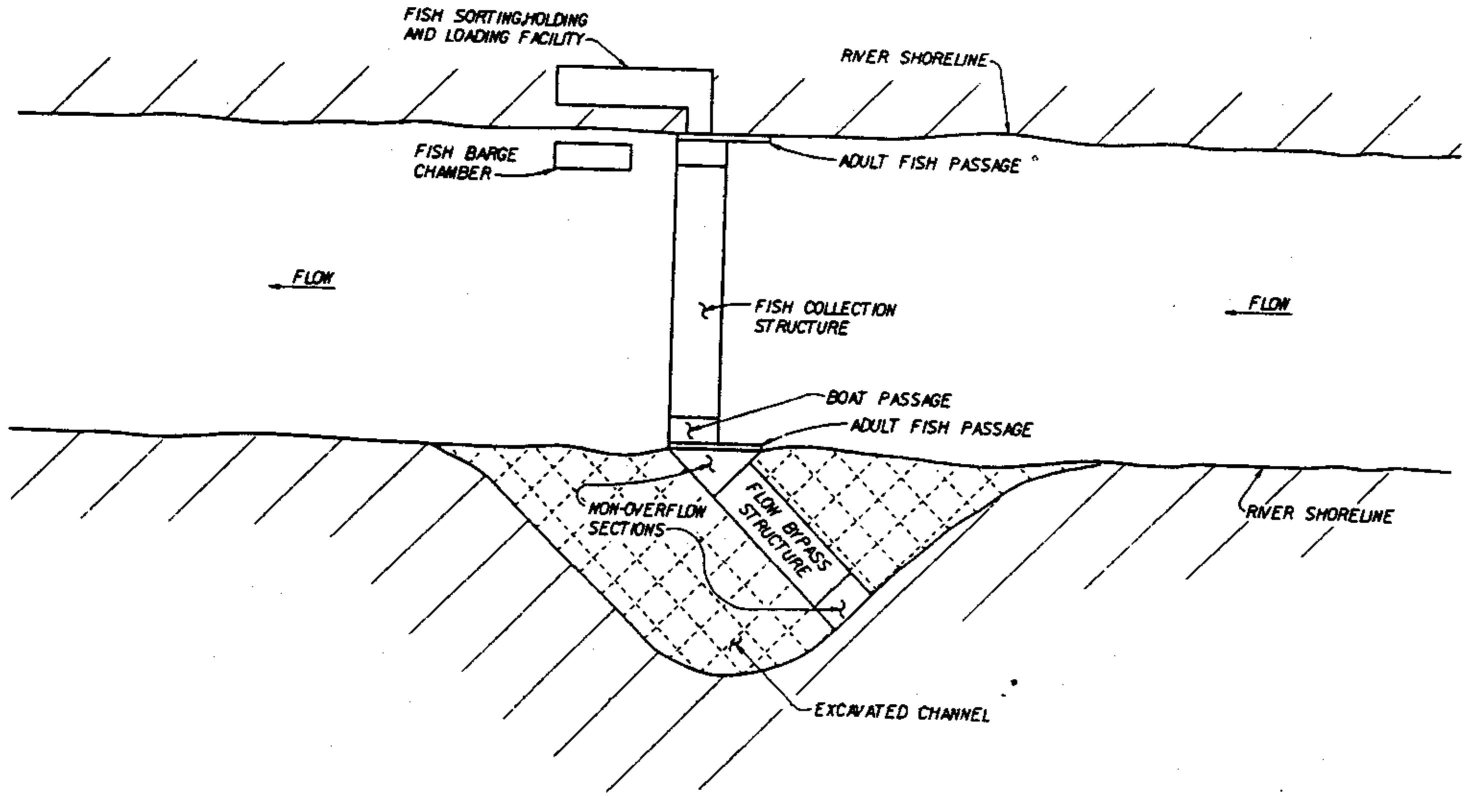
SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS

LOW VELOCITY BARRIER SYSTEM
CONCEPT C - BRIDGE STRUCTURE/FIXED BARRIER SYSTEM

L.REESE
LEIGH

SCALE AS SHOWN | INV. NO.

ENCLOSURE 2-7



COMMON SITE PLAN - HIGH VELOCITY SCREENS

SCALE IN FEET
400' 0 400'

NOTE:
LAYOUT SHOWN ASSUMES: (1) A SITE LOCATION ON THE SNAKE RIVER DOWNSTREAM OF LEWISTON, (2) FISH COLLECTION FOR RIVER FLOWS UP TO 160,000 CFS, AND (3) FACILITY WILL SAFELY PASS A STANDARD PROJECT FLOOD EQUAL TO 420,00 CFS.

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U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

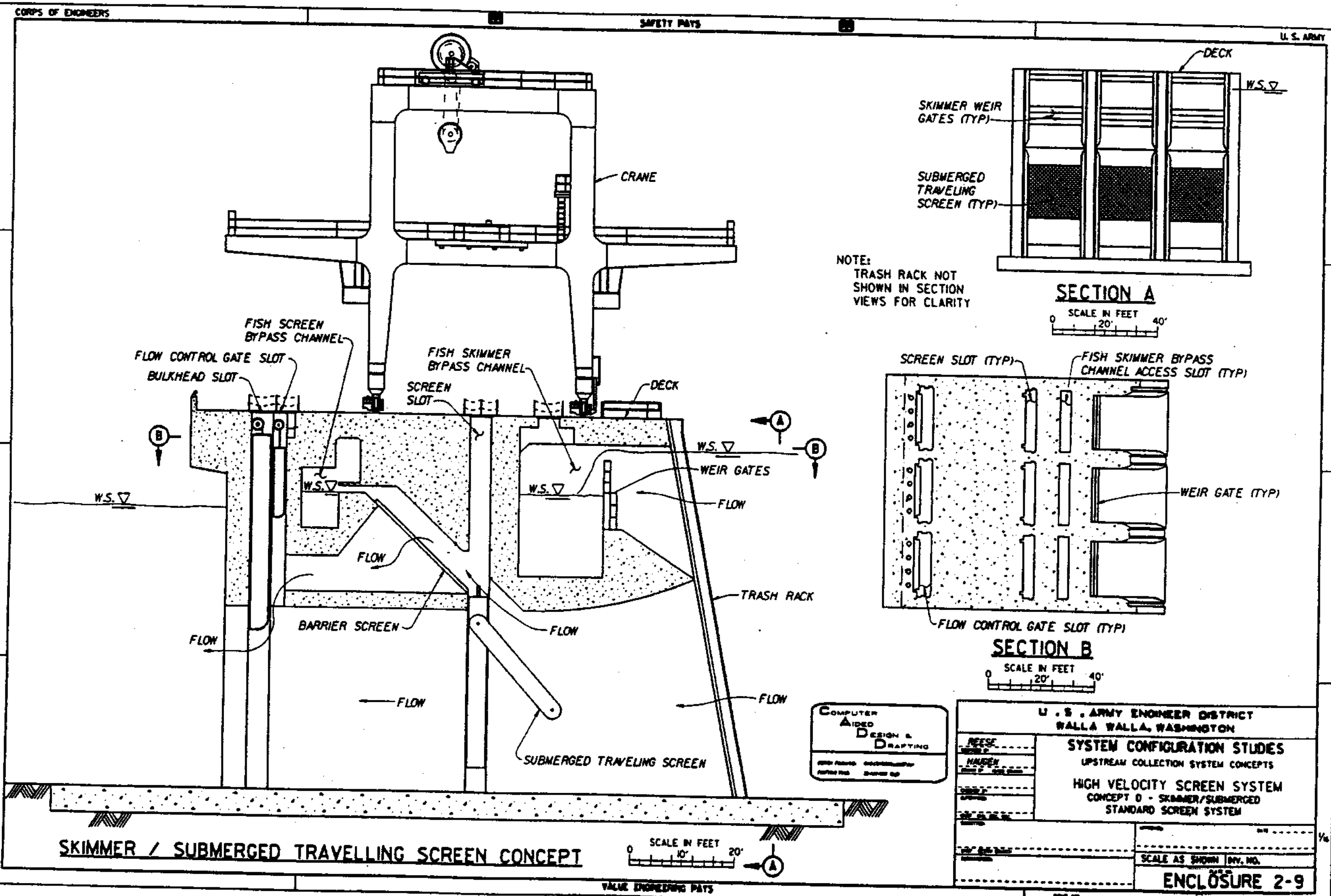
REESE
HAUGEN

SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS
SITE PLAN
COMMON SITE PLAN FOR HIGH VELOCITY SCREEN CONCEPTS

SCALE AS SHOWN

ENCLOSURE 2-8

REFERENCE FILES: SCSaUCS.BLK.TB
PEN TABLES: NO
SCALE: 1"=400'-0"


CORPS OF ENGINEERS
SAFETY PAYS
U. S. ARMY
CRANE
FISH SCREEN BYPASS CHANNEL
FLOW CONTROL GATE SLOT
BULKHEAD SLOT
FISH SKIMMER BYPASS CHANNEL
SCREEN SLOT
DECK
W.S.
WEIR GATES
FLOW
FLOW
BARRIER SCREEN
FLOW
FLOW
TRASH RACK
FLOW
FLOW
SUBMERGED TRAVELING SCREEN
SKIMMER / SUBMERGED TRAVELLING SCREEN CONCEPT
SCALE IN FEET
0 10' 20'
NOTE:
TRASH RACK NOT SHOWN IN SECTION VIEWS FOR CLARITY
DECK
SKIMMER WEIR GATES (TYP)
SUBMERGED TRAVELING SCREEN (TYP)
SECTION A
SCALE IN FEET
0 20' 40'
SCREEN SLOT (TYP)
FISH SKIMMER BYPASS CHANNEL ACCESS SLOT (TYP)
WEIR GATE (TYP)
FLOW CONTROL GATE SLOT (TYP)
SECTION B
SCALE IN FEET
0 20' 40'
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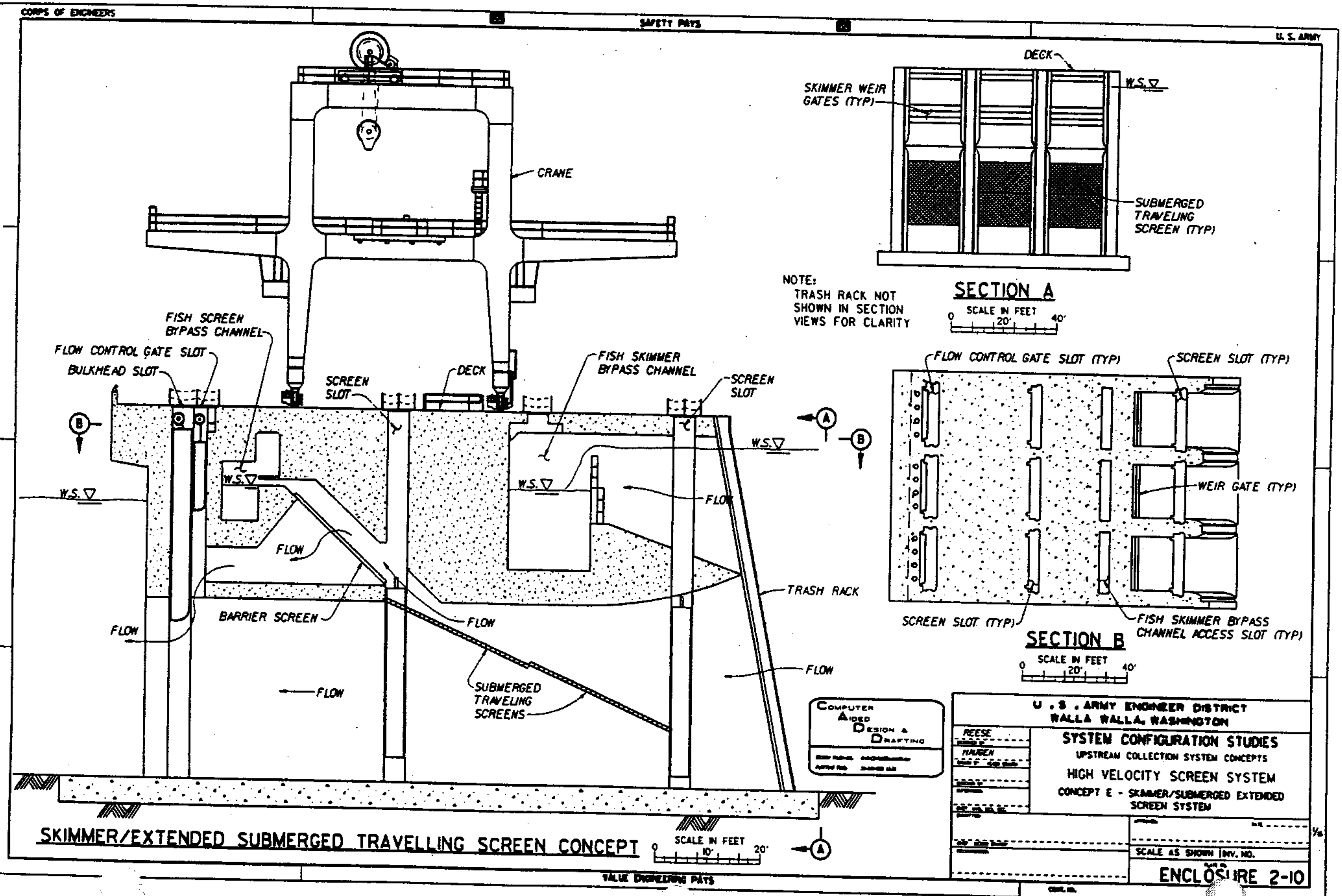
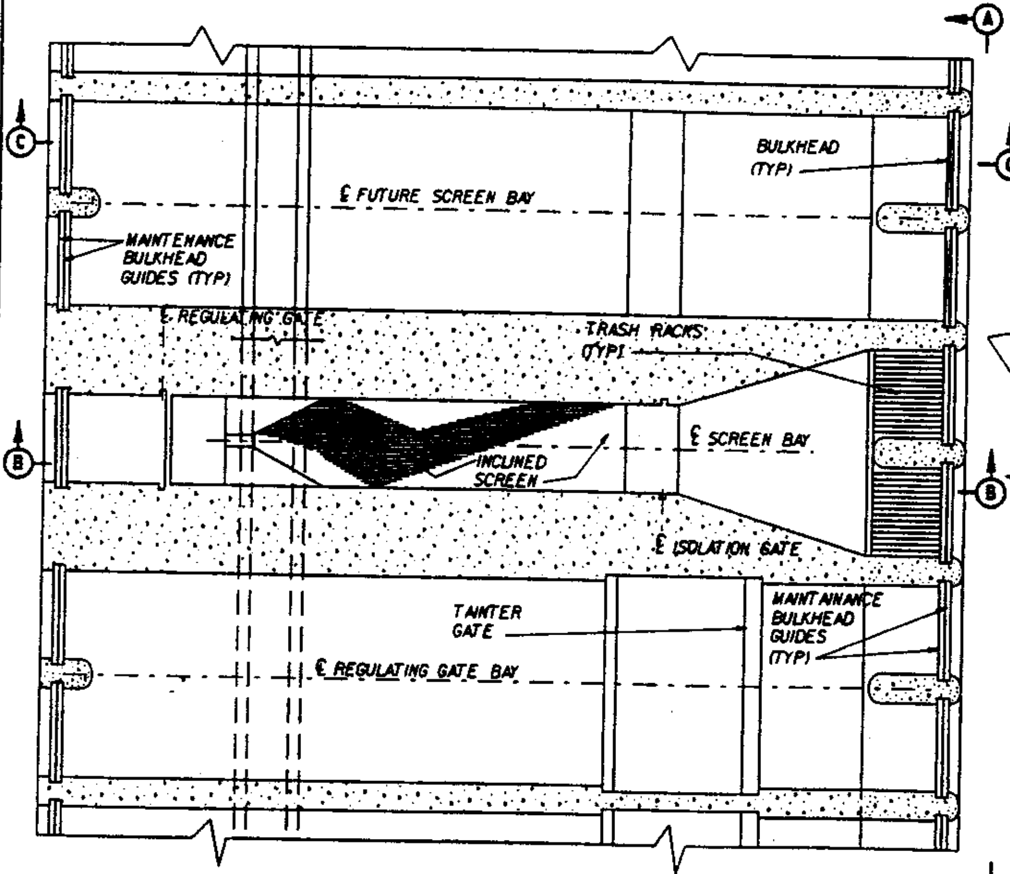
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
REESE
HAUGEN
SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS
HIGH VELOCITY SCREEN SYSTEM
CONCEPT D - SKIMMER/SUBMERGED STANDARD SCREEN SYSTEM
SCALE AS SHOWN
ENCLOSURE 2-9
VALUE ENGINEERING PAYS
SCS4.SD.BLK.TB - OF+ST
NO
1/8"=1'-0"
SCS4CSPD7.dgn

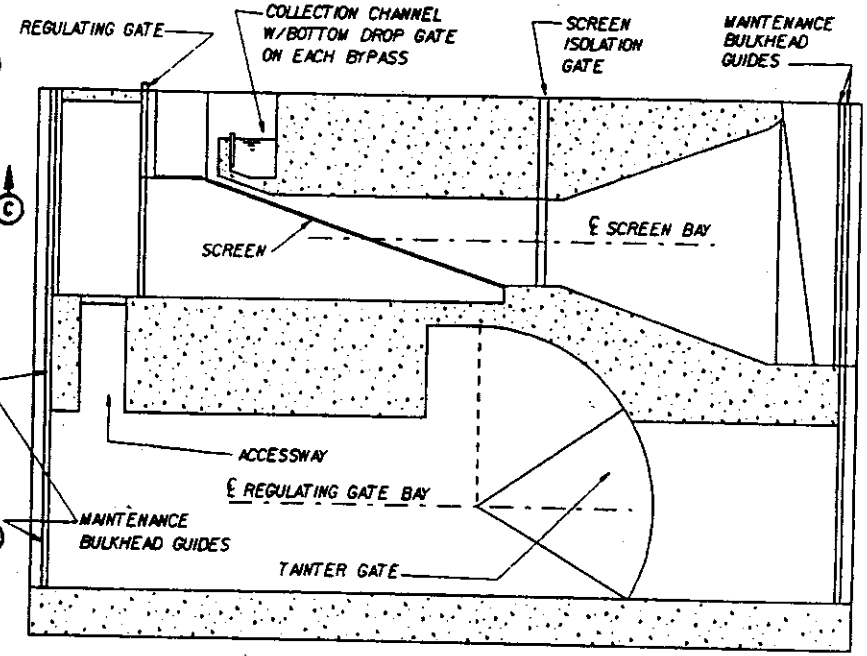


CORPS OF ENGINEERS
SAFETY PAYS
U. S. ARMY
CRANE
FISH SCREEN BYPASS CHANNEL
FLOW CONTROL GATE SLOT
BULKHEAD SLOT
SCREEN SLOT
DECK
FISH SKIMMER BYPASS CHANNEL
SCREEN SLOT
W.S.
FLOW
BARRIER SCREEN
SUBMERGED TRAVELING SCREENS
TRASH RACK
NOTE: TRASH RACK NOT SHOWN IN SECTION VIEWS FOR CLARITY
DECK
SKIMMER WEIR GATES (TYP)
SUBMERGED TRAVELING SCREEN (TYP)
SECTION A
SCALE IN FEET 0 20' 40'
FLOW CONTROL GATE SLOT (TYP)
SCREEN SLOT (TYP)
WEIR GATE (TYP)
FISH SKIMMER BYPASS CHANNEL ACCESS SLOT (TYP)
SECTION B
SCALE IN FEET 0 20' 40'
SKIMMER/EXTENDED SUBMERGED TRAVELLING SCREEN CONCEPT
SCALE IN FEET 0 10' 20'
COMPUTER AIDED DESIGN & DRAFTING
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
REESE
HAUGEN
SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS
HIGH VELOCITY SCREEN SYSTEM
CONCEPT E - SKIMMER/SUBMERGED EXTENDED SCREEN SYSTEM
SCALE AS SHOWN
INV. NO.
ENCLOSURE 2-10
VALUE ENGINEERING PAYS
SCS4.SD.BLK.TB - OF=57
NO
1/8"=1'-0"



PARTIAL PLAN

SCALE IN FEET
0 20' 40'



SECTION B

TRANSVERSE SECTION - TYPICAL COLLECTION BAY

SCALE IN FEET
0 20' 40'

NOTES:

1. VERTICAL SLOT FISH ENTRANCE AND REGULATING GATE CONCEPT BASED ON A SYSTEM CURRENTLY USED AT WELLS DAM ON THE COLUMBIA RIVER.

COMPUTER AIDED DESIGN & DRAFTING

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

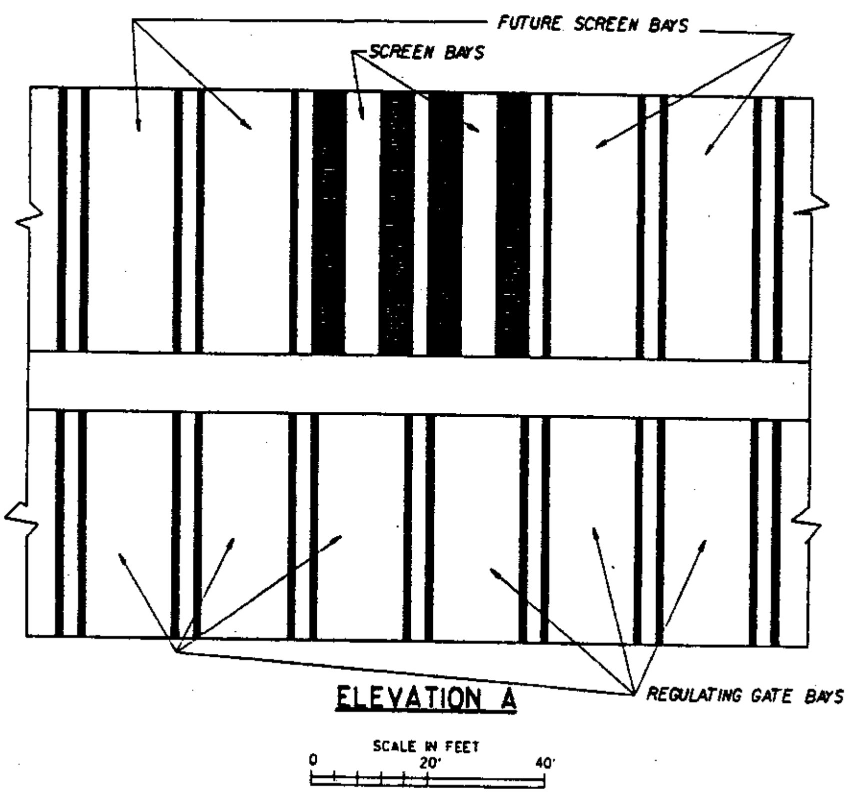
REESE
HAUGEN/LEIGH

SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS
HIGH VELOCITY SCREEN SYSTEM
CONCEPT F - VERTICAL SLOT-FLOW CONTROL/MODOLAR INCLINED SCREEN SYSTEM (SEE NOTE 1)
PARTIAL PLAN AND SECTION B

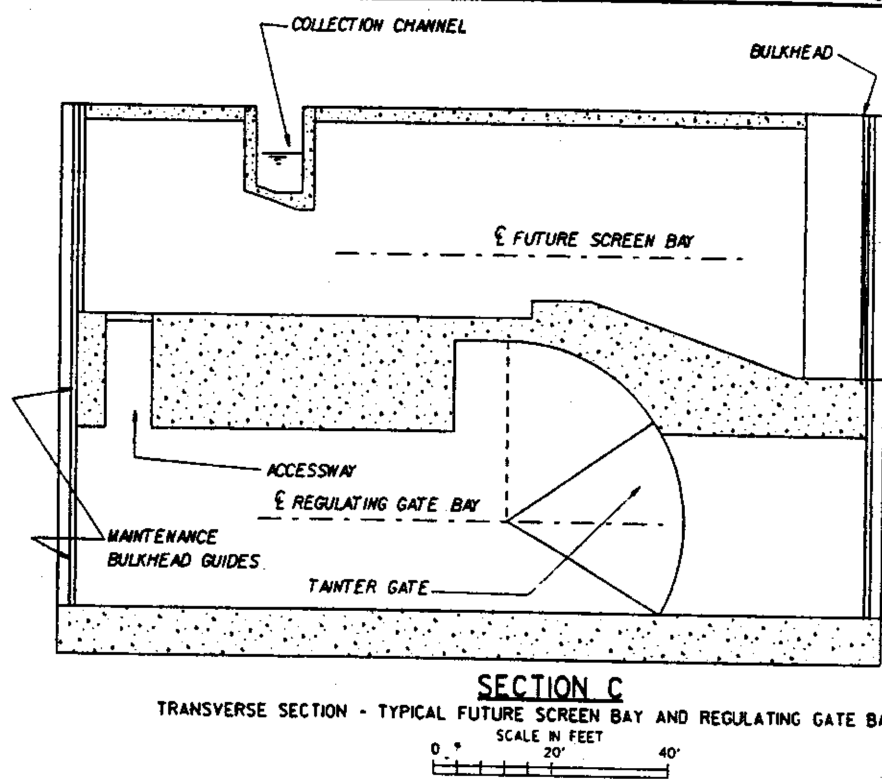
SCALE AS SHOWN

ENCLOSURE 2-11

SCSHCS.BLK.TB



ELEVATION A



SECTION C

TRANSVERSE SECTION - TYPICAL FUTURE SCREEN BAY AND REGULATING GATE BAY

NOTES:

1. VERTICAL SLOT FISH ENTRANCE AND REGULATING GATE CONCEPT BASED ON A SYSTEM CURRENTLY USED AT WELLS DAM ON THE COLUMBIA RIVER.

COMPUTER AIDED DESIGN & DRAFTING

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

REESE
HAUGEN/LEIGH

SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS
HIGH VELOCITY SCREEN SYSTEM
CONCEPT F - VERTICAL SLOT-FLOW CONTROL/MODULAR INCLINED SCREEN SYSTEM (SEE NOTE 1)
ELEVATION A AND SECTION C

SCALE AS SHOWN

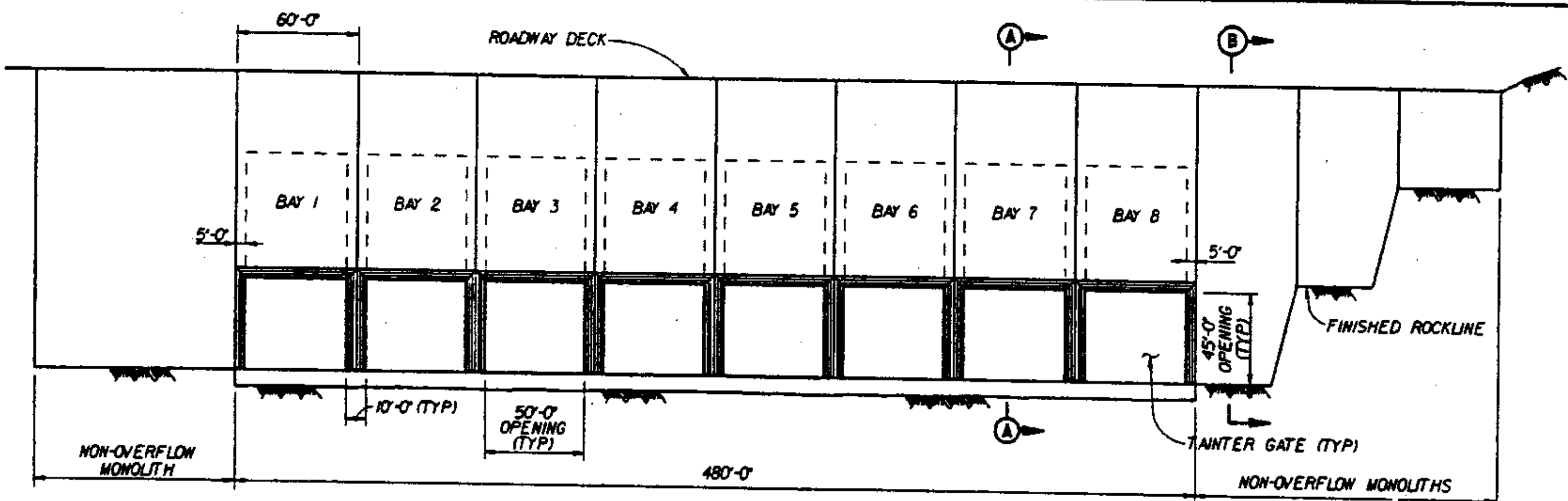
ENCLOSURE 2-12

REFERENCE FILES: SCSUCS.BLK.TB

CORPS OF ENGINEERS

SAFETY PAYS

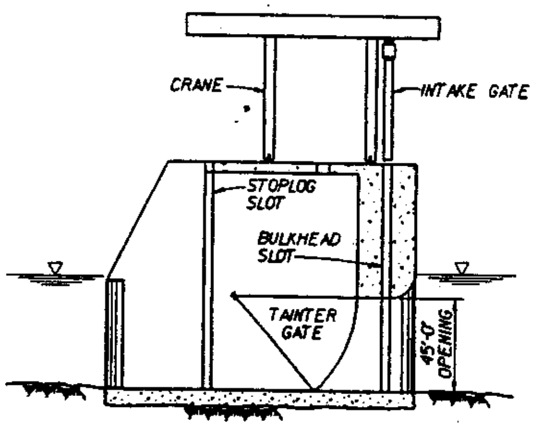
U. S. ARMY



CONCRETE OUTLINE - UPSTREAM ELEVATION

SCALE IN FEET

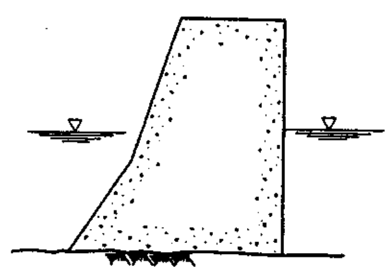
60' 0 60'



SECTION A

SCALE IN FEET

60' 0 60'



SECTION B

SCALE IN FEET

60' 0 60'

COMPUTER AIDED DESIGN & DRAFTING

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

COLLISON

SHENEFIELD

SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS

HIGH VELOCITY SCREEN SYSTEM
FLOW BYPASS STRUCTURE

SCALE AS SHOWN

ENCLOSURE 2-13

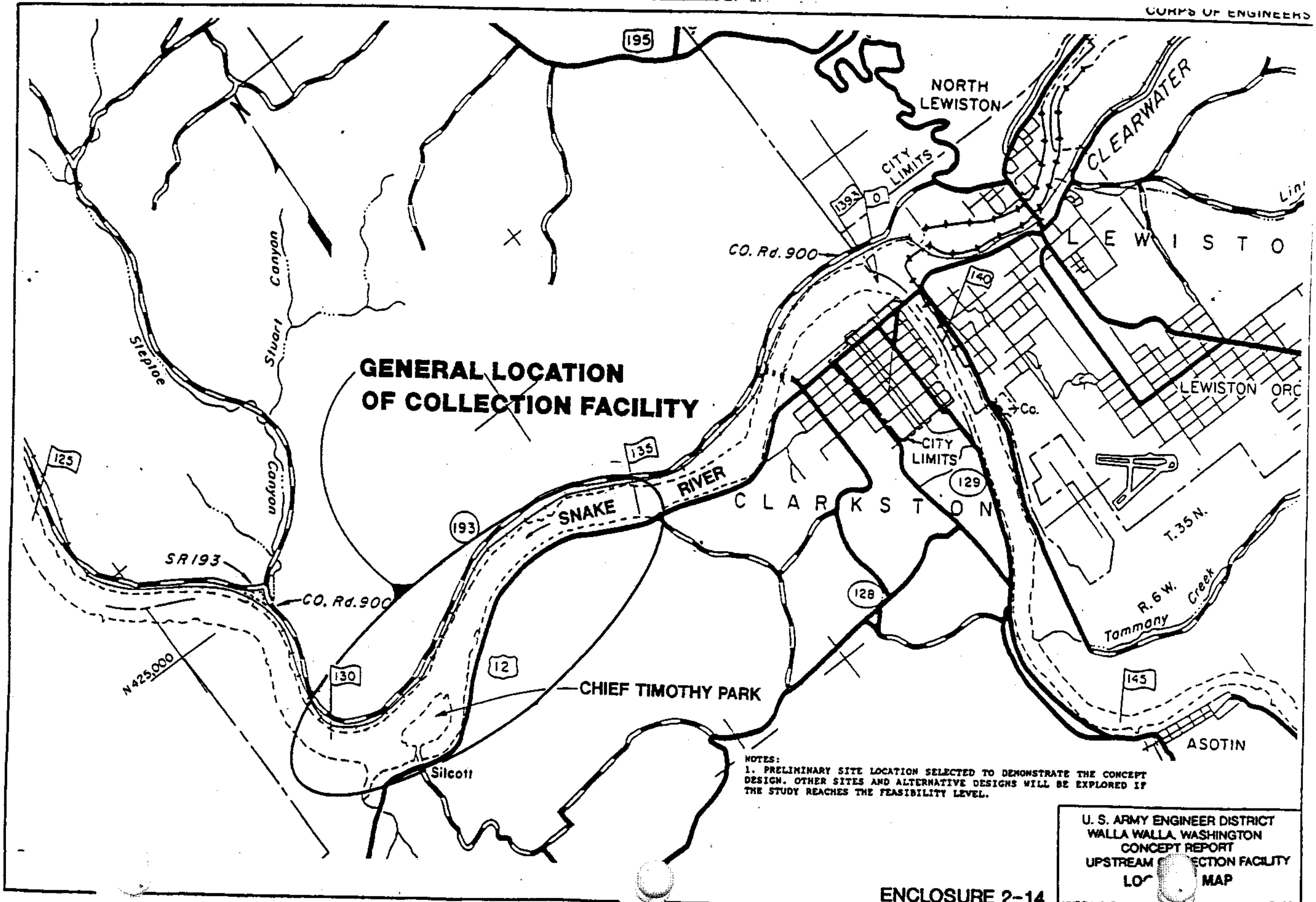
VALUE ENGINEERING PAYS

REFERENCE FILES: LSD.BLK.TB

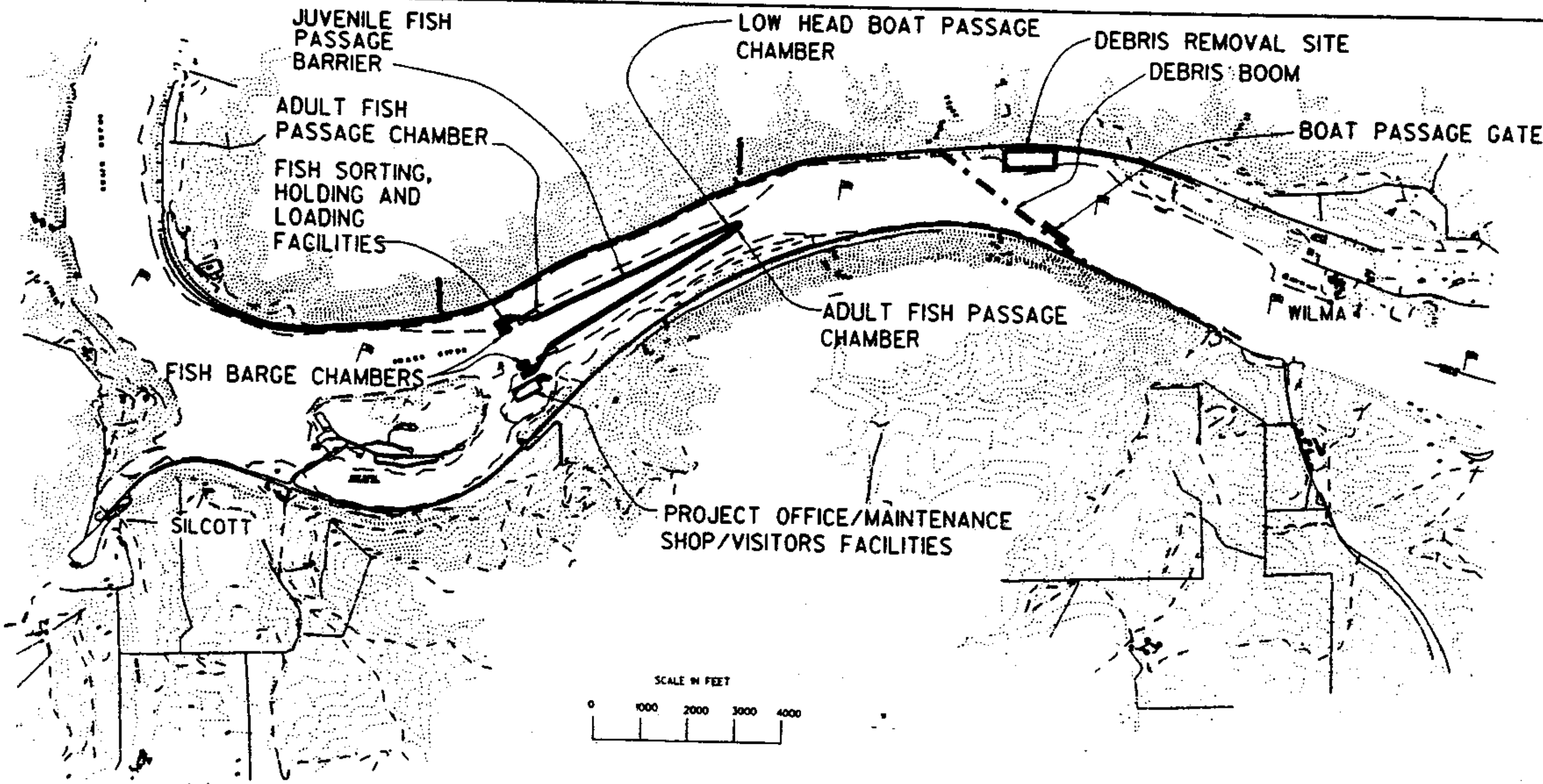
PDV TABLES: NONE

SCALE: 1:1

SCSUCSP10.dgn



ENCLOSURE 2-14



NOTES:

1. PRELIMINARY SITE LOCATION SELECTED TO DEMONSTRATE THE CONCEPT DESIGN. OTHER SITES AND ALTERNATIVE DESIGNS WILL BE EXPLORED IF THE STUDY REACHES THE FEASIBILITY LEVEL.

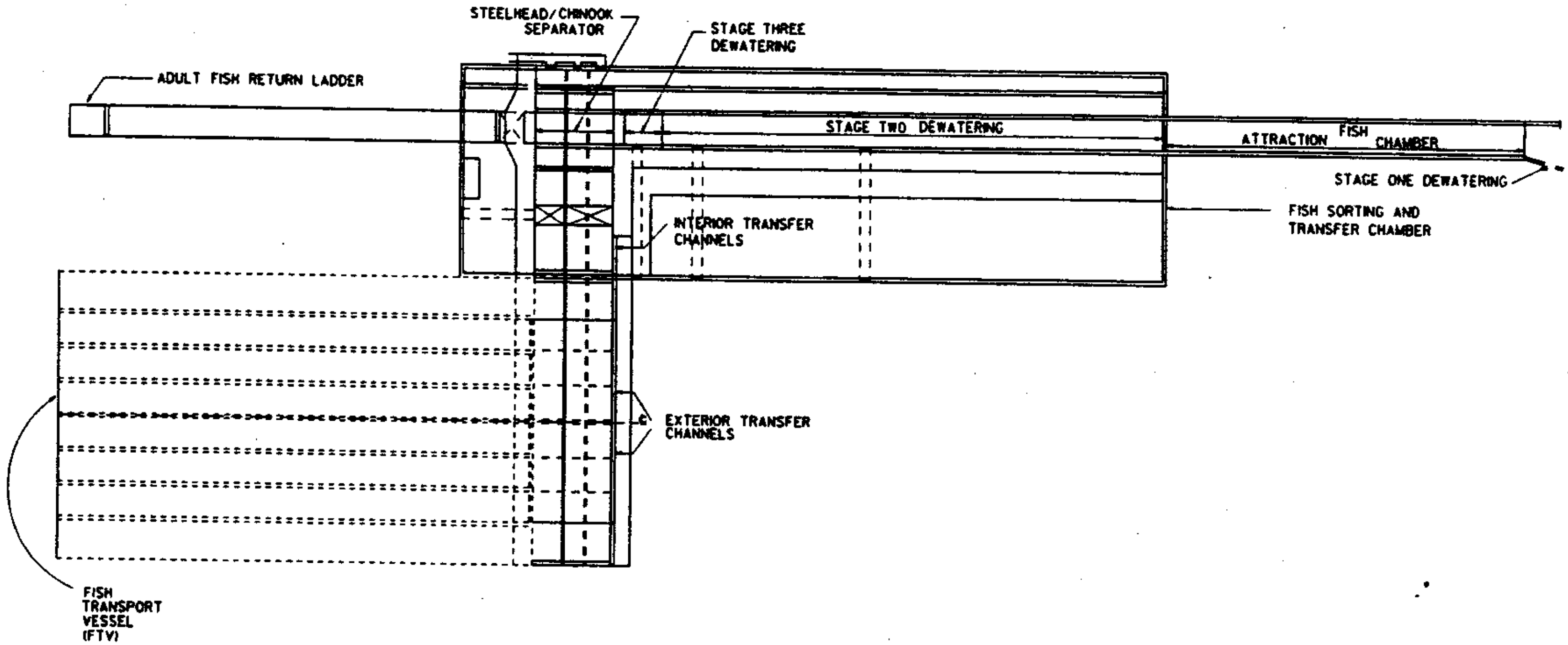
SCSM UCCTS.DGN
PNTABLE UCCTS.PL

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

CONCEPT REPORT

UPSTREAM COLLECTION FACILITY
PRELIMINARY SITE PLAN

HYDRAULIC DESIGN CENPWEN-DB-HY AUG. 93



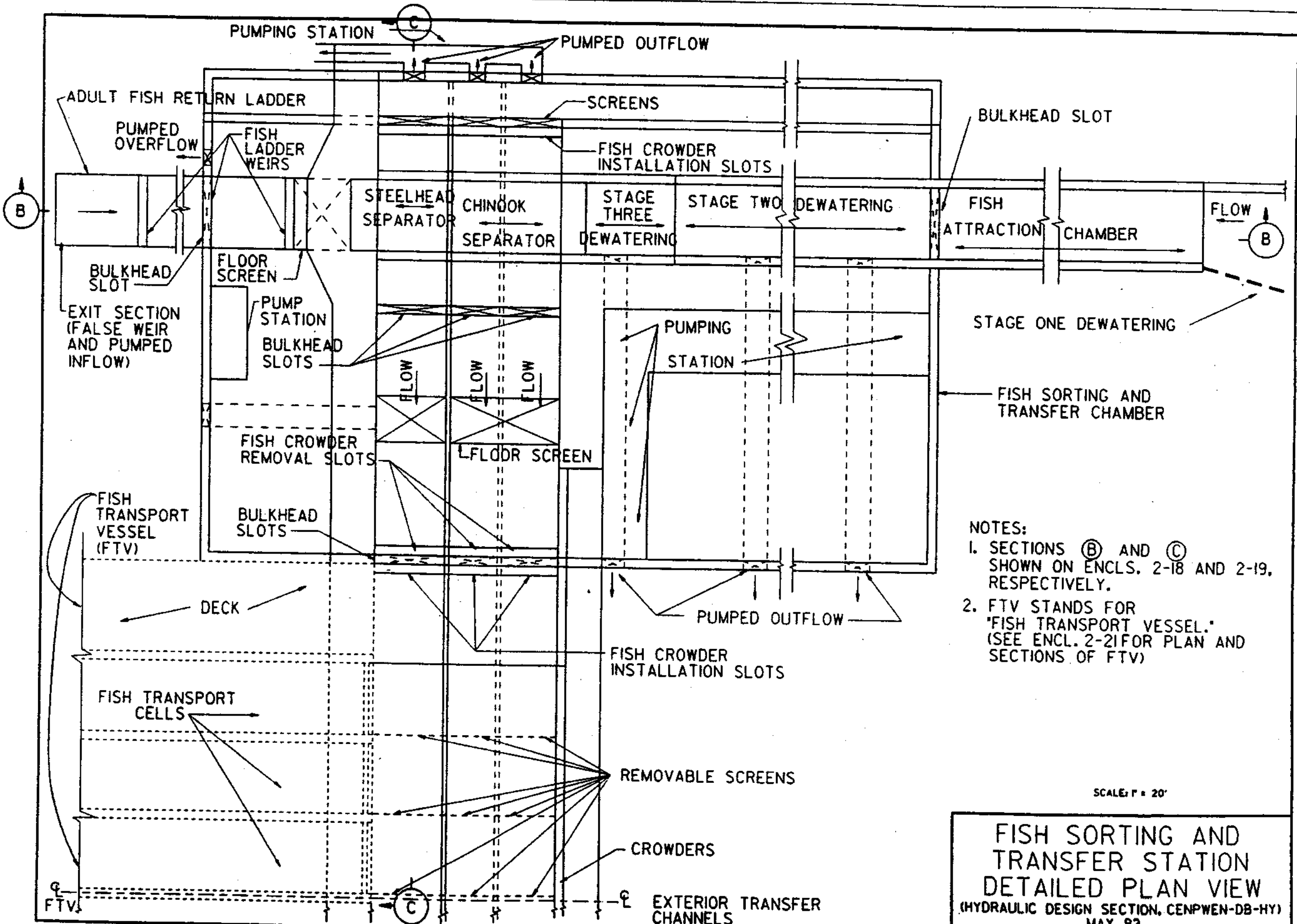
SCALE: 1" = 20'

FISH SORTING AND TRANSFER STATION GENERAL PLAN

(HYDRAULIC DESIGN SECTION, CENPWEN-DB-HY)
MAY 92

ENCLOSURE 2-16

FILENAME: SAMH COLFH.DGN



NOTES:
1. SECTIONS Ⓑ AND Ⓒ SHOWN ON ENCLS. 2-18 AND 2-19, RESPECTIVELY.
2. FTV STANDS FOR "FISH TRANSPORT VESSEL." (SEE ENCL. 2-21 FOR PLAN AND SECTIONS OF FTV)

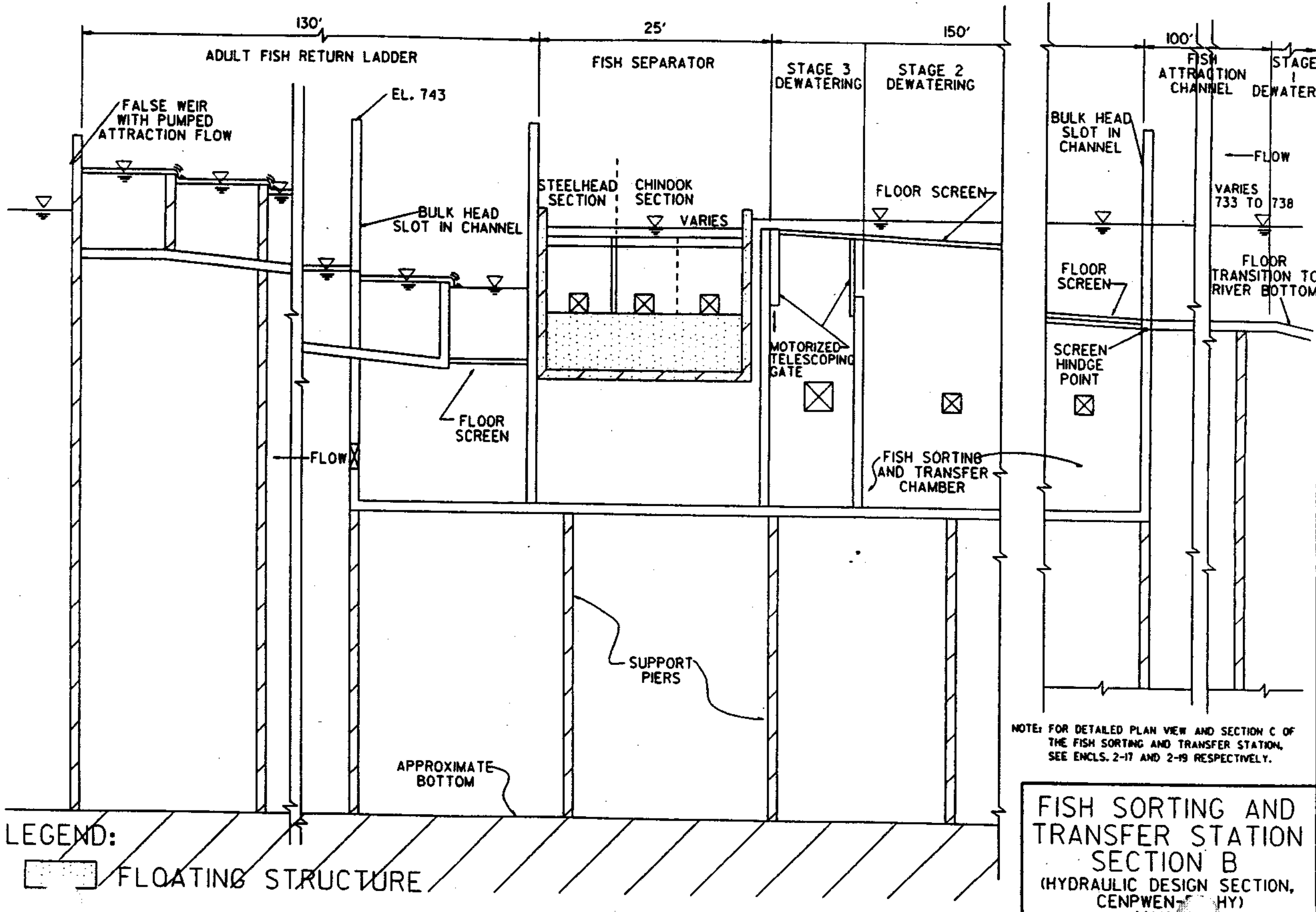
SCALE: 1" = 20'

FISH SORTING AND TRANSFER STATION DETAILED PLAN VIEW

(HYDRAULIC DESIGN SECTION, CENPWEN-DB-HY)
MAY 92

FILENAME: SAMH COLFA.DGN

G



NOTE: FOR DETAILED PLAN VIEW AND SECTION C OF THE FISH SORTING AND TRANSFER STATION, SEE ENCLS. 2-17 AND 2-19 RESPECTIVELY.

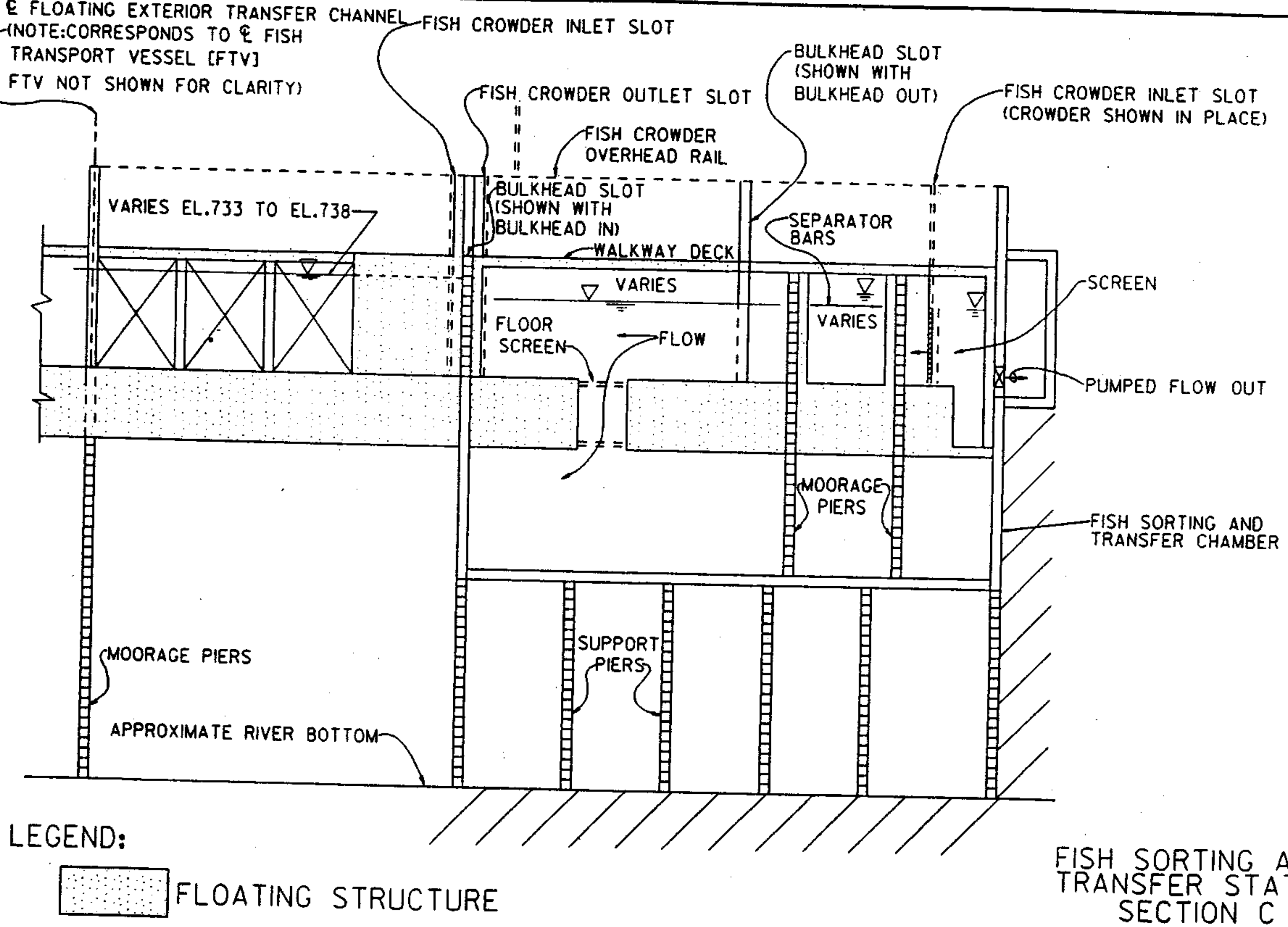
FISH SORTING AND TRANSFER STATION SECTION B

(HYDRAULIC DESIGN SECTION, CENPWEN-[illegible]HY) MAY

...E: SAMN COLFG.DGN

...OSURE 2-18

F



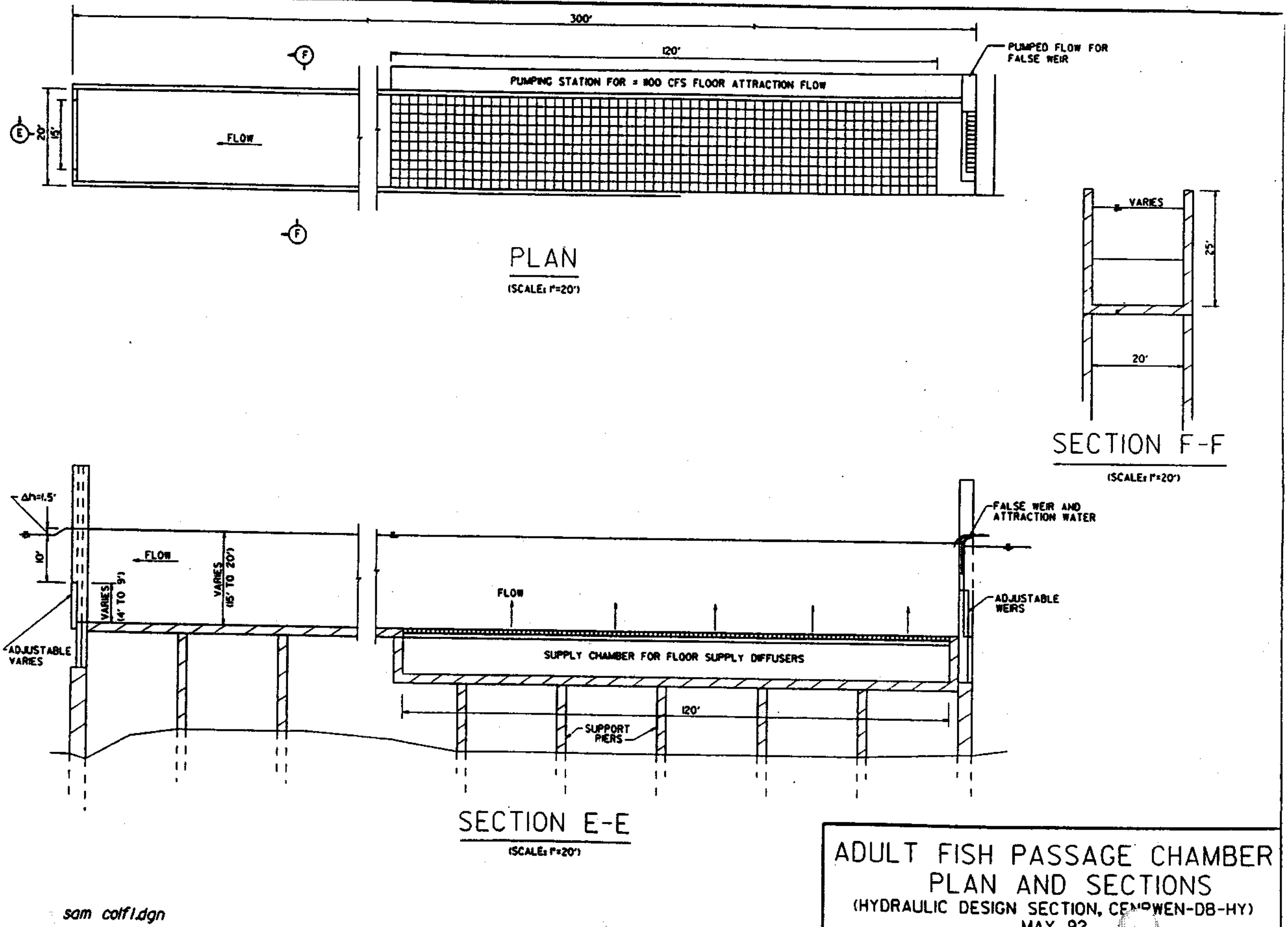
FISH SORTING AND
TRANSFER STATION
SECTION C

(HYDRAULIC DESIGN SECTION
CENPWEN-DB-HY)
MAY 92

SCALE 1''=20'

FILENAME: SAMH COLFF.DGN

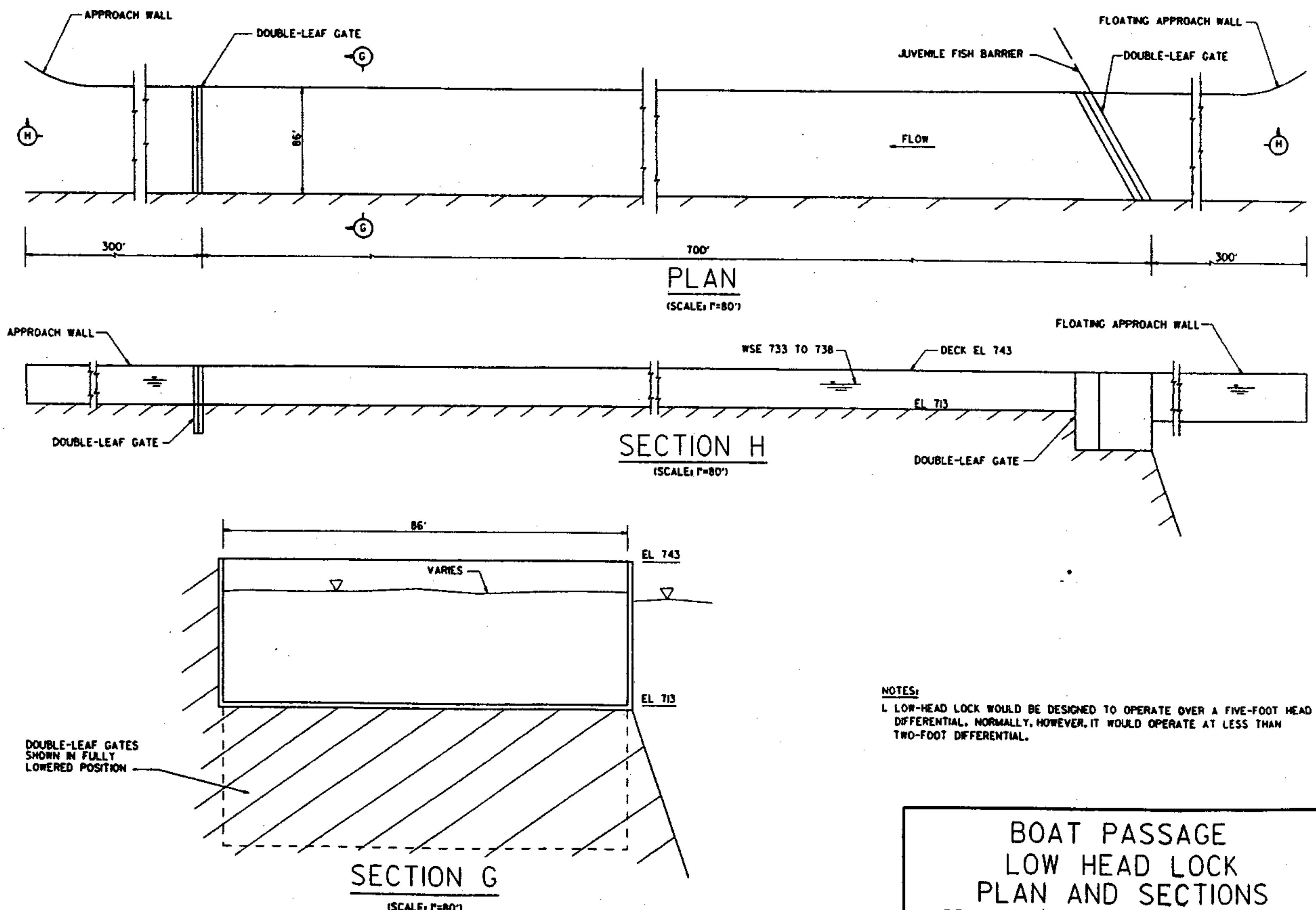
ENCLOSURE 2-19



ADULT FISH PASSAGE CHAMBER
PLAN AND SECTIONS

(HYDRAULIC DESIGN SECTION, CENPWEN-DB-HY)
MAY 92

ENCLOSURE 2-

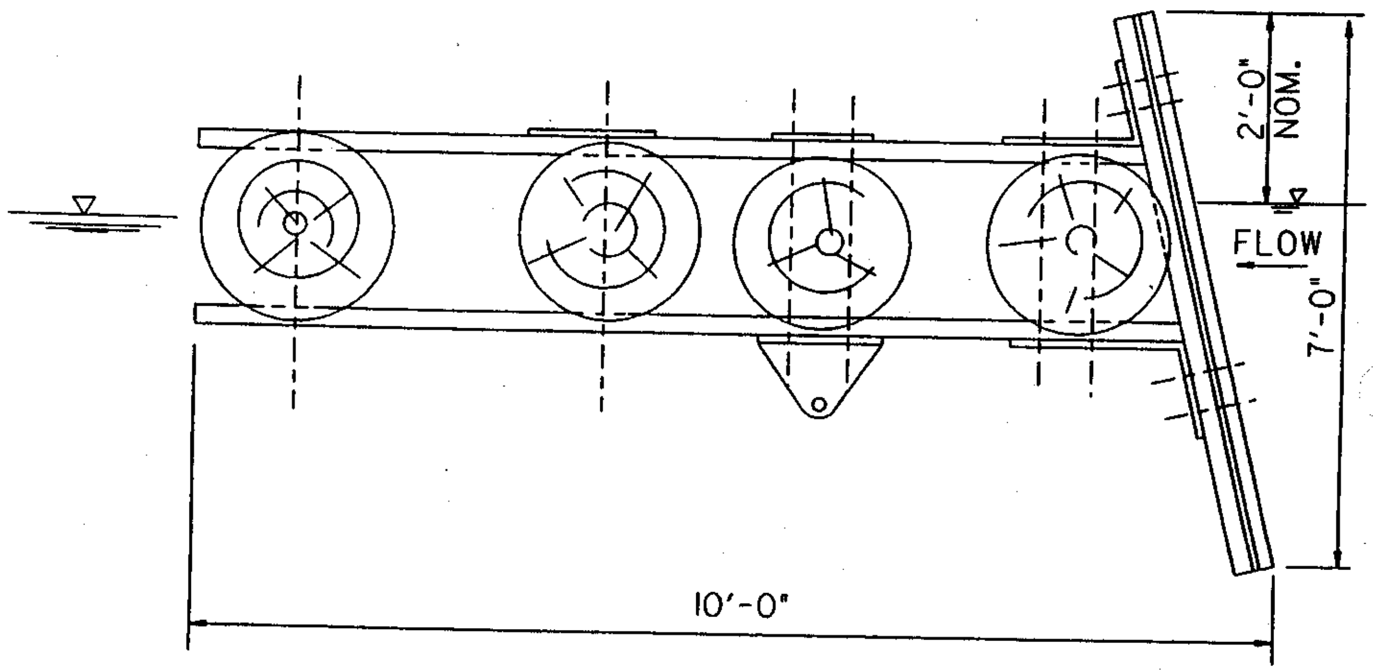


NOTES:
1. LOW-HEAD LOCK WOULD BE DESIGNED TO OPERATE OVER A FIVE-FOOT HEAD DIFFERENTIAL. NORMALLY, HOWEVER, IT WOULD OPERATE AT LESS THAN TWO-FOOT DIFFERENTIAL.

BOAT PASSAGE
LOW HEAD LOCK
PLAN AND SECTIONS
(HYDRAULIC DESIGN SECTION, CENPWEN-DB-HY)
MAY 92

FILENAME: SAMH COLFIA DGN

E



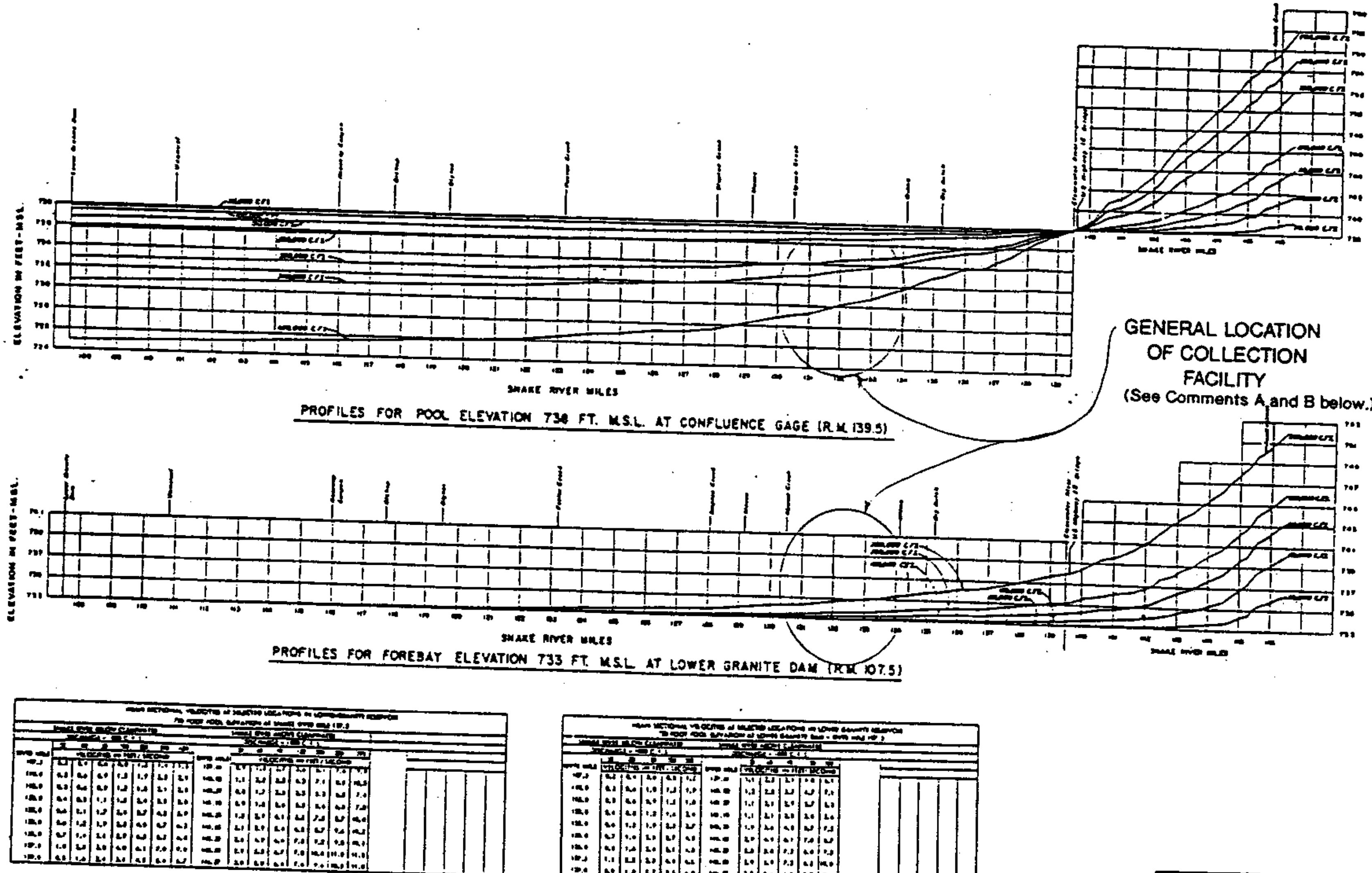
SECTION

NOT TO SCALE

DEBRIS BOOM
TYPICAL SECTION

(HYDRAULIC DESIGN, CENPWEN-DB-HY)
MAY 92

/usr3/ood/aom/oolfe.dgn
17-NOV-1993 06:56



COMMENTS:

A. BACKWATER PROFILES SHOWN WITHOUT AN UPSTREAM COLLECTION FACILITY IN-PLACE.

B. PRELIMINARY SITE LOCATION SELECTED TO DEMONSTRATE THE CONCEPT DESIGN. OTHER SITES AND ALTERNATIVE DESIGNS WILL BE EXPLORED IF THE STUDY REACHES THE FEASIBILITY LEVEL.

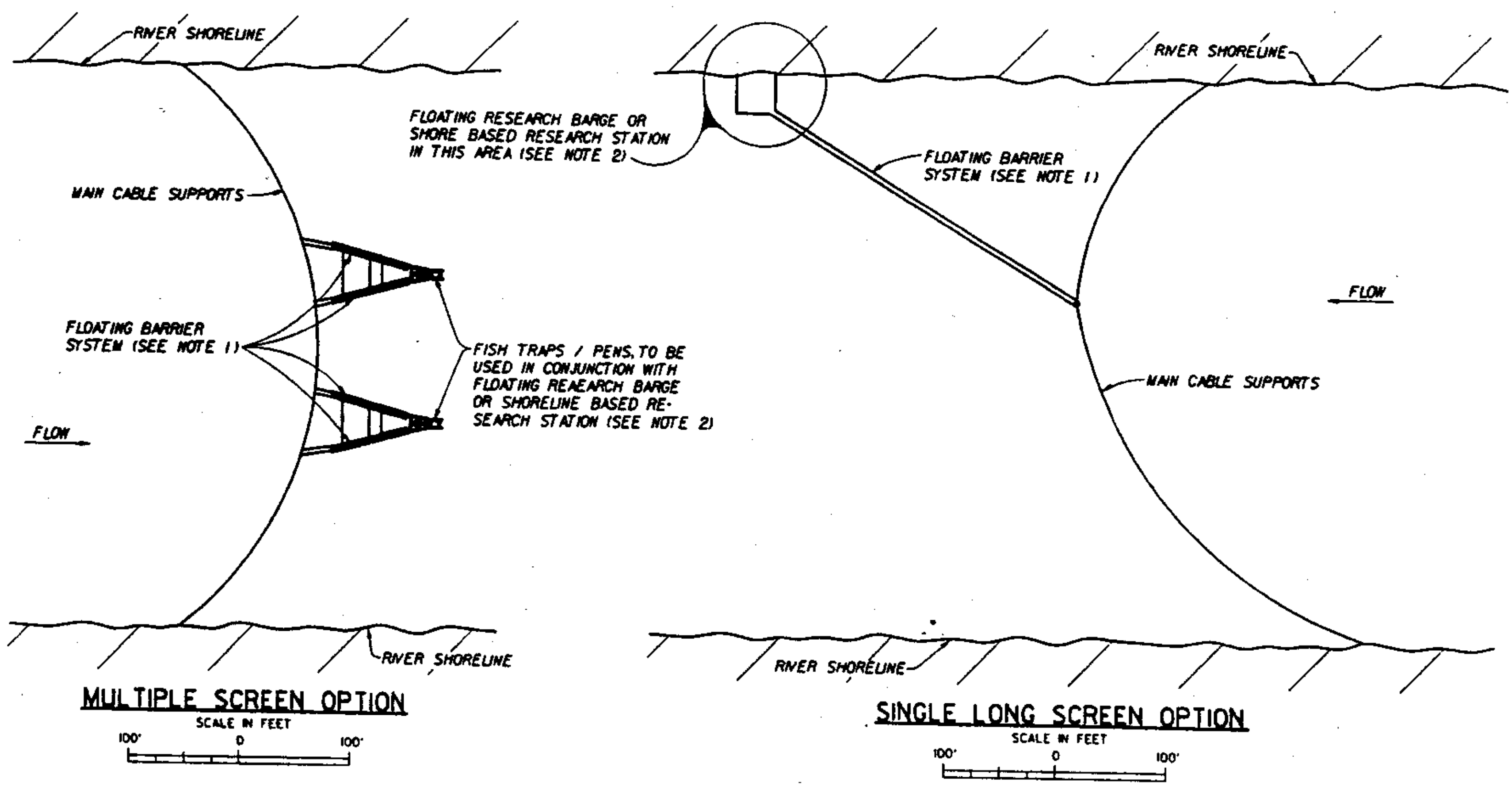
NOTES:

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

LOWER GRANITE LOCK AND DAM

RESERVOIR BACKWATER PROFILES
738 FT. POOL EL. AT R.M. 139.5
AND 733 FT. POOL EL. AT R.M. 107.5

ENCLOSURE 2-23



NOTES:

1. FLOATING BARRIER SYSTEM MIGHT BE A VERSION OF THE EXISTING FISH TRAP USED IN THE VICINITY OF LEWISTON (SEE PLATE 2-25) OR IT MIGHT BE A VERSION OF THE FLOATING PLATFORM CONCEPT (SEE PLATES 2-4 AND 2-5.
2. ACTIVITIES THAT MIGHT BE DONE RELATED TO RESEARCH MAY INCLUDE FISH SORTING, MARKING, ETC. IN ADDITION TO POSSIBLY LOADING FISH INTO A TRANSPORT VESSEL.

COMPUTER AIDED DESIGN & DRAFTING

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

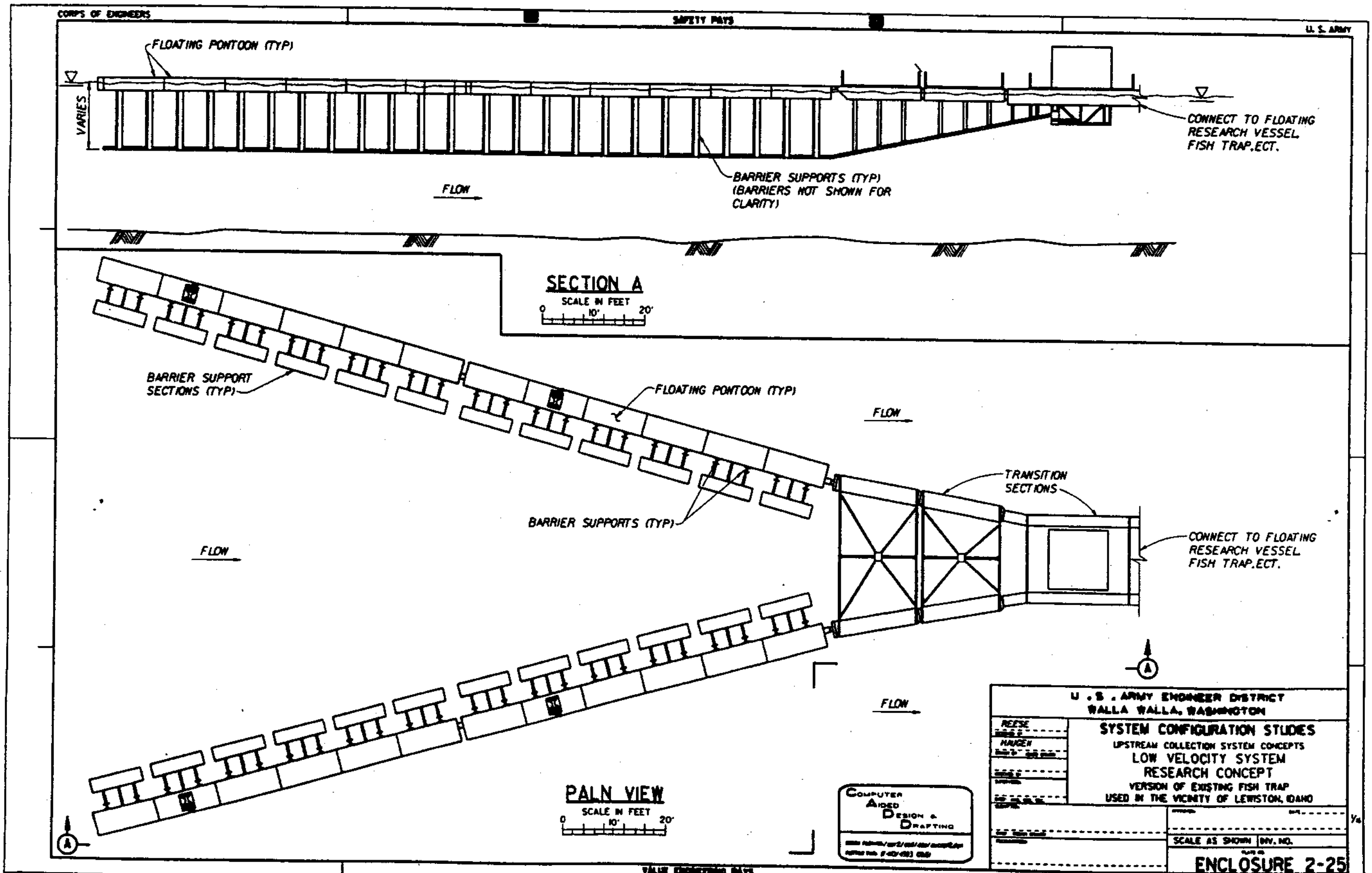
REESE
HAUGEN

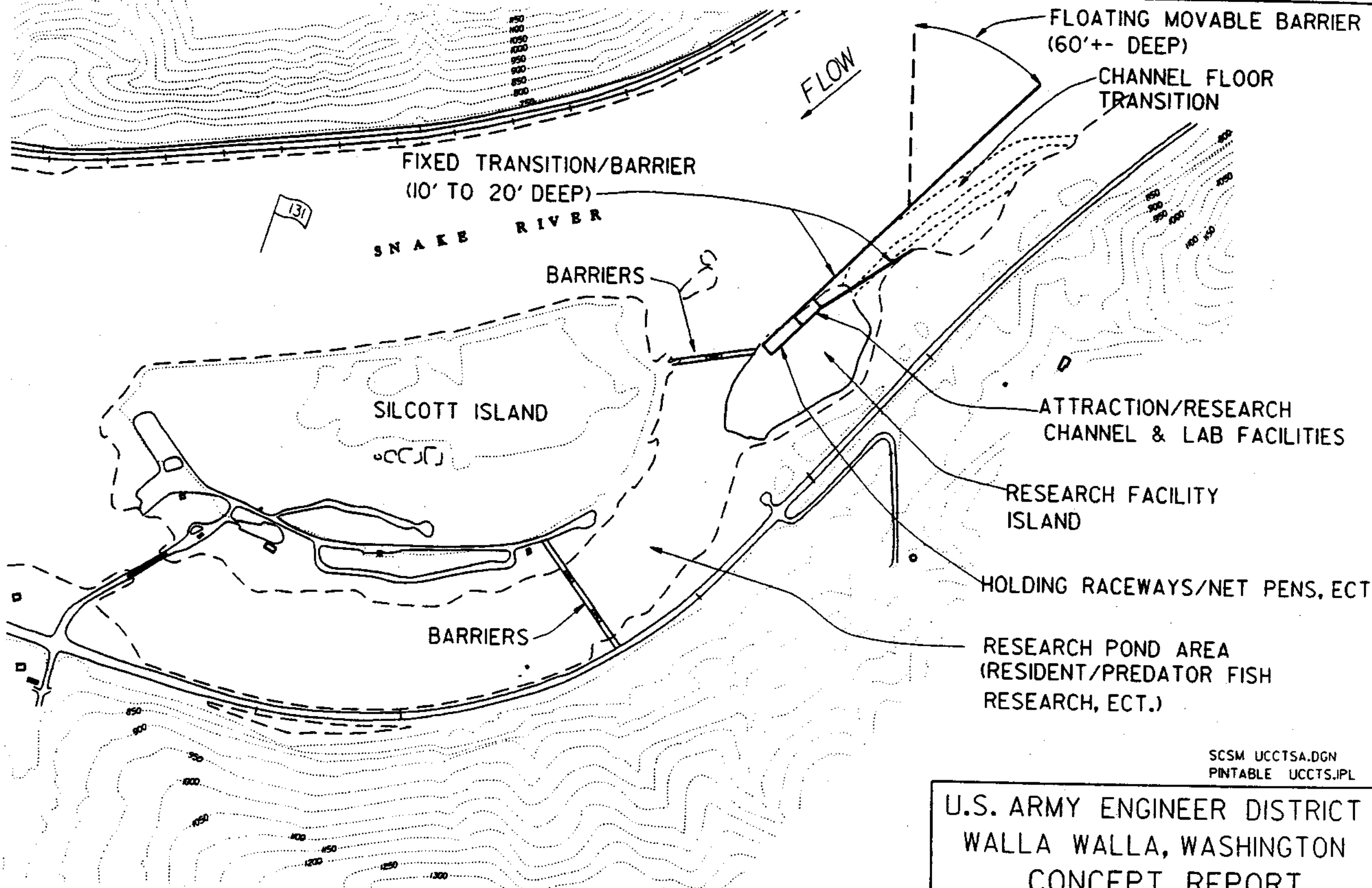
SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS
LOW VELOCITY SYSTEM
RESEARCH CONCEPT
POTENTIAL SITE PLANS

SCALE AS SHOWN

ENCLOSURE 2-24

SCS4UCS.BLX,TB
NO
1"=20.
SCS SUCSPILDGN


CORPS OF ENGINEERS
SAFETY PAYS
U. S. ARMY
FLOATING PONTOON (TYP)
VARIES
CONNECT TO FLOATING RESEARCH VESSEL FISH TRAP.ECT.
BARRIER SUPPORTS (TYP) (BARRIERS NOT SHOWN FOR CLARITY)
FLOW
SECTION A
SCALE IN FEET
0
10'
20'
BARRIER SUPPORT SECTIONS (TYP)
FLOATING PONTOON (TYP)
BARRIER SUPPORTS (TYP)
TRANSITION SECTIONS
CONNECT TO FLOATING RESEARCH VESSEL FISH TRAP.ECT.
A
PALN VIEW
SCALE IN FEET
0
10'
20'
COMPUTER AIDED DESIGN & DRAFTING
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
REESE
HAUGEN
SYSTEM CONFIGURATION STUDIES
UPSTREAM COLLECTION SYSTEM CONCEPTS
LOW VELOCITY SYSTEM
RESEARCH CONCEPT
VERSION OF EXISTING FISH TRAP
USED IN THE VICINITY OF LEWISTON, IDAHO
SCALE AS SHOWN
ENCLOSURE 2-25
VALUE ENGINEERING PAYS



SCALE IN FEET

0 1000 2000

NOTES:

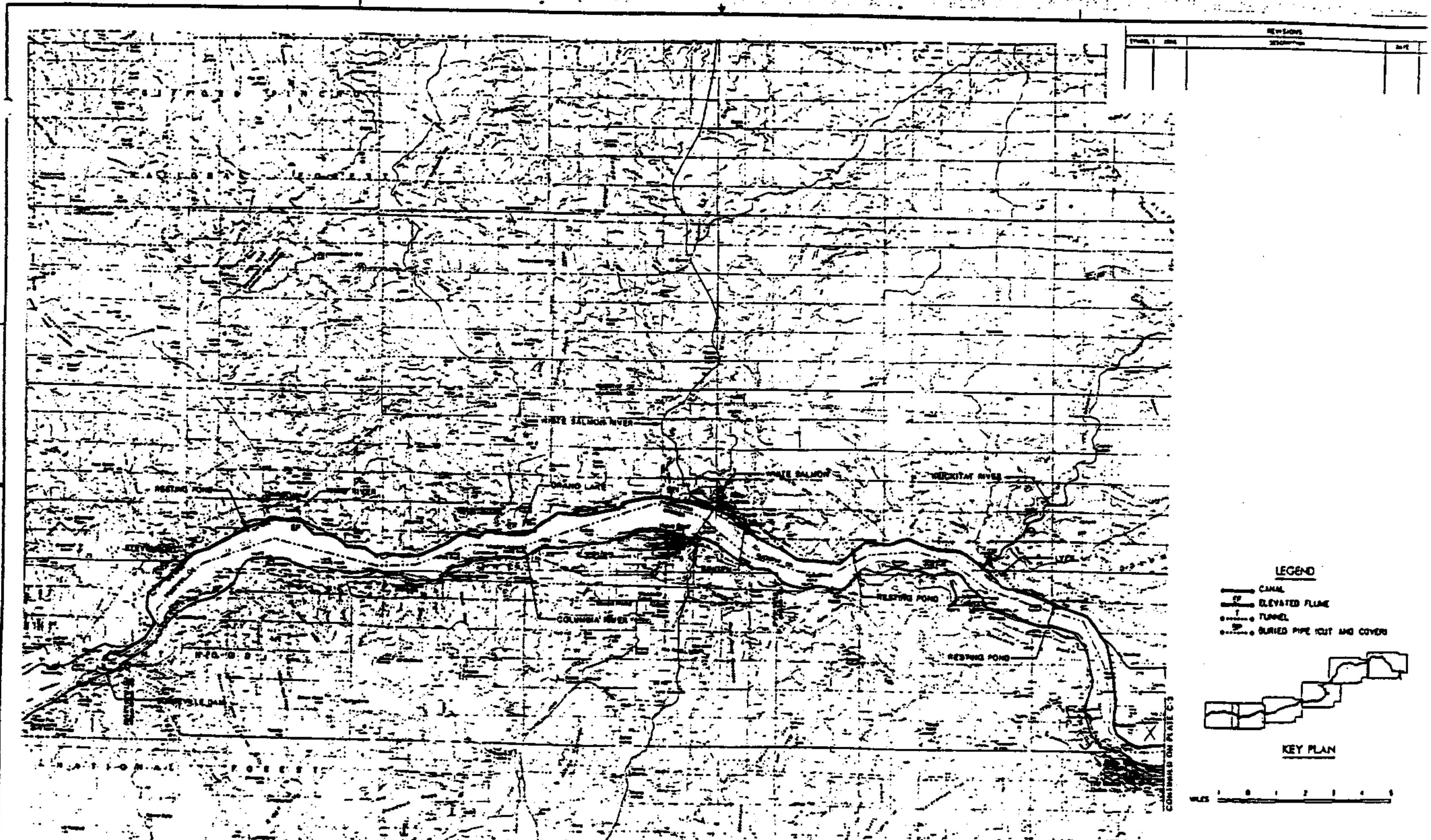
1. PRELIMINARY RESEARCH FACILITY PLAN AND SITE LOCATION SELECTED TO DEMONSTRATE CONCEPT DESIGN. OTHER SITE AND ALTERNATIVE DESIGNS WILL BE EXPLORED IF THE STUDY REACHES THE FEASIBILITY LEVEL.

SCSM UCCTSA.DGN
PINTABLE UCCTS.IPL

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
CONCEPT REPORT
RESEARCH FACILITY
PLAN

HYDRAULIC DESIGN CENPWEN-DB-HY AUG. 93

ENCLOSUR -26



U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

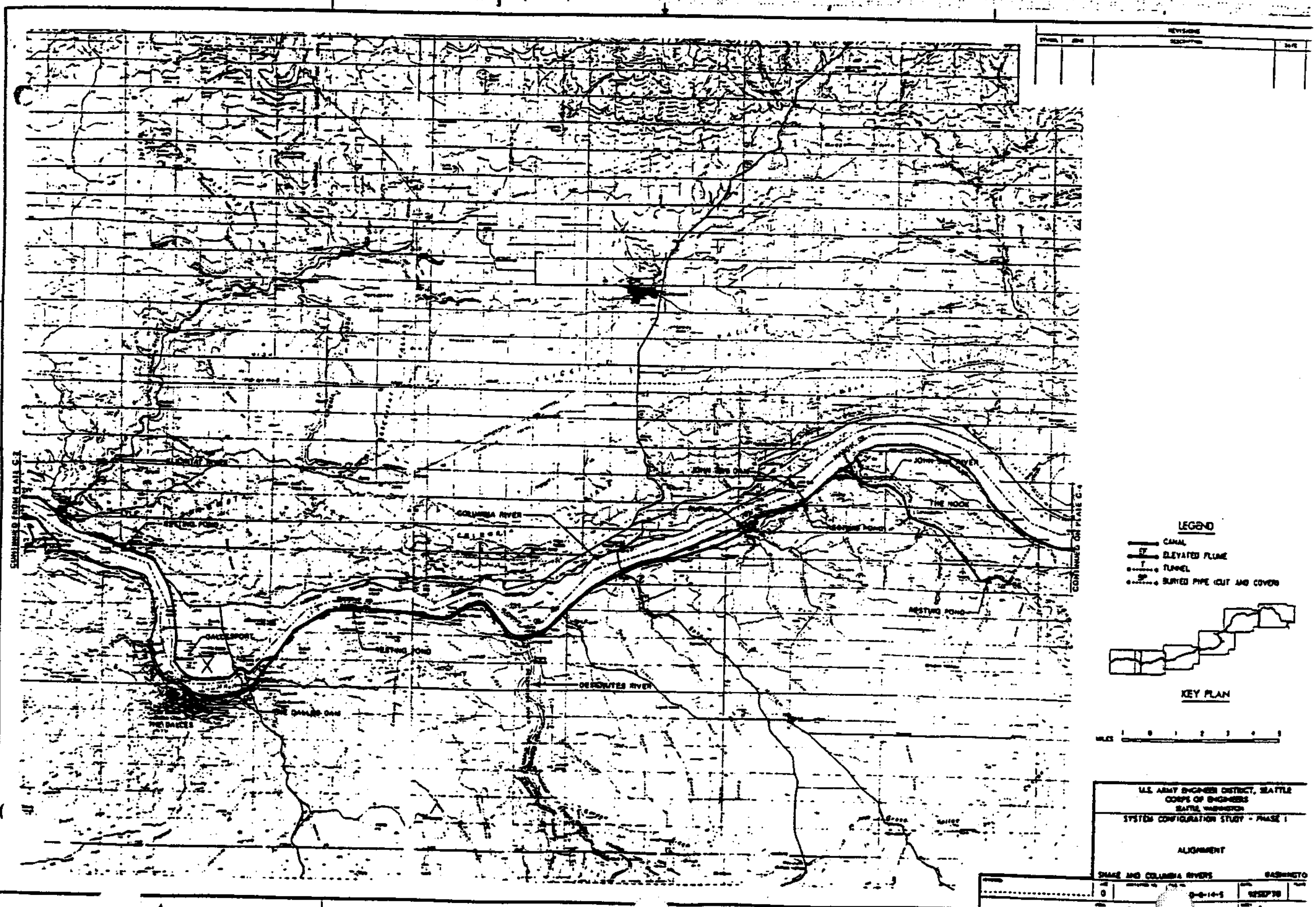
SYSTEM CONFIGURATION STUDY - PHASE 1

ALIGNMENT

SNAKE AND COLUMBIA RIVERS WASHINGTON

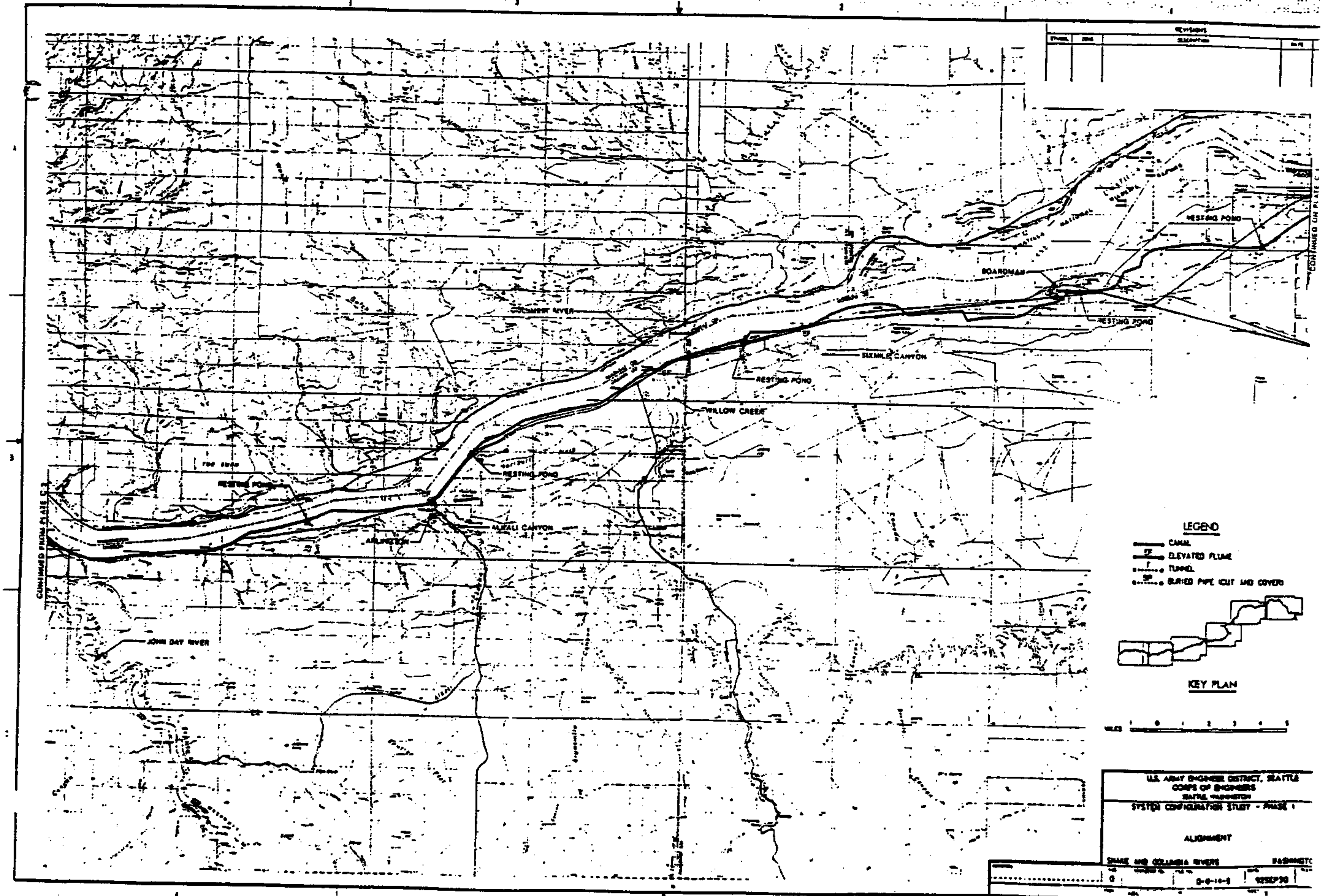
D-6-14-5

ENCLOSURE 3-1

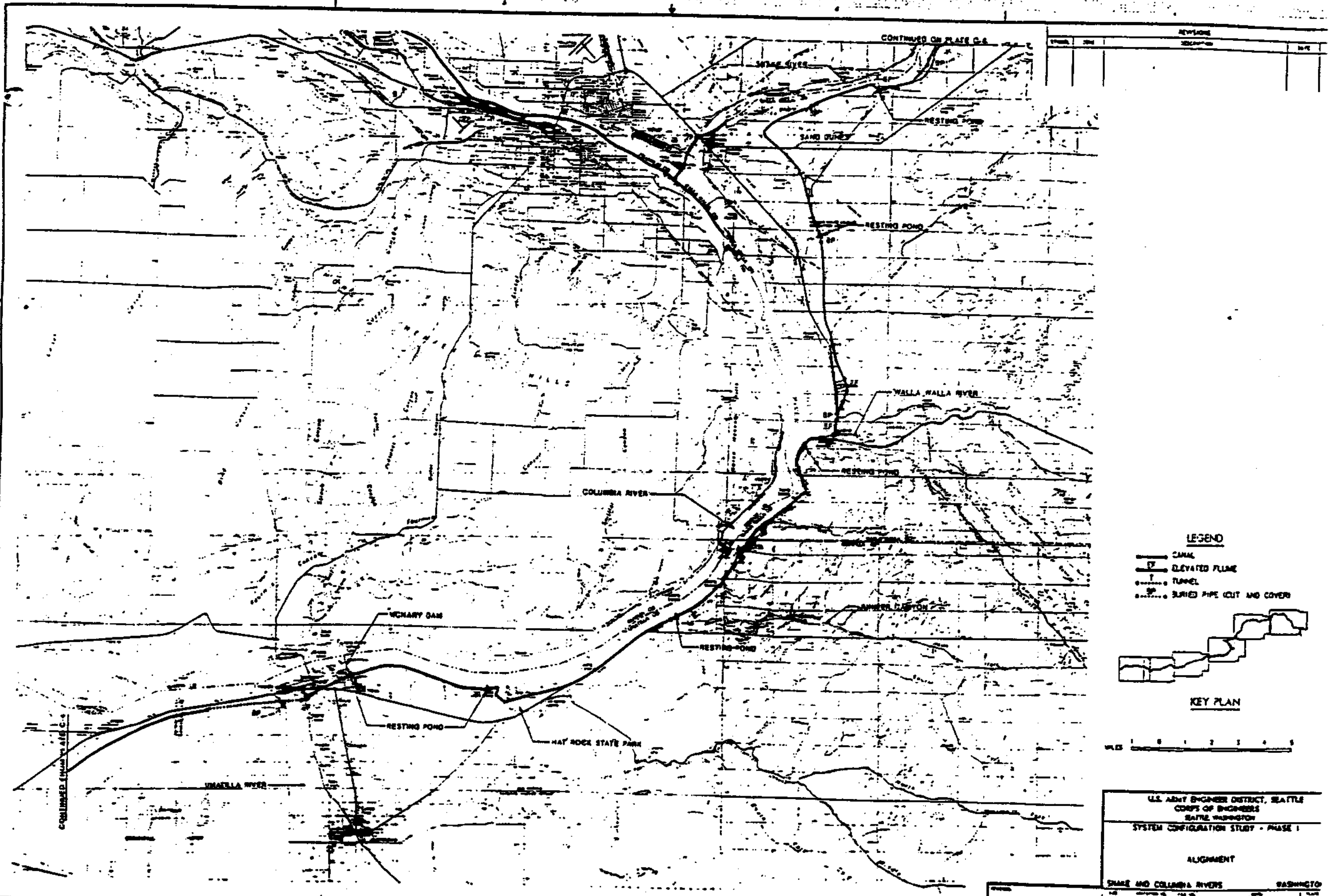


CONTINUED FROM PLATE C-2
COLUMBIA RIVER
JOHN DAY DAM
JOHN DAY RIVER
THE NOOK
RESTING POND
DESCHUTES RIVER
THE DALLES DAM
THE DALLES
CONTINUED ON PLATE C-4
LEGEND
CANAL
ELEVATED FLUME
TUNNEL
BURIED PIPE (CUT AND COVER)
KEY PLAN
MILES
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON
SYSTEM CONFIGURATION STUDY - PHASE I
ALIGNMENT
SNAKE AND COLUMBIA RIVERS
REVISIONS

CLOSURE 3-2



ENCLOSURE 3-3



U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

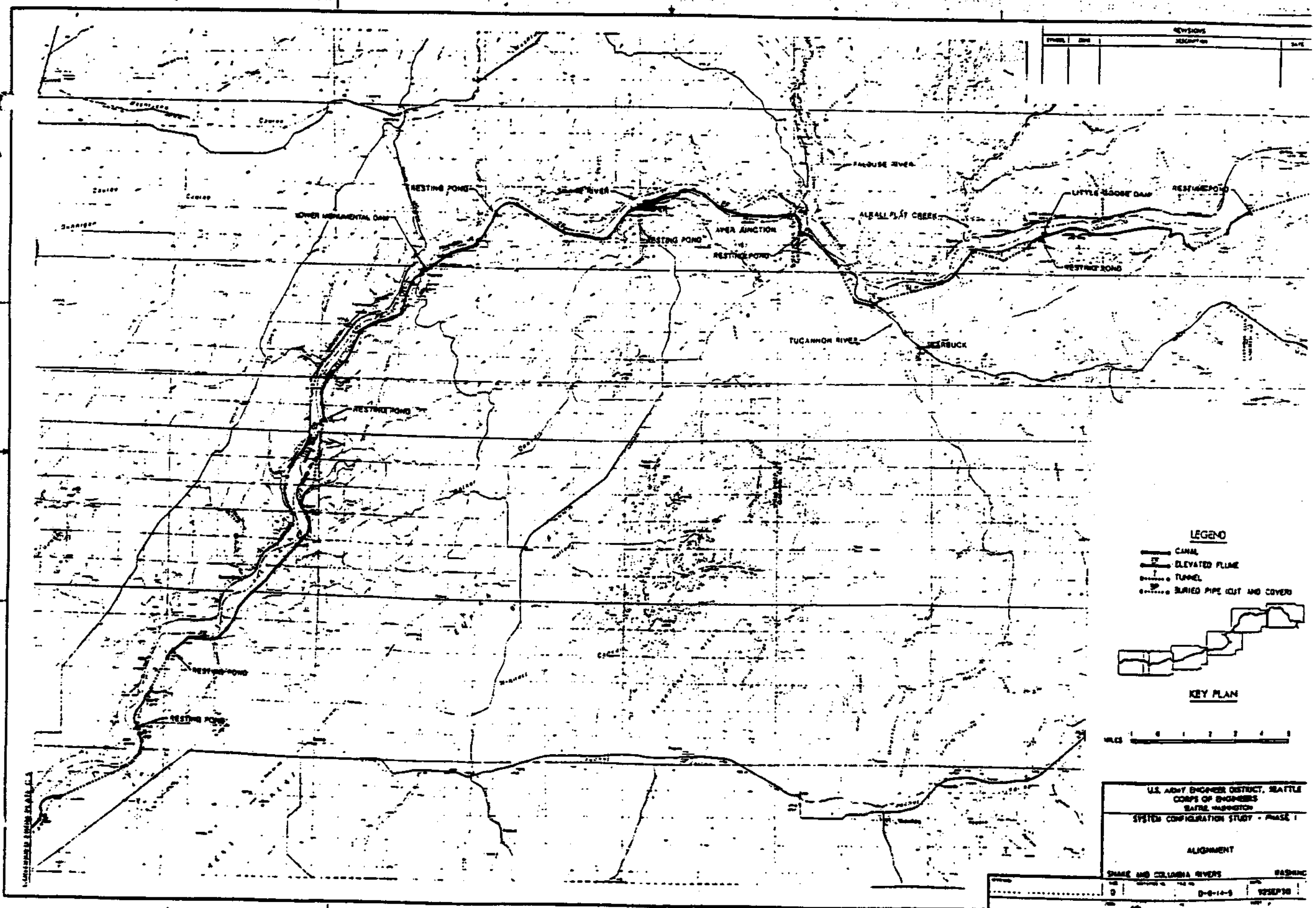
SYSTEM CONFIGURATION STUDY - PHASE I

ALIGNMENT

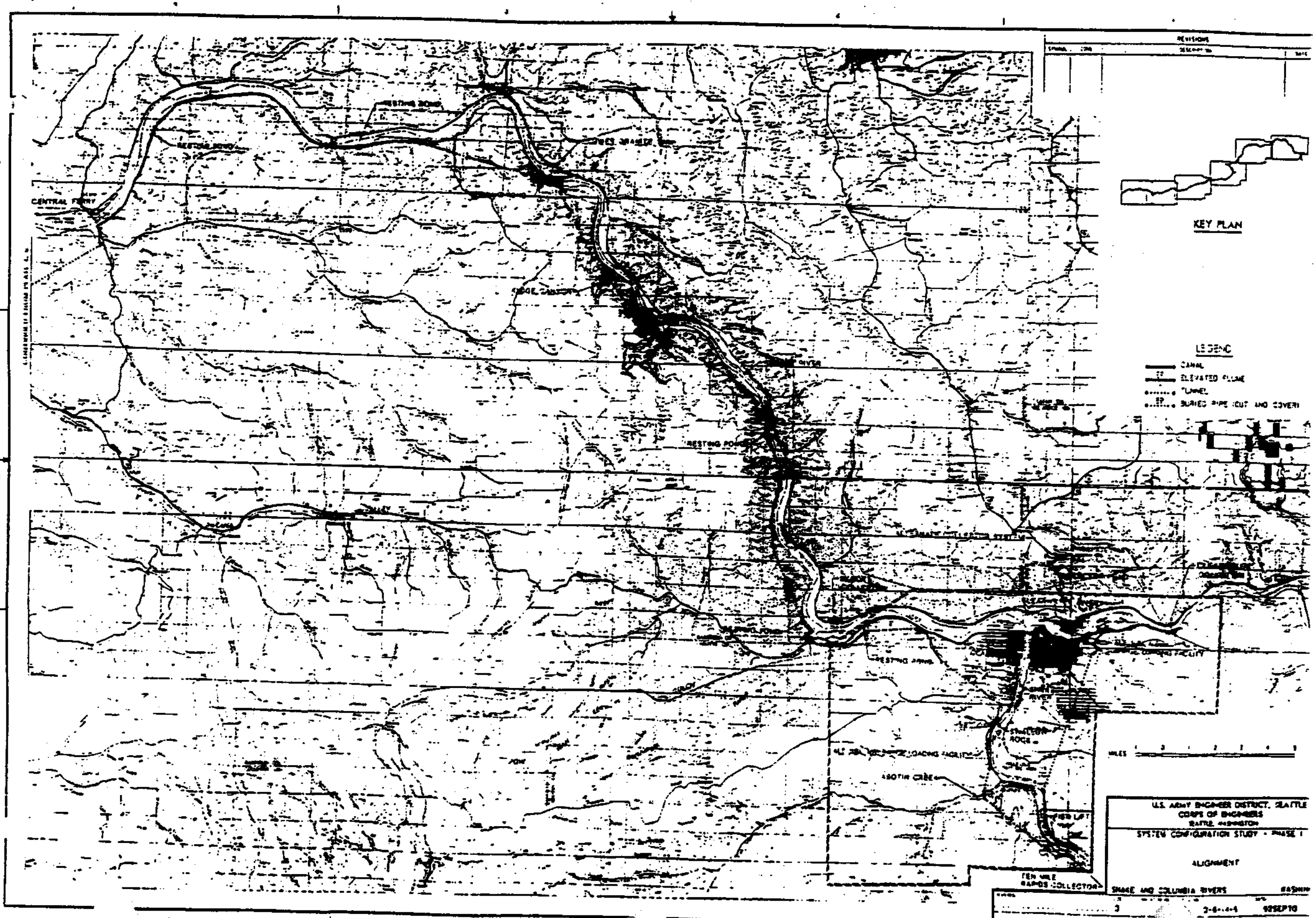
SNAKE AND COLUMBIA RIVERS WASHINGTON

0 | D-8-14-5 | 92SEP30

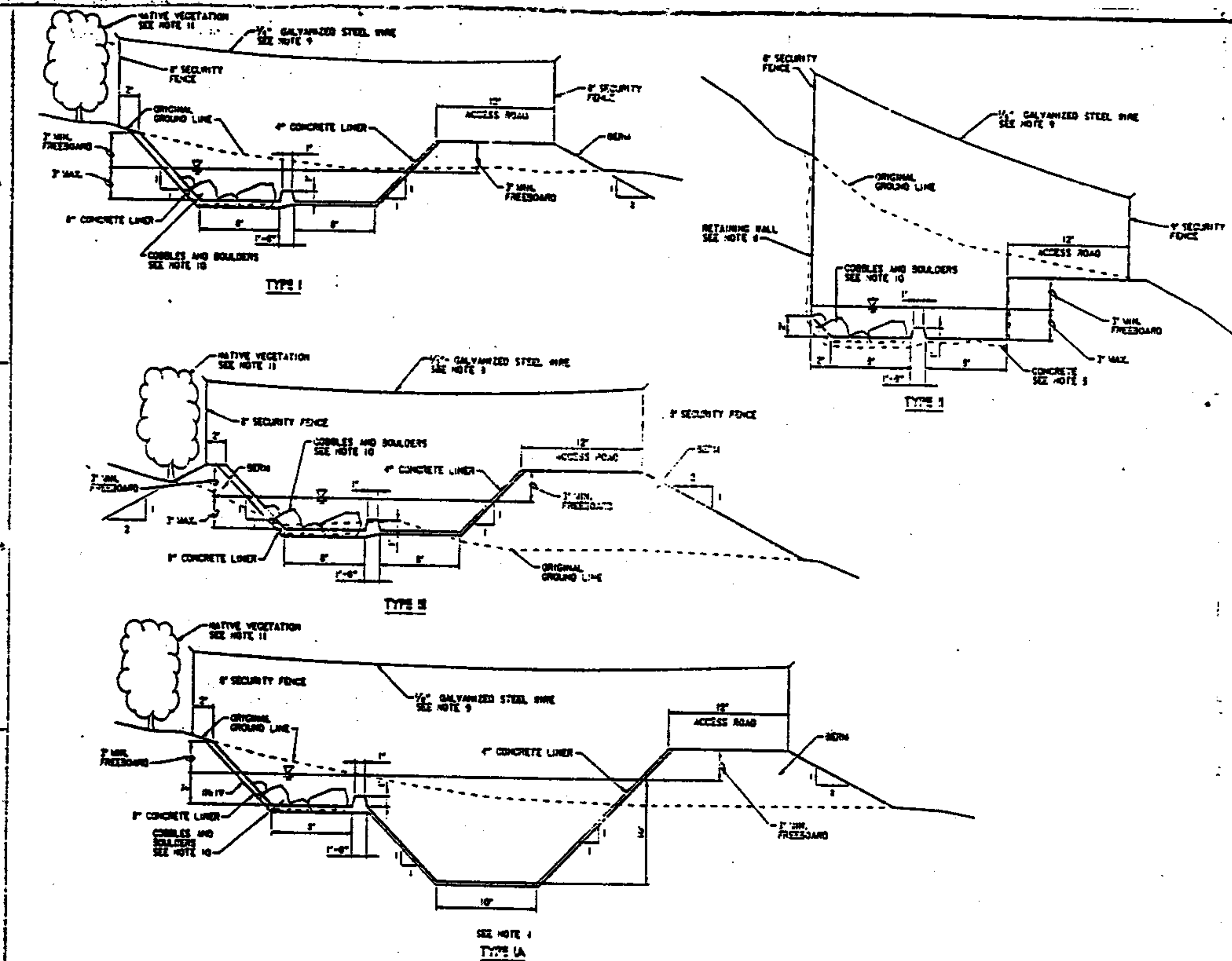
...OSURE 3-4



ENCLOSURE 3-5


CENTRAL FERRY
RESTING POND
RIDGE CANYON
RESTING POND
KEY PLAN
LEGEND
CANAL
ELEVATED FLUME
TUNNEL
BURIED PIPE (CUT AND COVER)
RESTING POND
ASOTIN CREEK
MILES
TEN MILE RAPIDS COLLECTOR
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON
SYSTEM CONFIGURATION STUDY - PHASE I
ALIGNMENT
SNAKE AND COLUMBIA RIVERS

CLOSURE 3-6



EXCAVATED CANAL SECTIONS

SCALE: 1" = 5'

NOTES:

1. SECTION TYPE I IS A TYPICAL SECTION TO BE APPLIED WHERE THE SIDE SLOPE OF THE EXISTING GROUND IS LESS THAN 1 ON 4 AND THE EXISTING MATERIAL IS NOT DIFFICULT TO EXCAVATE.
2. SECTION TYPE II IS A TYPICAL SECTION TO BE APPLIED WHERE THE SIDE SLOPE OF THE EXISTING GROUND IS GREATER THAN 1 ON 4.
3. SECTION TYPE III IS A TYPICAL SECTION TO BE APPLIED WHERE THE SIDE SLOPE OF THE EXISTING GROUND IS LESS THAN 1 ON 4 AND THE EXISTING MATERIAL IS DIFFICULT TO EXCAVATE.
4. SECTION TYPE IA IS A TYPICAL SECTION TO BE USED FOR EXCAVATED CANAL ON THE REACH ALONG THE JOHN DAY POOL ONLY. THE SMALL SLOPE OF THE HYDRAULIC GRADE LINE ON THIS REACH REQUIRES THAT A CANAL WITH A CONSIDERABLY LARGER CROSS SECTION BE CONSTRUCTED TO CARRY THE 200 CFS DESIGN FLOW. VARIATIONS OF SECTIONS II AND III WITH 10' DEPTH AND 10' BOTTOM WIDTH MAY ALSO BE USED ON THE JOHN DAY REACH.
5. WHERE CANAL IS CUT INTO EXISTING ROCK, CRACKS WILL BE GROUTED BELOW THE TOP OF FREEBOARD AND LARGE DEPRESSIONS WILL BE FILLED WITH CONCRETE. APPLY SHOTCRETE TO EXPOSED ROCK AND TROWEL SMOOTH TO FILL MINOR DEPRESSIONS UP TO THE TOP OF FREEBOARD. FILL MATERIAL FOR BERMS AND PERMEABLE OR ERODIBLE EXPOSED MATERIAL SHALL BE COVERED BY 4" CONCRETE LINER ON THE CANAL BOTTOM AND SIDE SLOPES UP TO THE TOP OF THE FREEBOARD.
6. IF EXPOSED MATERIAL IS STABLE ROCK, RETAINING WALL IS NOT REQUIRED.
7. EXCAVATED NATIVE MATERIALS SHALL BE USED TO CONSTRUCT BERMS. REMOVE COBBLES AND BOULDERS FROM EXCAVATED MATERIAL AND PROCESS AS REQUIRED TO MEET MATERIAL SPECIFICATIONS. ANGULAR COBBLES SHALL BE PLACED ON THE SURFACE OF EXTERIOR SIDE SLOPES FOR EROSION CONTROL. NON-ANGULAR COBBLES AND BOULDERS MAY BE PROCESSED FOR AGGREGATE OR DISPOSED OF AT CONTRACTOR'S OPTION.
8. CULVERTS WILL BE 12", 18", 24", OR 36" DIAMETER. MULTIPLE 24" OR 36" DIAMETER CULVERTS MAY BE REQUIRED IN SOME LOCATIONS.
9. 1/8" GALVANIZED STEEL WIRES WILL BE SECURED TO FENCING WITH 12" SPACING BETWEEN EACH WIRE. THESE WIRES ARE INTENDED TO DISCOURAGE AVIAN PREDATION OF SALMON SMOLTS IN THE CANAL.
10. COBBLES AND BOULDERS SHALL BE ANGULAR, WEIGHT BETWEEN 100 AND 300 LBS. AND SHALL BE RANDOMLY PLACED TO COVER THE SOUTHERN HALF OF THE CANAL SECTION. COBBLES AND BOULDERS SHALL BE SET IN THE CONCRETE LINER IMMEDIATELY AFTER THE CONCRETE HAS BEEN PLACED. THE CONCRETE LINER SHALL BE AT LEAST 8" THICK WHERE COBBLES AND BOULDERS ARE EMBEDDED IN THE LINER.
11. NATIVE VEGETATION WILL BE USED ALONG THE SOUTH SIDE OF THE ALIGNMENT TO INCREASE SHADING OF THE WATER SURFACE IN THE CANAL.

REDUCED TO SIZE OF FULL SIZE

U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

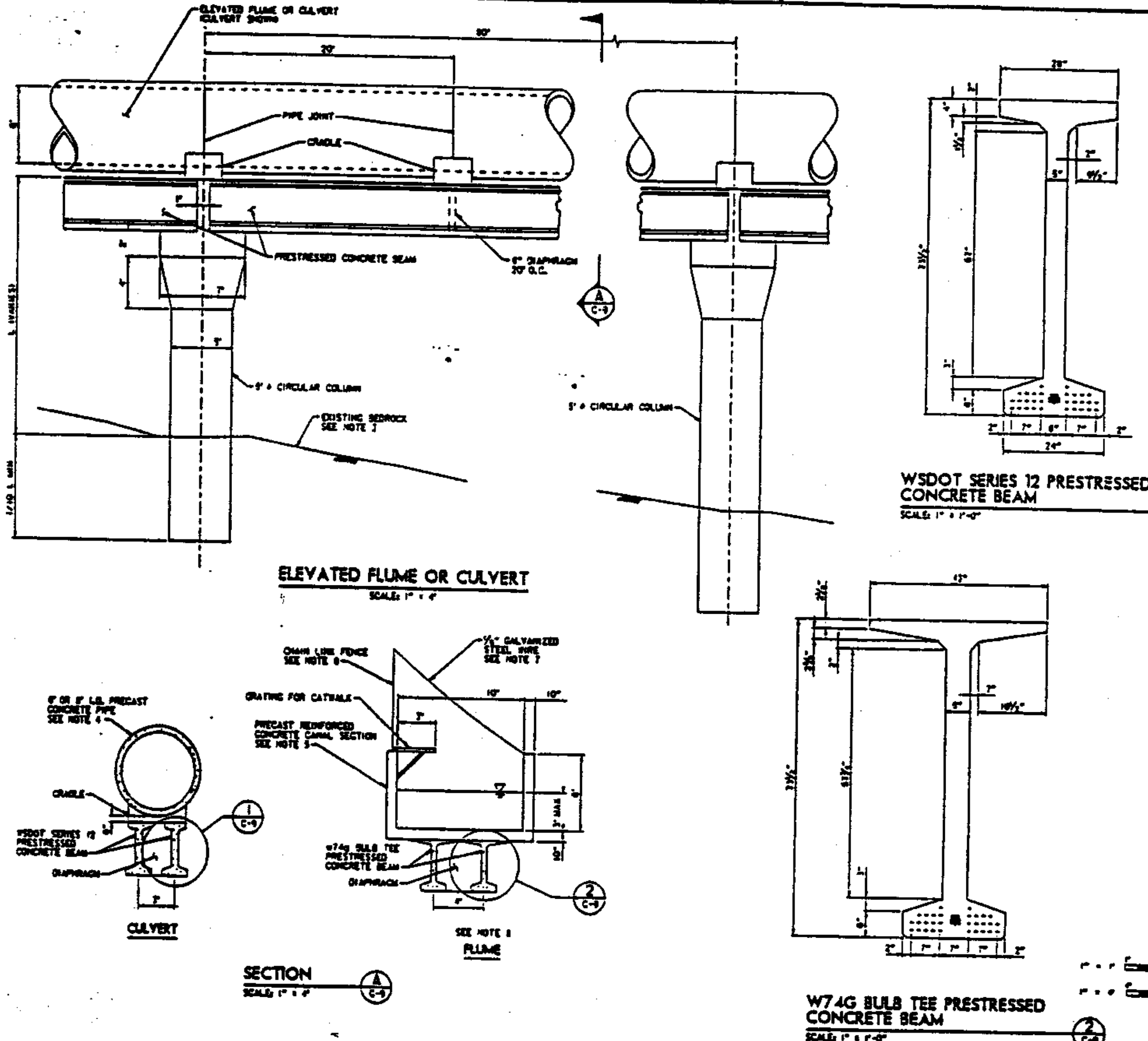
SYSTEM CONFIGURATION STUDY - PHASE I

EXCAVATED CANAL

SNAKE AND COLUMBIA RIVERS

WASHINGTON

ENCLOSURE 3-7



NOTES:

1. AN ELEVATED CANAL OR CULVERT SECTION WOULD BE USED WHERE THE CANYON WALLS ARE TOO STEEP OR UNSTABLE TO ALLOW EXCAVATION OF A CANAL ON GRADE, WHEN CROSSING A VALLEY, CANYON, OR DEEP DRAW, WHEN CROSSING MAJOR TRIBUTARIES, AND WHEN CROSSING ROADS AND UTILITIES.
2. THE ELEVATED CULVERT SECTION MAY BE USED TO CARRY FLOW UNDER PRESSURE. ELEVATED CULVERT COULD BE CONSTRUCTED AT A LOWER ELEVATION THAN THE OPEN RECTANGULAR CANAL THEREBY REDUCING THE HEIGHT OF THE COLUMN WHICH SUPPORT THE CANAL.
3. COLUMNS MAY BE LOCATED WITHIN THE RESERVOIRS PARTICULARLY IN AREAS HAVING VERY STEEP CANYON WALLS. CONSTRUCTION OF COLUMNS WITHIN THE RESERVOIR WOULD REQUIRE A CAISSON AT EACH COLUMN.
4. CONCRETE CULVERT MAY CARRY OPEN CHANNEL FLOW OR WATER UNDER PRESSURE. TOP OF PIPE WOULD BE PAINTED USING A HIGHLY REFLECTIVE PAINT TO REDUCE HEAT ABSORPTION.
5. RECTANGULAR CANAL SECTIONS WOULD CONSIST OF 20 FOOT LONG PRE-CAST UNITS WITH WATER TIGHT JOINTS.
6. CHAIN LINK FENCING SHALL BE SECURED TO THE TOP OF THE SOUTH WALL OF THE FLUME. PLASTIC SLATS SHALL BE WOVEN THROUGH THE CHAIN LINK FENCE TO PROVIDE SHADING FOR THE FLUME.
7. 1/8" GALVANIZED STEEL WIRES WILL BE SECURED TO FENCING WITH 12" SPACING BETWEEN EACH WIRE. THESE WIRES ARE INTENDED TO DISCOURAGE AVIAN PREDATION OF SALMON SMOLTS IN THE CANAL.
8. SOME SEGMENTS OF ELEVATED FLUME MAY BE USED AS A BRIDGE FOR THE CANAL ACCESS ROAD. IN THESE SEGMENTS THE FLUME WILL BE COVERED WITH GRATING CAPABLE OF SUPPORTING A VEHICLE. GUARD RAILS WILL BE ATTACHED TO THE SIDE WALLS OF THE FLUME. THE SECURITY FENCE AND GALVANIZED STEEL WIRE WILL NOT BE REQUIRED IN THESE SEGMENTS.

REDUCED TO 50% OF FULL SIZE

U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

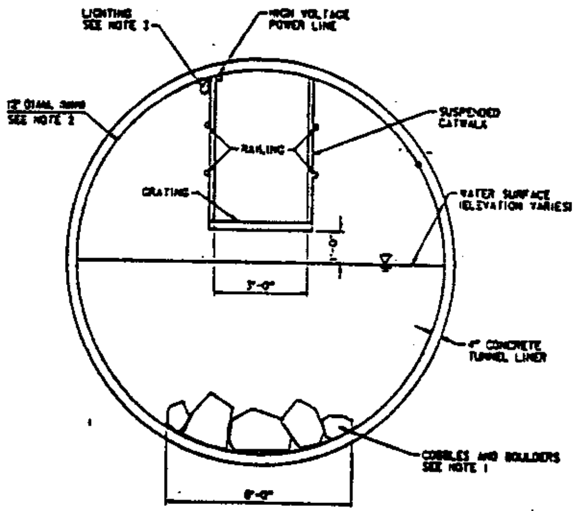
SYSTEM CONFIGURATION STUDY - PHASE I

ELEVATED FLUME AND CULVERT

SNAKE AND COLUMBIA RIVERS

0 | D-8-14-5 | 92SEP90

ENCLOSURE 3-8



TUNNEL SECTION

SCALE: 1" = 2'

NOTES:

1. COBBLES AND BOULDERS SHALL BE ANGULAR, WEIGHT BETWEEN 100 AND 500 LBS. AND SHALL BE GROUTED IN PLACE CONTINUOUSLY ALONG A 8' WIDE STRIP RUNNING DOWN THE MIDDLE OF THE TUNNEL INVERT.
2. TUNNEL DIAMETER MAY BE LARGER THAN 12' FOR SOME SECTIONS OF TUNNEL DEPENDING ON THE AVAILABILITY OF 12' DIAMETER TUNNEL BORING MACHINES.
3. TUNNEL WILL BE LIGHTED BY 200 WATT LIGHTS IN WATER-TIGHT FIXTURES LOCATED 50' O.C. ON 1250' LONG STRINGERS. A HIGH VOLTAGE LINE RUNNING THROUGH THE TUNNEL WILL PROVIDE POWER TO TRANSFORMERS FOR THE LIGHTING STRINGERS.

REDUCED TO 50% OF FULL SIZE

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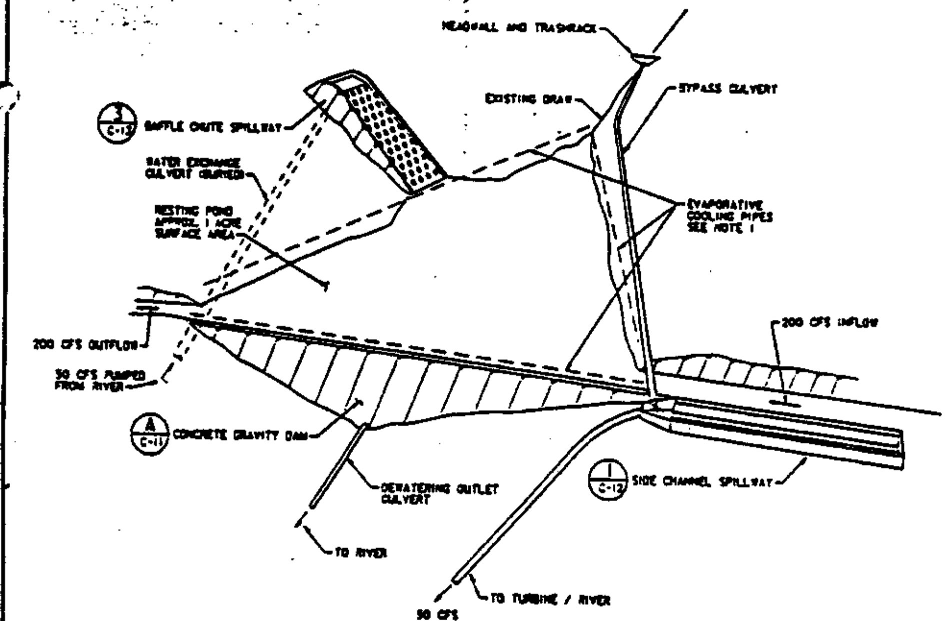
SYSTEM CONFIGURATION STUDY - PHASE I

TUNNEL

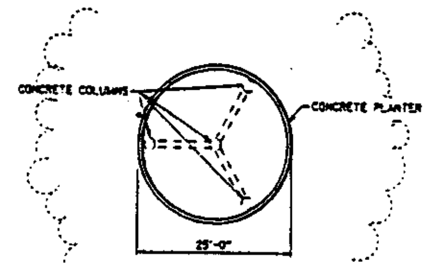
SNAKE AND COLUMBIA RIVERS WASHINGTON

D-8-14-5

ENCLOSURE 3-9



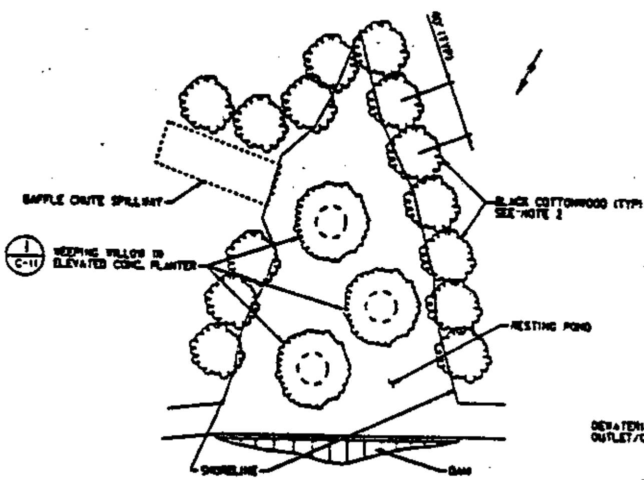
PERSPECTIVE VIEW



PLAN

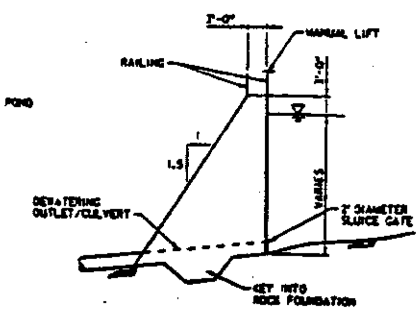
NOTES:

1. EVAPORATIVE COOLING PIPES SHALL BE SUSPENDED 10' ABOVE THE POND SURFACE ELEVATION AND SHALL HAVE MIST EMITTING NOZZLES LOCATED EVERY 10'. EACH SIDE OF THE POND INCLUDING THE DAM SHALL HAVE AN EVAPORATIVE COOLING PIPE AND VARIABLE CAPACITY PUMP (20 GPM MAX.) WHICH CAN BE OPERATED INDEPENDENTLY.
2. BLACK COTTONWOOD TREES SHALL BE ALL FEMALE TO PREVENT PRODUCTION OF SEEDS AND CATKINS. MATURE TREES WILL HAVE A SPREAD OF UP TO 40 FEET AND HEIGHTS OF UP TO 100 FEET.

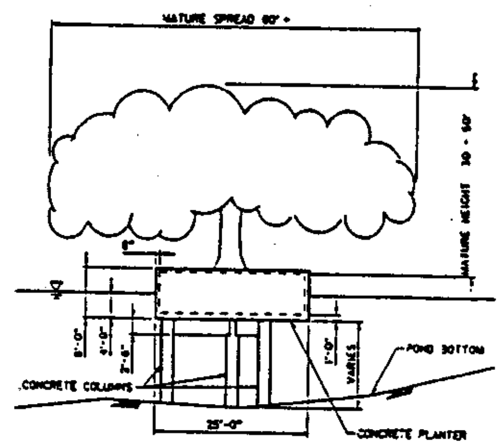


LANDSCAPE PLAN

RESTING POND
NOT TO SCALE



CONCRETE GRAVITY DAM
SCALE: 1" = 10'



ELEVATION

WEEPING WILLOW IN ELEVATED CONC. PLANTER
SCALE: 1" = 10'

REDUCED TO 50% OF FULL SIZE

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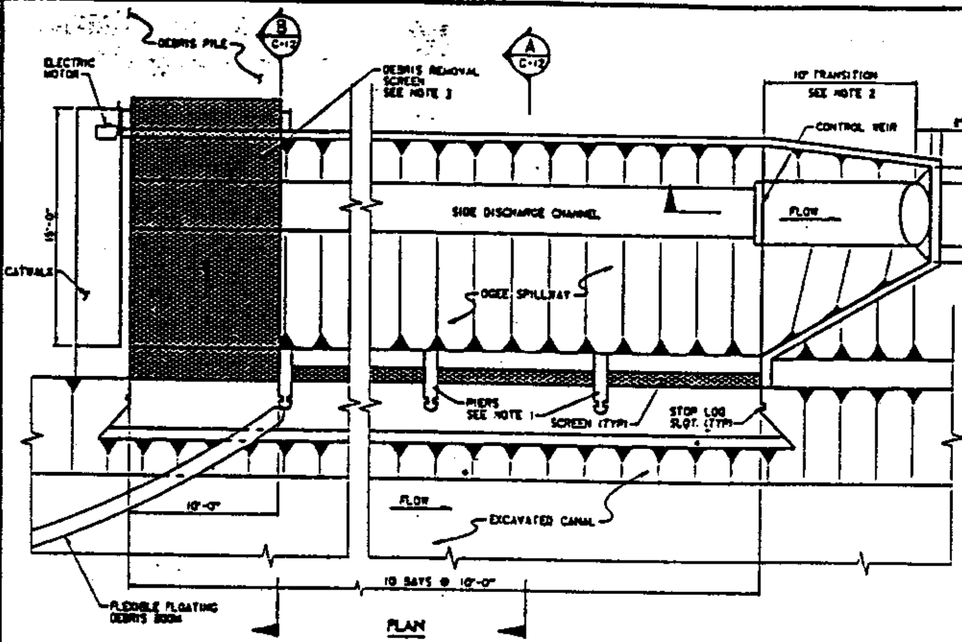
SYSTEM CONFIGURATION STUDY - PHASE I

RESTING POND

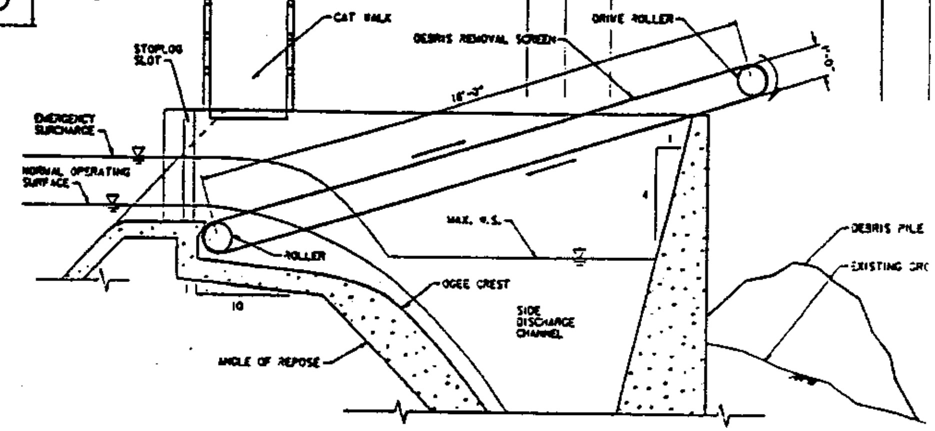
SNAKE AND COLUMBIA RIVERS

D-8-14-5

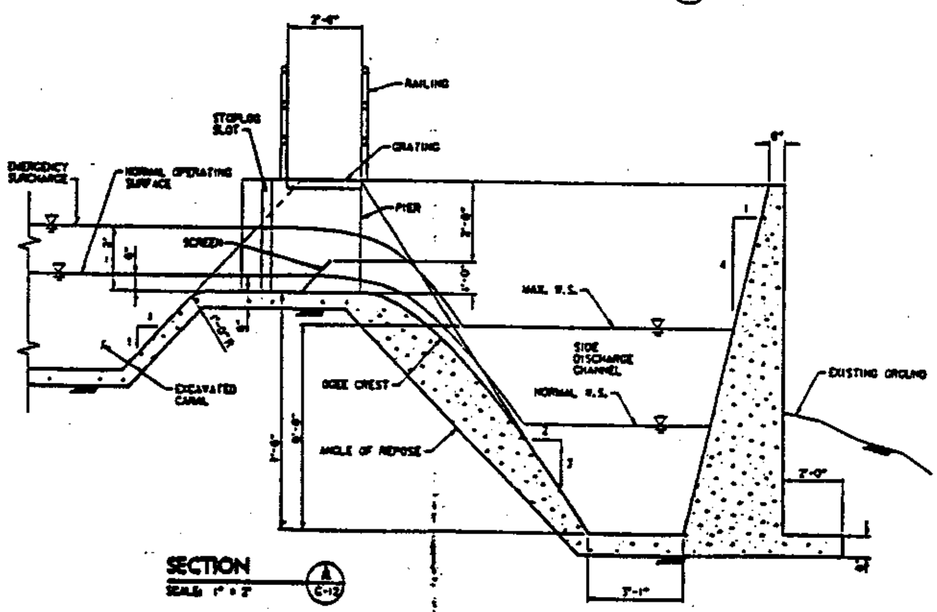
ENCLOSURE 3-10



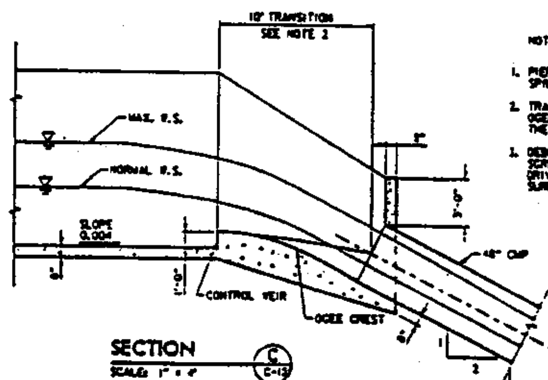
SIDE CHANNEL SPILLWAY (1 / C-11)
SCALE: 1" = 4'



SECTION (B / C-12)
SCALE: 1" = 2'



SECTION (A / C-12)
SCALE: 1" = 2'



SECTION (C / C-12)
SCALE: 1" = 4'

NOTES:

1. PIERS SUPPORT SCREENS, GRATING, AND RAILING FOR CAT-WALK OVER SPILLWAY. GRATING AND RAILING ARE NOT SHOWN IN PLAN VIEW.
2. TRANSITION INTO 48" CMP SHALL BE FORMED TO PROVIDE A SMOOTH OGEE CURVE AND TRANSITION FROM THE TRAPEZOIDAL SIDE CHANNEL TO THE BOTTOM HALF OF THE 48 INCH CMP.
3. DEBRIS REMOVAL SCREEN CONSISTS OF A CONTINUOUS BELT OF METAL SCREEN WITH A ROLLER AT EACH END. A SMALL ELECTRIC MOTOR DRIVES THE TOP ROLLER AND IS GEARED SUCH THAT THE SCREEN SURFACE MOVES AT APPROXIMATELY 10 FT PER MINUTE.

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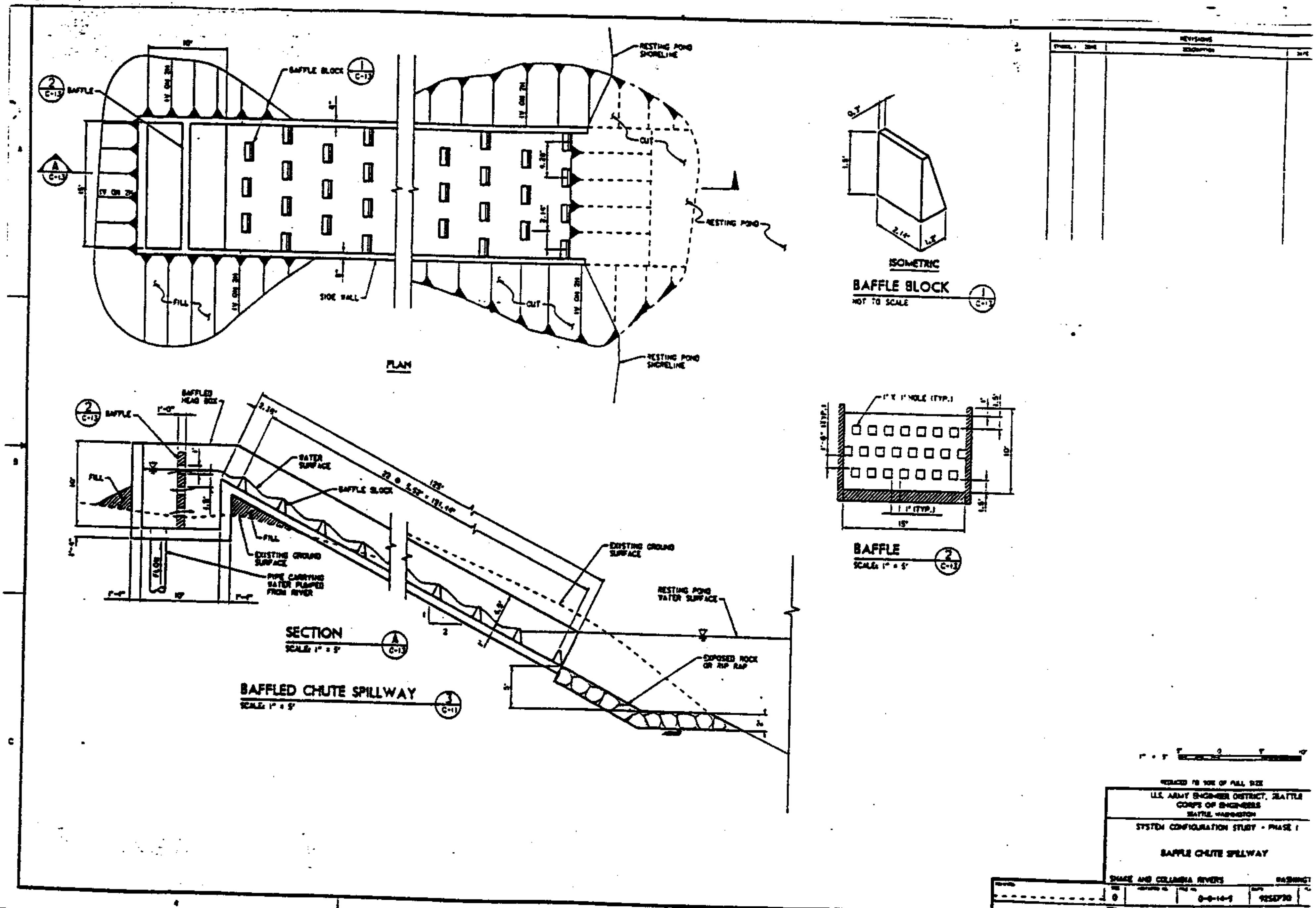
SYSTEM CONFIGURATION STUDY - PHASE I

SIDE CHANNEL SPILLWAY

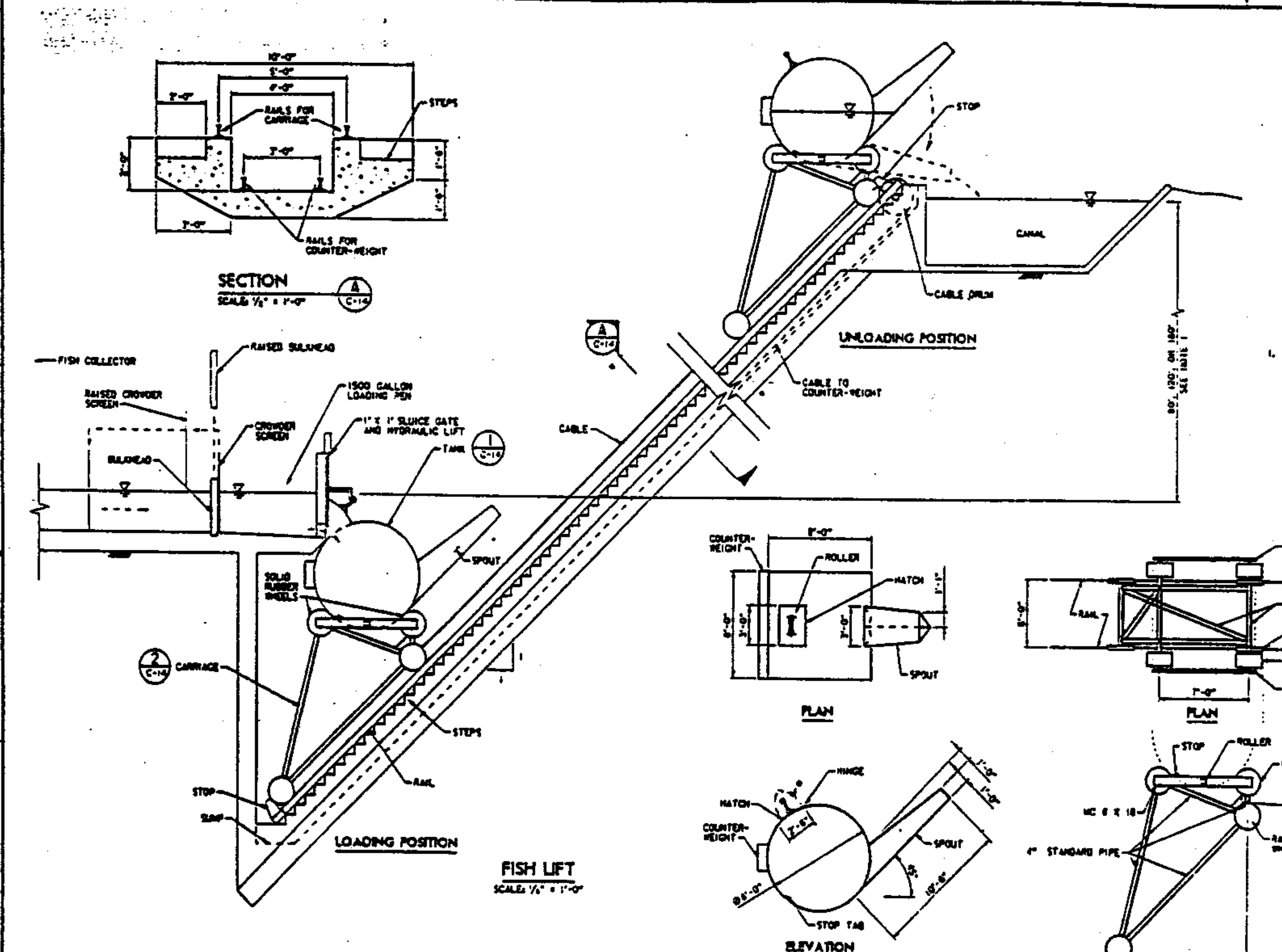
SNAKE AND COLUMBIA RIVERS

0-0-14-5 · 92SEP93

ENCLOSURE 3-11



ENCLOSURE 3-12



NOTES:

1. TABLE 1 SHOWS THE DIFFERENCE BETWEEN WATER SURFACE ELEVATIONS AT THE TOP AND BOTTOM OF THE FISH LIFT AT EACH OF THE FISH LIFT SITES.

TABLE 1

ALTERNATE COLLECTOR SYSTEM LOCATIONS

LOCATION	HEIGHT
SNAKE RIVER AT SILCOTT	120'
SNAKE RIVER AT 10 MILE RAPIDS	180'
CLEARWATER RIVER	80'

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SYSTEM CONFIGURATION STUDY - PHASE I

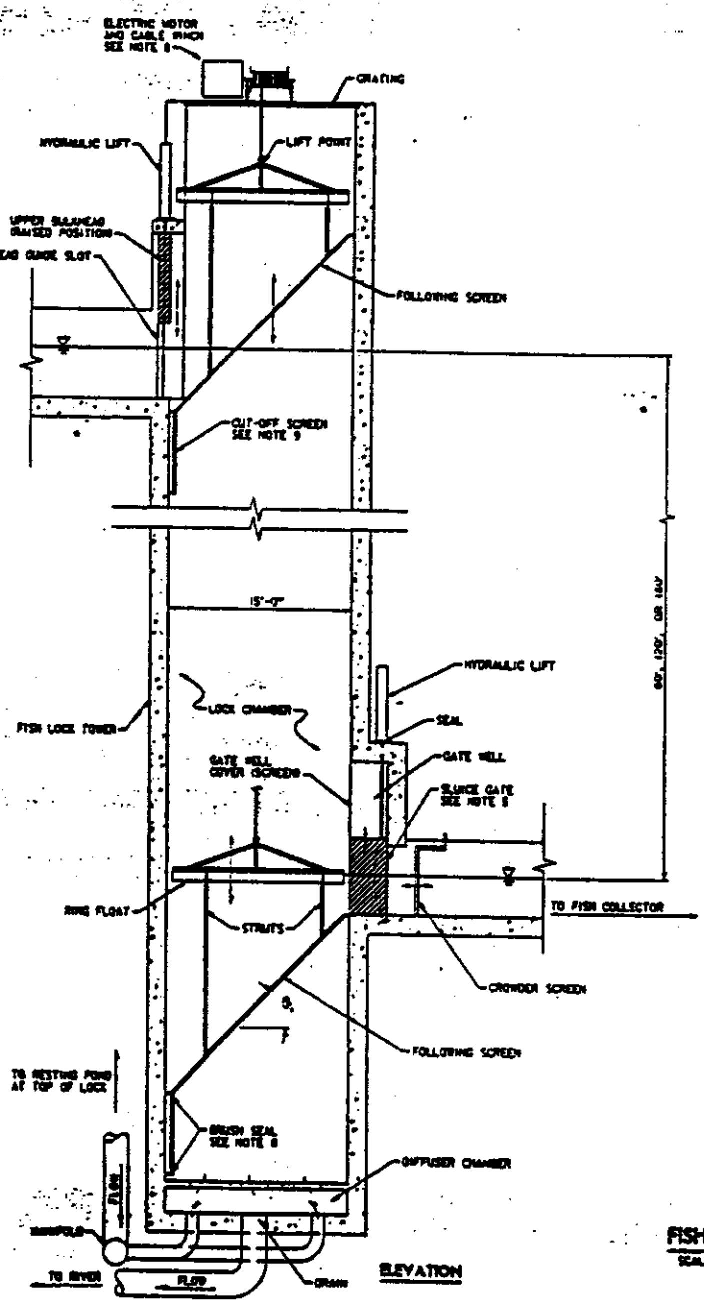
FISH LIFT

SNAKE AND COLUMBIA RIVERS

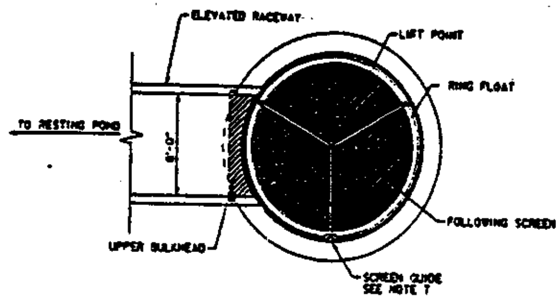
D-6-14-5

92SEP30

ENCLOSURE 3-13



ELEVATION



PLAN VIEW
TOP OF LOCK

ALTERNATE COLLECTOR SYSTEM LOCATIONS

LOCATION	HEIGHT
SNAKE RIVER AT SILCOTT	120'
SNAKE RIVER AT 10 MILE RAPIDS	180'
CLEARWATER RIVER	60'

FISH LOCK
SCALE: 1" = 5'

NOTES:

1. THE FISH LOCK CYCLE BEGINS WITH THE UPPER BULKHEAD IN THE LOWERED POSITION, THE SLUICE GATE IN THE RAISED POSITION, AND THE FOLLOWING SCREEN AT THE BOTTOM OF THE LOCK CHAMBER.
2. FISH ARE CROWDED INTO THE LOCK CHAMBER BY MOVING THE CROWDER SCREEN UP TO THE GUIDE SLOT FOR THE SLUICE GATE. THE SLUICE GATE IS THEN LOWERED AND THE LOCK CHAMBER FILLED WITH WATER WHICH IS ENTERS THROUGH THE DIFFUSER CHAMBER. AS THE LOCK FILLS WITH WATER THE FOLLOWING SCREEN MOVES UPWARDS DUE TO THE BOUYANCY OF THE FLOAT RING ATTACHED TO THE FRAME OF THE FOLLOWING SCREEN.
3. WHEN THE WATER LEVEL IN THE LOCK CHAMBER REACHES THE WATER LEVEL IN THE RACEWAY AT THE TOP OF THE TOWER, THE UPPER BULKHEAD IS RAISED. THE FOLLOWING SCREEN IS GRADUALLY LIFTED FROM THE WATER. AS THE SCREEN IS RAISED, THE SLOPED SCREEN BOTTOM FORCES THE SMOLTS TO EXIT THE LOCK AND ENTER ELEVATED RACEWAY WHICH CARRIES THE SMOLTS TO THE MIGRATORY CANAL.
4. THE UPPER BULKHEAD IS THEN CLOSED AND THE WATER IN THE CHAMBER IS ALLOWED TO DRAIN TO THE RIVER. THE SLUICE GATE IS THEN RAISED COMPLETING THE LOCK CYCLE.
5. THE SLUICE GATE AT THE BOTTOM OF THE LOCK IS AN EXTRA HEAVY DUTY SLUICE GATE WITH A FRAME AND SCREENS ATTACHED SUCH THAT THERE WILL BE NO GAPS BETWEEN THE SLUICE GATE AND THE EDGE OF THE FOLLOWING SCREEN. THE GATE WELL COVER ATTACHED TO THE SLUICE GATE PREVENTS SMOLTS FROM ENTERING THE SLUICE GATE WELL WHEN THE CHAMBER IS FILLED.
6. A BRUSH SEAL IS USED AROUND THE PERIMETER OF THE FOLLOWING SCREEN AND THE CUT-OFF SCREEN AND IS COMPOSED OF STIFF BRISTLES WHICH PREVENT SMOLTS FROM PASSING BETWEEN THE FRAME OF THE FOLLOWING SCREEN AND THE WALLS OF THE LOCK CHAMBER.
7. THE SCREEN GUIDE PREVENTS THE FOLLOWING SCREEN FROM ROTATING WITHIN THE LOCK CHAMBER.
8. THE ELECTRIC MOTOR AND WINCH WILL MAINTAIN TENSION IN THE CABLE AS THE FOLLOWING SCREEN RISES AND FALLS WITH THE WATER LEVEL IN THE LOCK CHAMBER. A FLOAT ACTIVATED SWITCH WILL CAUSE THE HYDRAULIC LIFT TO RAISE THE UPPER BULKHEAD WHEN THE CHAMBER IS COMPLETELY FILLED. WHEN THE UPPER BULKHEAD REACHES THE FULLY OPEN POSITION, THE ELECTRIC MOTOR WILL LIFT THE FOLLOWING SCREEN OUT OF THE WATER.
9. THE CUT-OFF SCREEN PREVENTS SMOLTS FROM SWIMMING UNDER THE FOLLOWING SCREEN WHEN THE SCREEN IS RAISED AT THE TOP OF THE LOCK.

REDUCED TO 50% OF FULL SIZE

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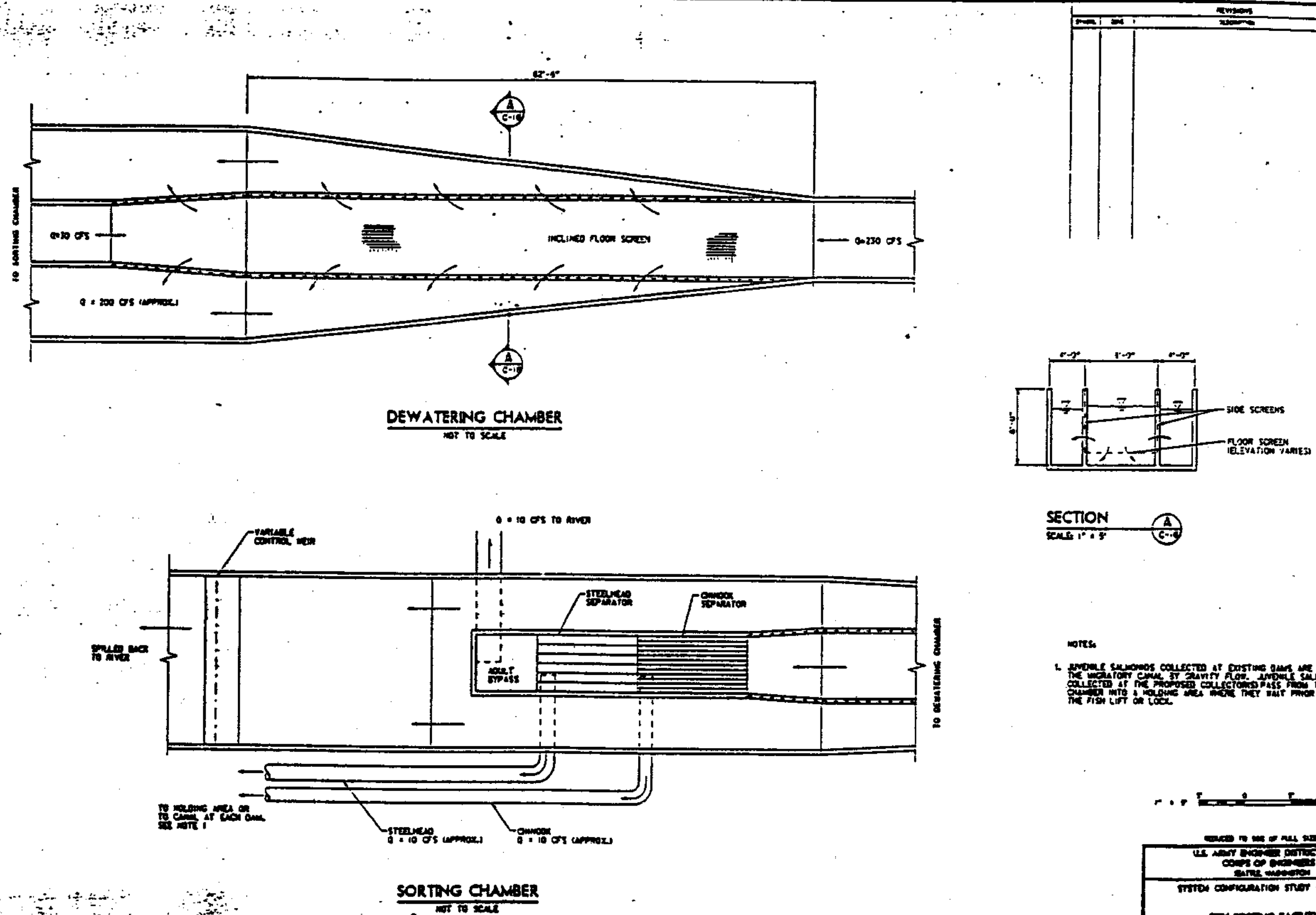
SYSTEM CONFIGURATION STUDY - PHASE I

FISH LOCK

SNAKE AND COLUMBIA RIVERS — WASHING[TON]

D-8-14-5 — 92SEP30

ENCLOSURE 3-14



NOTES:

1. JUVENILE SALMONIDS COLLECTED AT EXISTING DAMS ARE CARRIED TO THE MIGRATORY CANAL BY GRAVITY FLOW. JUVENILE SALMONIDS COLLECTED AT THE PROPOSED COLLECTOR(S) PASS FROM THE SORTING CHAMBER INTO A HOLDING AREA WHERE THEY WAIT PRIOR TO ENTERING THE FISH LIFT OR LOCK.

REDUCED TO 50% OF FULL SIZE

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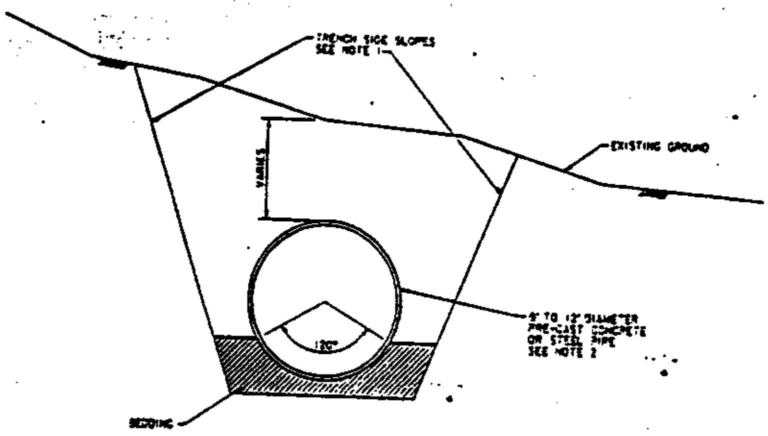
SYSTEM CONFIGURATION STUDY - PHASE I

FISH SORTING FACILITY

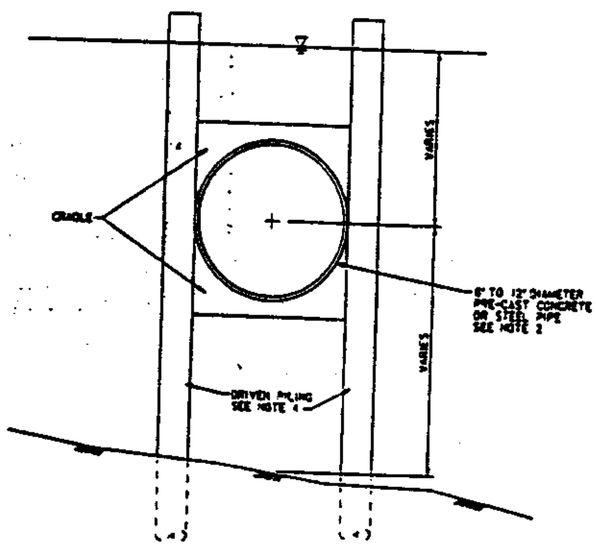
SNAKE AND COLUMBIA RIVERS

D-6-10-5

ENCLOSURE 3-15



BURIED PIPE SECTION
NOT TO SCALE



SEE NOTE 3
SUBMERGED PIPE SECTION
NOT TO SCALE

NOTES:

1. TRENCH SIDE SLOPE VARIES DEPENDING ON THE PROPERTIES OF THE EXCAVATED MATERIAL AND THE DEPTH OF THE TRENCH. TRENCHES EXCAVATED IN ROCK WILL HAVE NEARLY VERTICAL SIDE SLOPES. TRENCHES EXCAVATED IN LOOSE MATERIAL WILL HAVE SIDE SLOPES AT THE ANGLE OF REPOSE OF THE MATERIAL. DEEP TRENCHES MAY BE CONSTRUCTED USING TRENCH BOXES.
2. THE DIAMETER OF THE PIPE IS A FUNCTION OF THE SLOPE OF THE HYDRAULIC GRADE LINE FOR EACH SEGMENT OF PIPE. THE DIAMETER OF THE PIPE MAY VARY WITHIN EACH REACH.
3. THE SUBMERGED PIPE SECTION IS ONLY USED IMMEDIATELY UPSTREAM FROM EACH DAM.
4. PILING AND CRADLES SUPPORTING SUBMERGED PIPE WILL BE LOCATED AT 20' INTERVALS. PRECAST CONCRETE PADS WITH VERTICAL SUPPORTS WILL BE USED TO SUPPORT SUBMERGED PIPE WHERE PILE CANNOT BE DRIVEN INTO THE EXISTING MATERIAL.

REDUCED TO SIZE OF FULL SIZE

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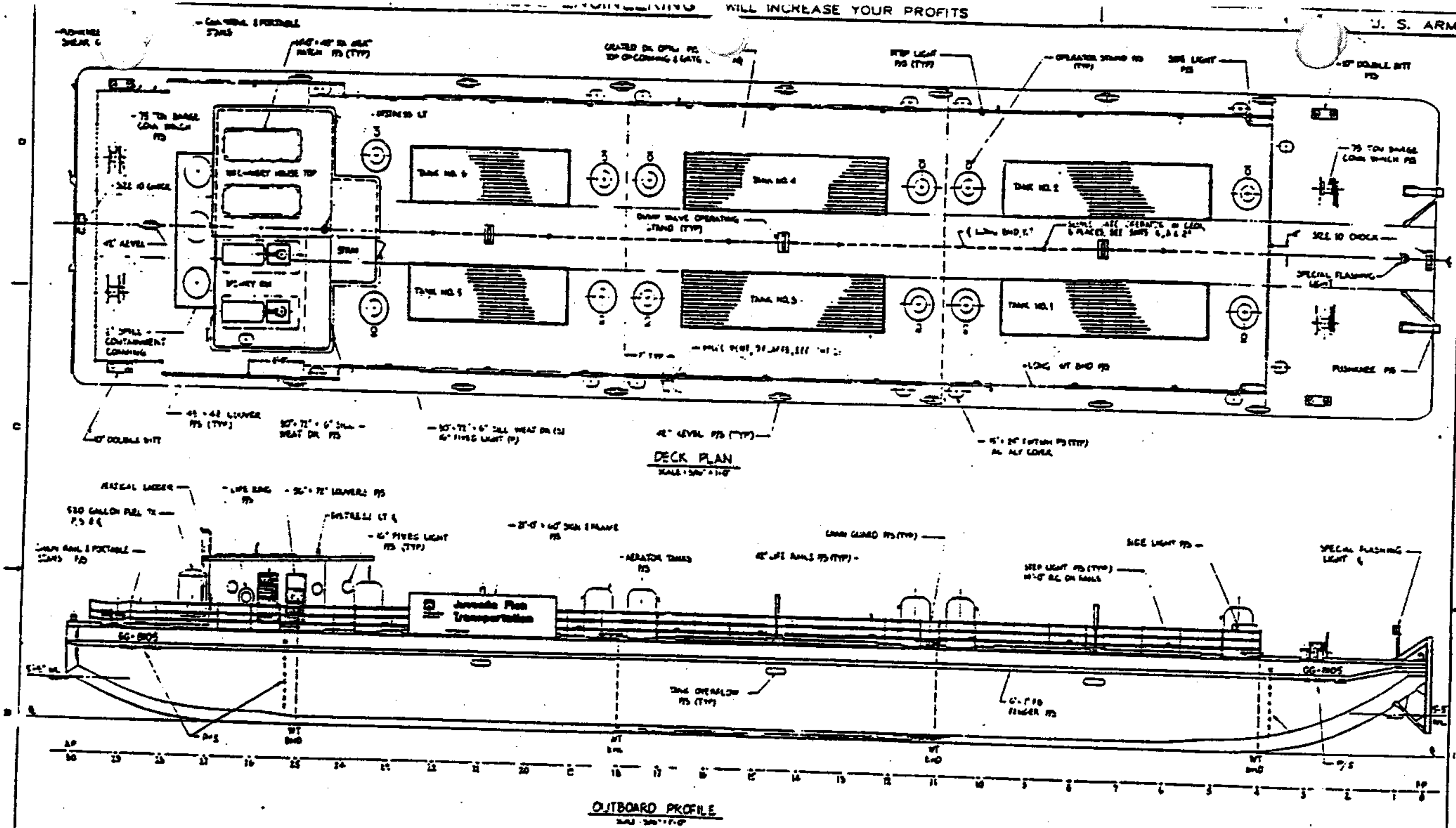
SYSTEM CONFIGURATION STUDY - PHASE I

BURIED PRESSURE PIPE

SNAKE AND COLUMBIA RIVERS WASHINGTON

0 | | 0-0-14-5 | | 10 OF 10

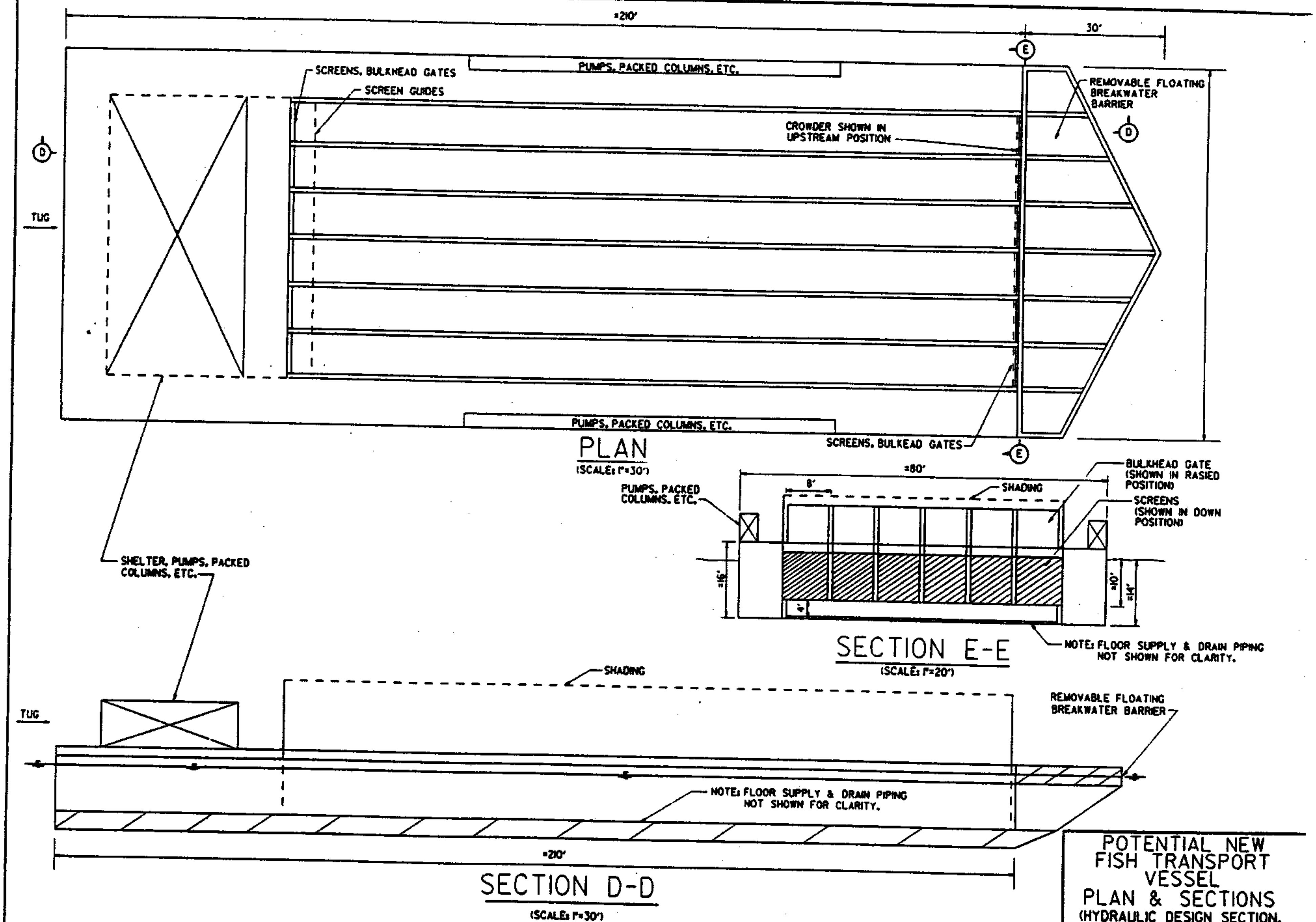
ENCLOSURE 3-16



PRINCIPAL CHARACTERISTICS

EXISTING FISH BARGE
TYPICAL GENERAL ARRANGEMENT

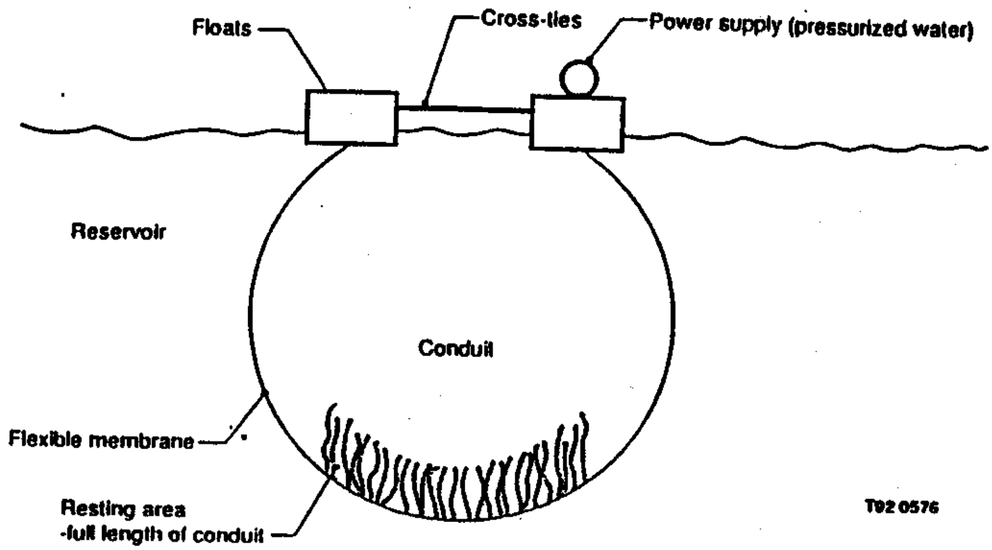
ENCLOSURE 4-1

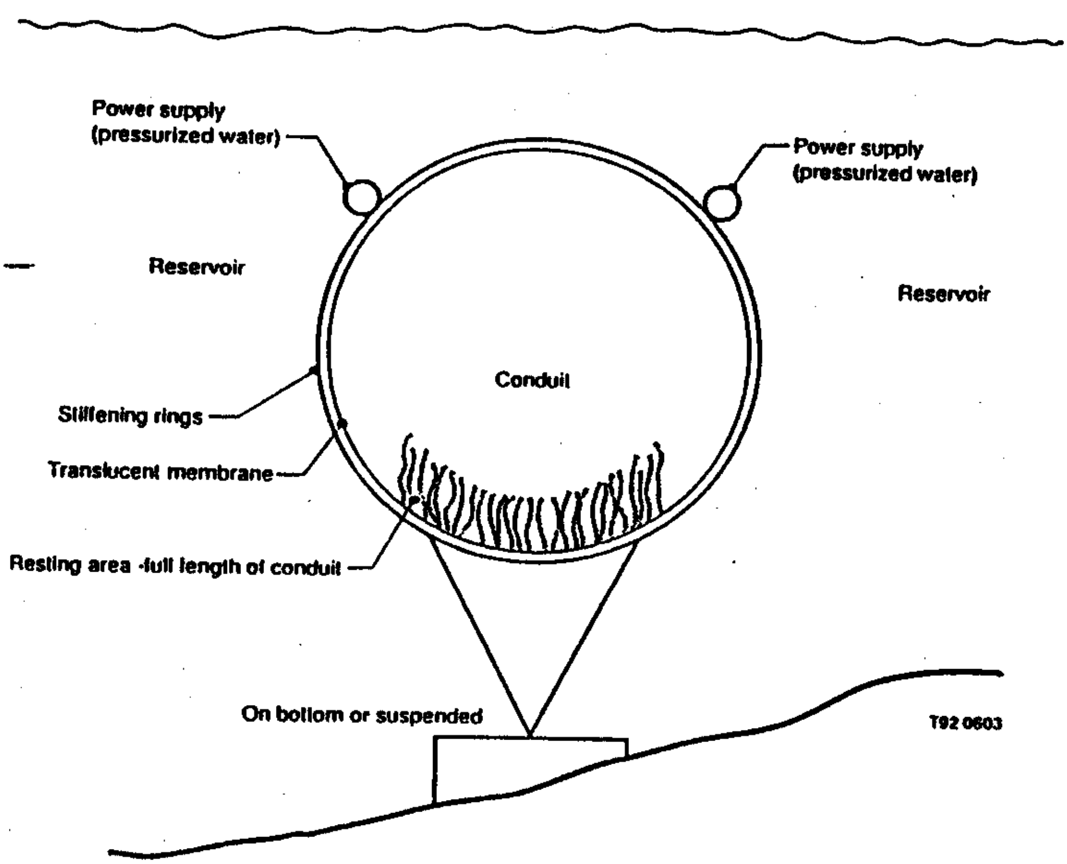


POTENTIAL NEW FISH TRANSPORT VESSEL
PLAN & SECTIONS
(HYDRAULIC DESIGN SECTION, CENPWEN-DB-HY)
MAY 92

FILENAME COLFIB.DGN

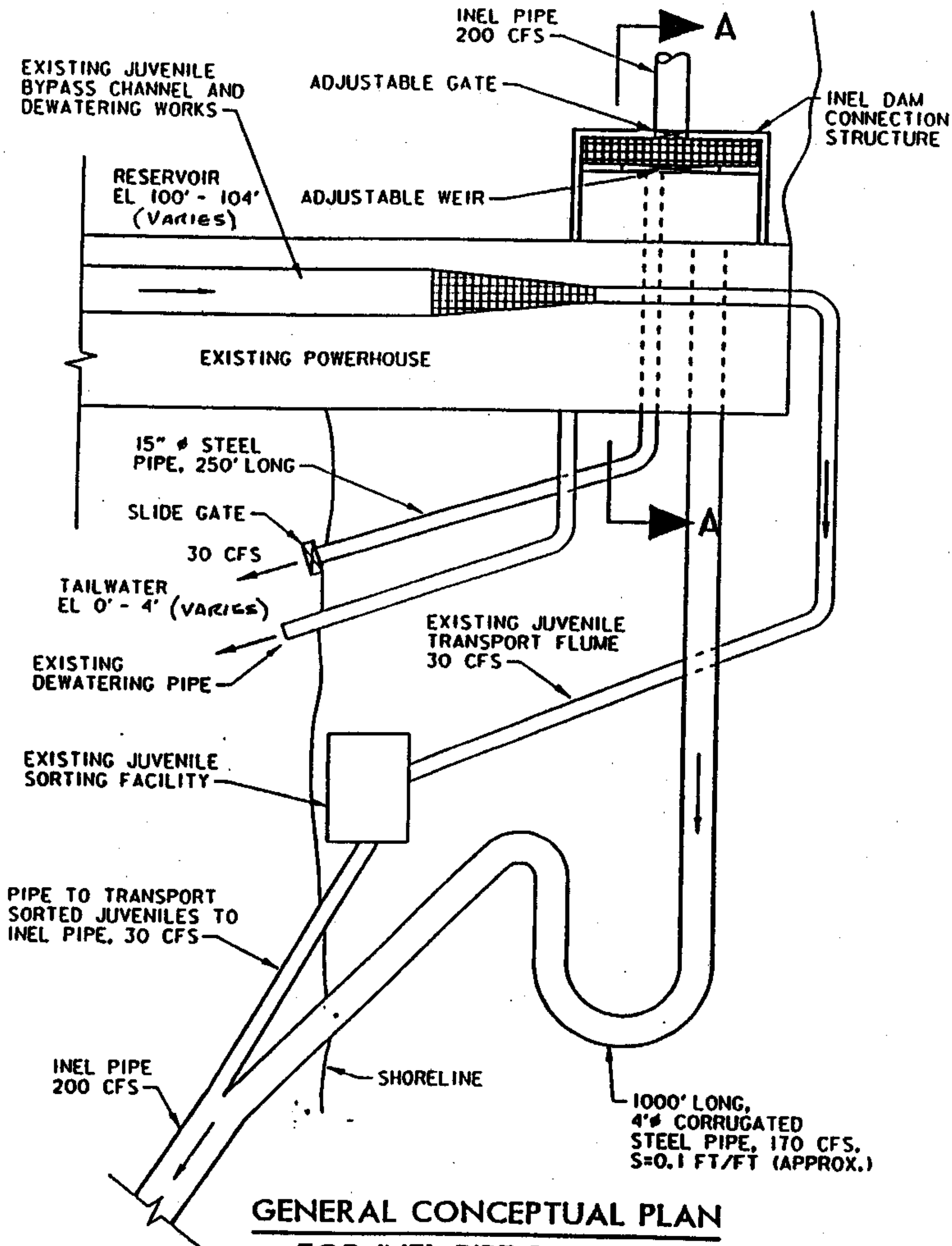
ENCLOSURE 4





OPEN CHANNEL AND CLOSED CONDUITS – TYPICAL INEL PIPELINE SECTIONS

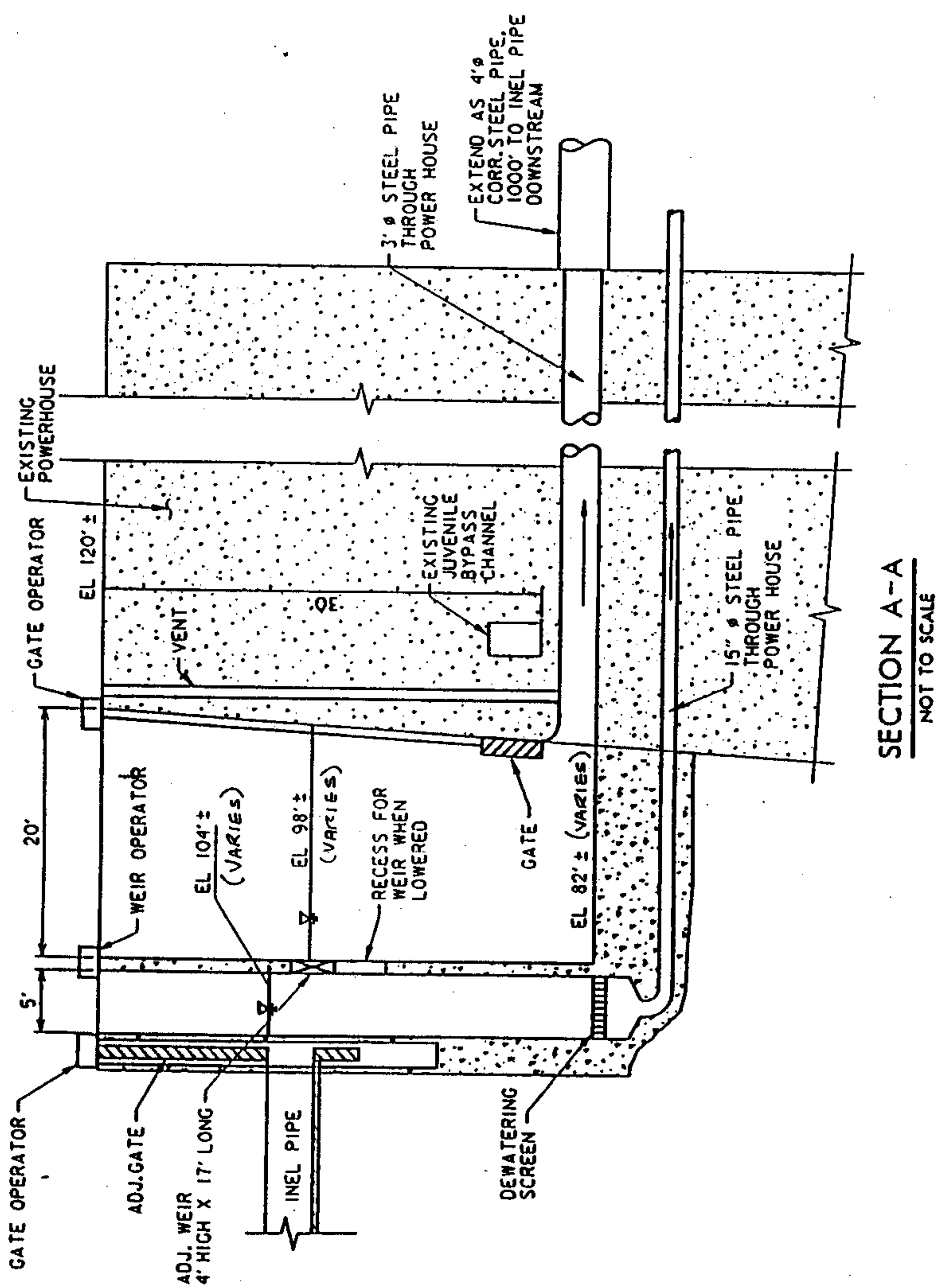
ENCLOSURE 5-1



GENERAL CONCEPTUAL PLAN
FOR INEL PIPE PASSAGE

INEL PIPE PASSAGE THROUGH A DAM – GENERAL CONCEPTUAL PLAN

ENCLOSURE 5-2



INEL PIPE PASSAGE THROUGH A DAM – SECTION A-A

ENCLOSURE 5-3

Idaho National Engineering Laboratory

Proposal For A Flexible In-reservoir Salmon Passage

Prepared For:

The U.S. Army Corps of Engineers

Presented By:

Dr. John A. Dearien, PE
Max L. Howell, Engineering Specialist
Dr. John S. Irving, Sr. Scientist
Ben N. Rinehart, Sr. Engineering Specialist
Glen C. Thurston, Sr. Engineering Specialist

EG&G Idaho

Work performed under DOE Contract No. DE-AC07-76ID01570

SUMMARY

This report summarizes the conceptual design of an in-reservoir floating or submerged conduit for transporting juvenile salmon and steelhead (known as smolts) downriver to increase the fish runs, particularly wild salmon, in the Columbia River Basin.

Efforts to control the waters of the Columbia River Basin for positive gains have not always yielded completely positive results. A less than desired consequence of these control efforts is the impact reservoirs and dams have had, and continue to have, on the Basin's salmon populations. A conceptual method of minimizing these impacts is the development and operation of an in-reservoir salmon conduit passage system. This system would minimize smolt mortality rates and provide a speedier and less stressful downstream passage to the ocean.

The Idaho National Engineering Laboratory (INEL) has proposed an in-reservoir floating or submerged conduit for smolt transportation as an alternative to an open concrete-lined channel. The method of fish collection is not addressed in this proposal since it is a separate problem that must be addressed for all conduit configurations. Several fish collection techniques have been proposed by the biologists and the United States Army Corps of Engineers (Corps) is presently addressing this issue. The fish would be taken past the dams in a fish passage designed by the Corps. The details of the dam modifications are being addressed by the Corps and; therefore, are not addressed in this proposal.

Several conduit configurations will be evaluated. All are flexible, in-reservoir configurations. While one configuration may be emphasized herein, the others will be given equal evaluation during the next phase. As presently envisioned, all configurations would be sized for 150 to 200 ft^3/sec flow and would consist of a flexible, thin membrane conduit with appropriate means of maintaining flow velocity within the required limits. The conduit would float above anchored tie-downs along the reservoir, or be submerged under shipping traffic routes or shoreline boating access lanes. Resting areas would be provided by either shore-based ponds, similar to those discussed for the land-based alternatives, or by in-reservoir net pens.

Passage through each dam would be provided by a new conduit bored through the structure and connected to the existing juvenile bypass systems. In this manner, juveniles from both the floating conduit and the existing bypass would be combined and transported further downstream. The connection between the INEL floating conduit and the existing dam structure would be accomplished with a sliding connector plate. Flow would pass through the sliding connector plate into a dewatering well. Dewatering would be provided by a floor screen in the well. A 17-ft wide adjustable weir would control the water level in the floating conduit and in the well. Downstream of the weir, a second chamber would stabilize flow conditions prior to passing the water through a 4 ft by 4 ft slide gate and into a 36-in. diameter steel lined conduit through the dam. The pipe would transition into a 48-in. diameter corrugated steel pipe (CSP) upon exiting the downstream face of the dam. The CSP pipe would drop to the elevation of the river in about 1,000 ft at velocities less than 20 ft per second and under free-surface conditions. A switchback section of pipe would be used to drop the elevation of the pipe without exceeding the pressure change tolerances of the fish.

Connection to the floating conduit in the tailwater pool could be accomplished with a flexible coupling or simply be emptied into a head tank. A transition section designed to pass the flow from supercritical to subcritical without a hydraulic jump would be provided. Smolts from the existing juvenile bypass system (sorting, collecting, and holding ponds at the base of the dam) would be transported into the floating conduit through a small flume or pipe designed to carry 30 ft^3/sec. The downstream floating conduit would be designed to carry the combined flow on to the next dam.

CONTENTS

FIGURES

TABLES

1. ENGINEERING PROPOSAL FOR THE DEVELOPMENT OF A FLEXIBLE IN-RESERVOIR SALMON PASSAGE

1.1 INTRODUCTION

The primary function of this activity is for the Idaho National Engineering Laboratory (INEL), of which EG&G Idaho, Inc. is the principal contractor, to provide a comprehensive biological and technical evaluation/assessment that will culminate in a design for a conduit. This conduit will provide for the safe downstream passage of juvenile salmon and steelhead fish (known as smolts) within the Columbia River Basin. Transporting mature fish back to their selective spawning areas is not within the scope of this fish transportation system.

The INEL has the capability to provide a broad spectrum of support services to the conduit team to assure timely and efficient design. The team is composed of the Department of Energy (DOE), Bonneville Power Administration (BPA), and the U.S. Army Corps of Engineers (Corps). Support will be derived from INEL personnel with subcontractors used for specialized expertise. The various forms of support include, but are not limited to, cost and schedule engineering support, technical analysis, and design engineering support for the juvenile fish flexible, in-reservoir conduit.

1.2 Basic Requirements

This fish transportation concept is designed to satisfy the four basic biological requirements, which are (a) rapid transit of smolts; (b) maintenance of "sense" trail; (c) biological and environmental compatibility with fish; and (d) reservoir use compatibility. In addition, this concept is also designed to meet the basic biological, engineering, and legal requirements (see Section 1.3). These four basic biological requirements are defined below.

Rapid transit of smolts: The transit system should provide a transit time between the point of hatching and the ocean which is roughly equivalent to the historical river speed, this being approximately 3 to 5 ft/sec.

Maintenance of "sense" trail: A transport system must supply a continuous input to the development of a "sense" trail if mature fish are expected to return to the proper spawning area. The migratory habits of fish indicate that fish accumulate knowledge or a "sense" of the path to the ocean as the path is traversed, and this "sense trail" is replayed in reverse when they return to spawn.

Biological and environmental compatibility with fish: Any transportation system must provide a proper environment for the fish during their passage. This environment includes proper temperature, oxygen, rest areas, feeding opportunities, protection from predators, etc. The materials and the transportation process itself must also be harmless to the fish.

Reservoir use compatibility: Many reservoir uses must be considered in the design and placement of a fish transportation system. These uses include shore-based activities which cannot be blocked in the access to the reservoir, reservoir navigation (both through and across the reservoir), and variations in reservoir heights due to electrical production and irrigation demands.

Below is a list of the advantages of the proposed conduit system and some unique options.

- Usable in any reservoir
- Accommodates reservoir usage - surface and shore
- Accommodates multiple tributaries
- Wide operating range for various fish species: speed, oxygenation, etc.
- Can be stored underwater or removed when not needed
- Variable location - initially and future
- Simple, mass-produced components
- Easily installed onsite.

These advantages and unique options are discussed below.

Usable in any reservoir: The conduit system can be used either as a surface system or as a submerged system.

Accommodates reservoir usage - surface and shore: The conduit system has the capability of being placed on the surface or submerged. This makes it usable for reservoirs which have barge traffic, boats, skiers, and fishermen.

Accommodates multiple tributaries: The conduit is so designed that branches from the main conduit can run to all tributaries that feed into the reservoir thus assuring that all fish are transported downstream.

Oxygenation: The system allows for the addition of oxygen if enough is not added naturally through the surface sections. If this is required, the pressurized water supply to the pumps can be supersaturated with oxygen and exhausted through the pumps into the conduit to supply oxygen to the fish. Medication or anything else which is dissolvable in water could be supplied by this route. This advantage is discussed further in Sections 2.1 and 2.5.

Underwater storage: Since the conduit will not be required year round, it can be sunk and stored on the bottom for most of the year due to its flexibility and water tolerant design, Recharging the flotation devices would bring it to its operational grade when needed.

Variable location: The lightweight and flexible nature of the conduit system allows it to be moved if future demands on the reservoir dictated. Modifications in its linear makeup (substitution of underwater sections for surface sections) would also be possible.

Simple, mass-produced components: There are only two basic components to the system: the conduit sections and the pumping sections (the underwater section is a fully-closed surface section). The pumping sections are used to connect the conduit sections together. By consisting of only two basic components, the system allows for full use of mass-production techniques.

Easily installed onsite: The fabrication process for the conduit consists of unrolling the conduit sections from the back of a construction boat, attaching the floats, and connecting the sections with the pumping sections.

Simple operation from one location: The pressurized water for the pumping sections is supplied from one or both ends of the conduit. Control of the pressured water constitutes control of the conduit.

1.3 Development Program

The development program consists of two primary activities: establishing requirements and designing and testing a prototype system.

1.3.1 Establishing Requirements

This task would scope the problem to be solved and include analysis of materials and components needed for the system.

1.3.1.1 Biological Requirements. This task would guarantee that all operational functions of the conduit were compatible with the known biological needs and behavioral characteristics of the fish. These requirements would be finalized with the assistance of Dr. Earnest Brannon, University of Idaho (U of I); experts from the University of Washington (U of W), Dr. John Irving, INEL; and specialists from the industry.

1.3.1.2 Legal Requirements. This task would define any legal requirements or restraints regarding the placement or operation of the conduit in the river system. This task would involve interaction with the appropriate Federal, State, and local agencies involved with, or potentially impacted by, placement and operation of the system.

1.3.1.3 Technical Requirements/Constraints. This task would define the technical design and operation characteristics of the conduit itself. This task would consider not only the engineering details required for the conduit to perform its transportation function, but also any modifications to these engineering details dictated by biological or legal requirements.

1.3.2 Designing and Testing a Prototype System

This task would begin with an evaluation of the various alternative configurations. Then a prototype system and 3,000 ft section will be designed and tested in water with fish.

1.3.2.1 Flexible Membrane Hydraulics. This task would determine the hydraulic characteristics of a flow channel constructed of a very flexible membrane. The behavior of such a flow channel is important in sizing pumps, choosing power supplies and restraint devices, and selecting materials.

1.3.2.2 Materials Evaluation. This task would select materials for the membrane, floats, hydraulic motors, pumps, and the smaller items used in the fabrication of the system. The materials selected must be biologically compatible with the fish (no plastics which might be harmful to the fish), durable with respect to long life in the reservoir system, and as maintenance-free as possible.

1.3.2.3 Pump Design. This task would design a pumping section with low-velocity blades, peristaltic action, jet pumping, or other means in order to pump the fish through the channel with minimal stress.

1.3.2.4 Sub-Scale Testing. This task would test flexible conduits and pumping sections in-river prior to finalizing a conduit size and configuration. Ample test areas are located in the Snake River adjacent to the INEL facilities.

1.3.2.5 Full-Scale Testing with Fish. This task would test a full-size (diameter) conduit and pumping section(s) with various sizes of fish to guarantee that the system functions without harm to the fish. Fish biologists will perform these tests.

2. SYSTEM AND COMPONENT DESCRIPTION

2.1 Biological Requirements and Concerns

Success of the conduit concept depends, in part, on how compatible the system is with the biological needs and behavioral characteristics of migrating smolts. Some of the initial biological concerns include:

- Stress on the smolts
- Migration requirements (e.g., homing, imprinting, light/dark cycles)
- Water velocity (e.g., timing of entry to estuary)
- Feeding and resting opportunities
- Injury (e.g., pressure, water shear, physical contact with conduit structure)
- Exclusion of predators (e.g., fish, birds, mammals)
- Oxygen and temperature requirements
- Gas Supersaturation (N_2).

These initial biological concerns are discussed below as related to the conduit concept. This list, however, is not inclusive and other biological requirements and concerns may be identified as design of the conduit system progresses.

Successful migration of smolts is directly related to the stress experienced during the migration process—the higher the stress, the lower the survival of smolts. Minimizing the stress experienced by smolts in each component of the conduit transport system is key to the success of the system. In addition, collection of smolts and the successful by-pass of dams are key to any transportation system, including the conduit system. The Corps is responsible for designing the fish collection systems upstream of Lower Granite Dam and from tributaries (e.g., Tucannon River) to connect to the main conduit system. The Corps will also design the passage through or around dams.

Once in the conduit, migrating smolts will require certain environmental conditions. These conditions can be divided into those that are life-threatening and those that impact the survival of smolts or return of adults. Life threatening conditions include inadequate water quality (e.g., low oxygen levels, high water temperatures) and an unsafe environment (e.g., presence of predators, physical hazards) within the conduit system. Other conditions, while not life threatening, could impact the survival of smolts downstream and thus, the return of adults to their natal areas (e.g., inadequate water velocity, no opportunity to rest or imprint on homing cues).

The ability to return to natal streams to spawn is essential to the recovery of the salmon and steelhead stocks. Smolts must have the opportunity to imprint on homing cues found in the Snake and Columbia Rivers and their tributaries. In addition, to complete the physiological processes involved in migrating from freshwater to estuarine or saltwater, migrating fish must be able to experience the normal light/dark cycles. Also, critical to this process is the timing of reaching the estuary. Adequate water velocities must be maintained, throughout the conduit, to transport fish downstream at about the same rate as occurred prior to construction of the dams.

Basic water quality parameters, such as dissolved oxygen, water temperature, and gas supersaturation must be maintained at adequate levels in the conduit to provide conditions wherein fish can survive. Meeting the basic requirements will help minimize stress on the fish, thus enhancing survival. For those migrants that feed to maintain energy reserves (e.g., fall chinook), food supplies must be available. Also, to increase survival, predators (e.g., birds, fishes, mammals) must be excluded from the conduit system. Because fish would be concentrated in a small area, predation could account for a significant loss, if not controlled.

Salmonid species have different requirements for migration. The transportation system designed to help smolts migrate downstream must take into account these differences. To be successful, the conduit system and associated components (collection and dam by-pass facilities) must minimize the injury and stress to fish passing through the system. In addition, the concerns discussed above (e.g., water quality, predation) need to be considered when designing collection and dam by-pass facilities and "resting" or "holding" areas for migrating smolts.

2.2 System Description and Operation

The Flexible In-reservoir Salmon Passage (FISP) is designed as a modular system consisting of a small number of mass produced component assemblies. The assemblies can then be joined together into a fish passage system which can be customized for use in any reservoir. Utilizing easily connected flexible conduit sections as the primary building block, the system will transport juvenile fish between the collection facilities and the passage systems at various dams via the route that has a minimum impact on other users of the reservoir. As shown on Figure 1, multiple collection points at various tributaries can easily be accommodated. The FISP System can be easily installed to provide a flexible, cost-effective method of transporting juvenile fish through the Columbia River Drainage.

The FISP System is composed of the following primary component assemblies:

1. Flexible conduit (submerged or surface)
2. Pump stations
3. Junctions (between tributary and main conduit)
4. Head tank (at collection points)
5. Power piping or electrical conduit.

The flexible conduits are approximately 8 ft in diameter and are tentatively planned to be 1,000 ft in length. Sections can be joined (or disengaged) to each other, to pump stations, to collection and delivery points, or to junctions between pipes. The conduit is constructed from a thin translucent flexible material. The bottom of the conduit will have a mat with leafy, plant-like structures to provide resting areas for the smolts along the conduit.

Most sections of conduit may be closed and have a circular cross section, as shown in Figure 2. The closed sections will be submerged within the reservoir to permit navigation and access from the shore for recreation or other use. Flowing water within the conduit will be at a slightly higher pressure than the water in the reservoir so that the conduit will maintain its shape.

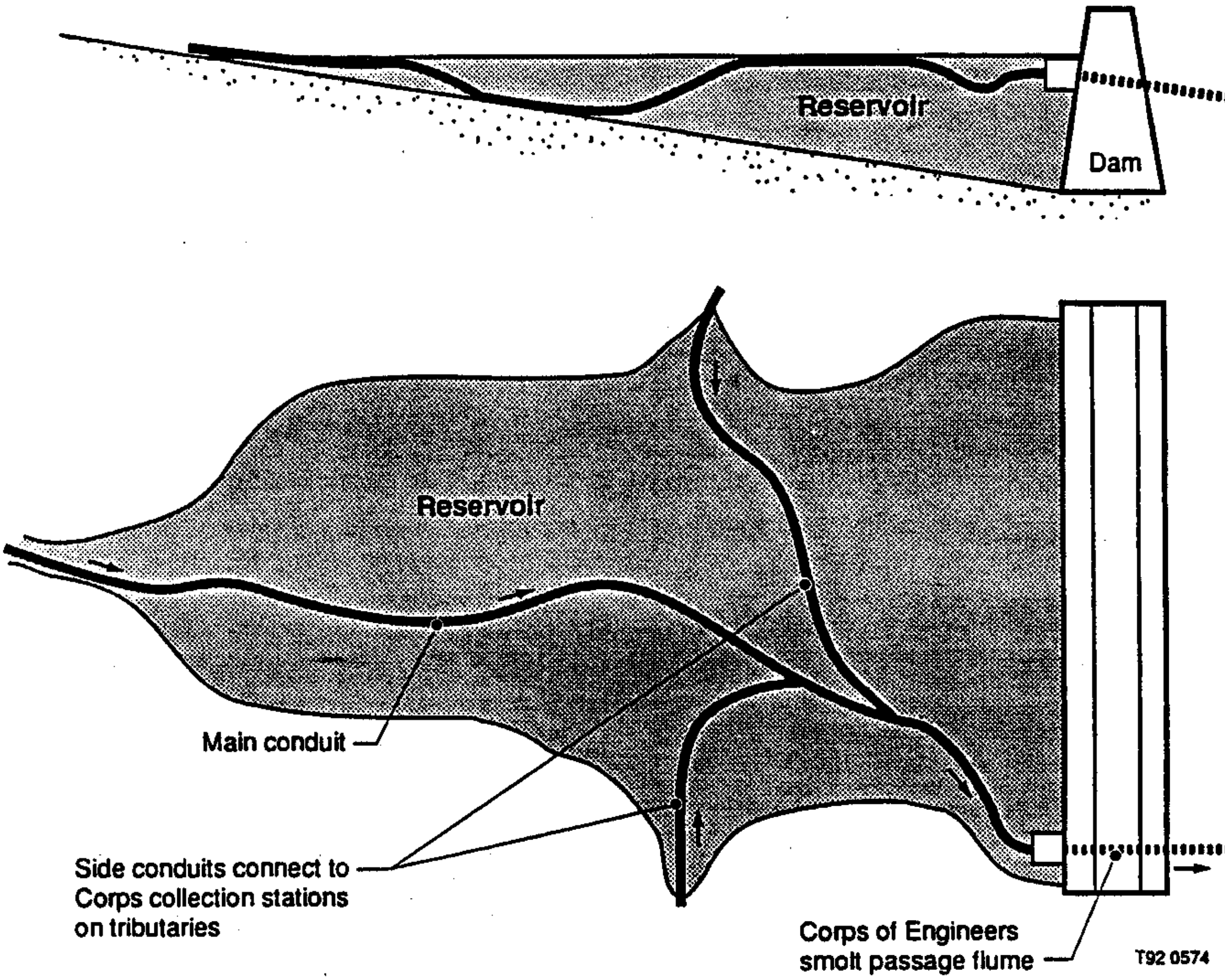


Figure 1. This conduit system has both surface and submerged sections and can be configured to reach all the tributaries draining into a reservoir if necessary.

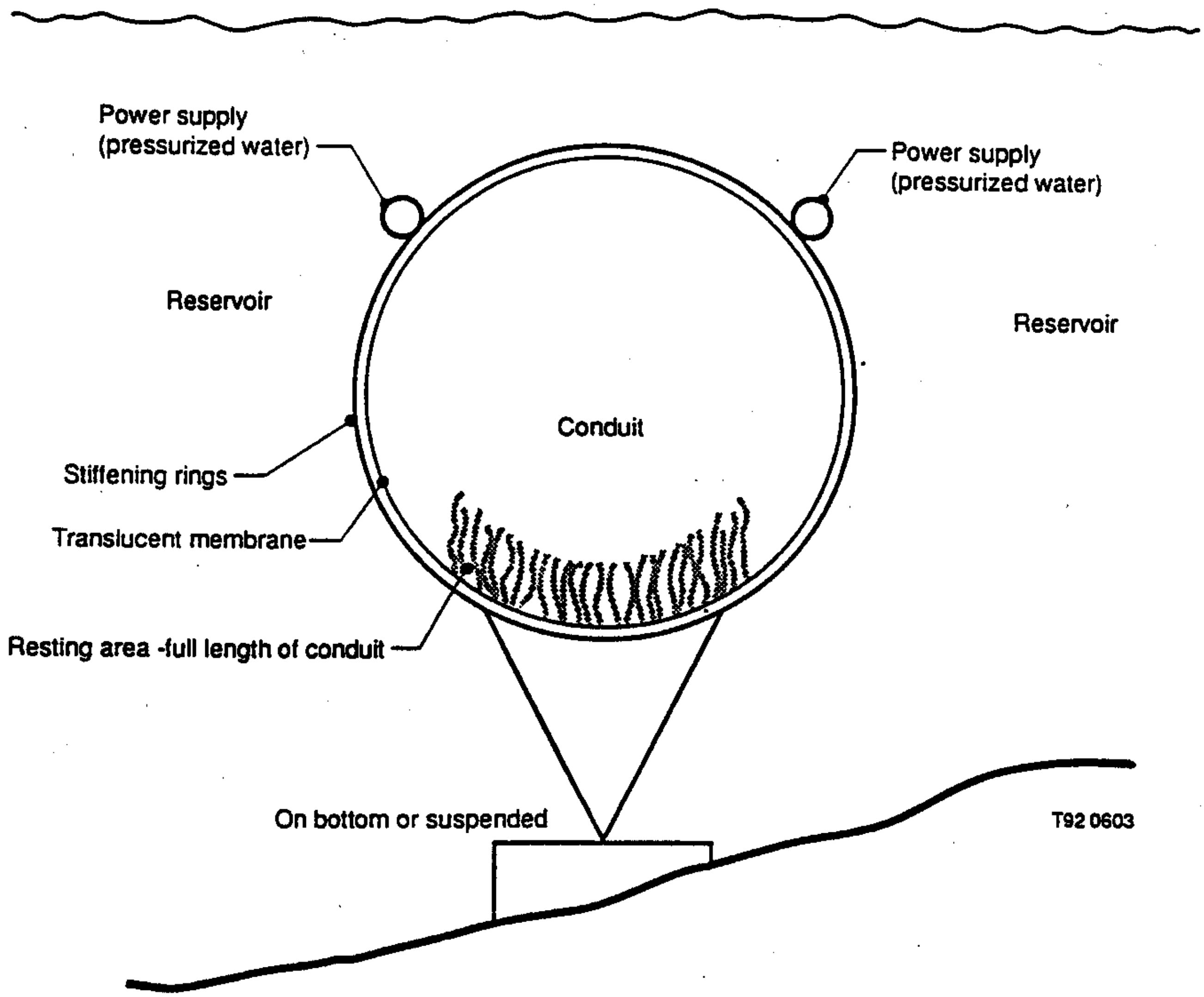


Figure 2. The conduit is completely closed in the underwater sections to avoid the fish escaping into the reservoir water. The conduit is anchored to the bottom. Since the design is only conceptual at this point, the figure is meant to be illustrative only. Final design will dictate the size of anchors, restraining cords, attachment process, and flotation devices.

Buoyancy of the conduit is controlled to ensure that the submerged sections are not deeper than required for navigation purposes. By controlling the depth of the conduit, gradients in temperature, pressure, and available light can be minimized. Where required, sections of open channel conduit can be installed on the surface of the reservoir. A surface conduit section is shown in Figure 3. Most of the conduit wall for both the surface and submerged sections will be fabricated from a comparatively impermeable material; however, porous sections will be provided at junctions, pump stations, or other appropriate locations where excess water can be exhausted to the reservoir while maintaining a current flow within the conduit.

Water (and juvenile fish) are introduced into a head tank at either the stream or river collection facility or at the dam passage flume provided by the Corps (see Figure 4). A flow rate of 150 to 200 ft^3/sec will maintain a flow velocity within the conduit of 3 to 4 ft/sec. The head tank provides sufficient head to pump the water and fish to the first pump station where water is added for imprinting and enriched with oxygen as required. The projected head losses within the conduit are about 4 in. per 1,000 ft. (A conduit system could be designed with flexible, high-strength materials such that a head tank could supply all the impetus to transport the water and fish to the next dam. However, periodic injection of water for imprinting and oxygenation would still be required.)

Many options are available for pumping water (and fish) through the system; several of these options are discussed in Section 2.4. All concepts considered (a) provide motive force to the water, (b) provide make-up water for imprinting, and (c) permit oxygen injection as required.

If food is required, it will be added at the pump stations. The pumping concept ultimately selected will conform first to the biological requirements of the fish and then second to mechanical efficiency; however, the use of the flexible conduit does not hinge upon which pump option is used.

Although the pump mechanism itself is submerged, each pump station would be suspended from a barge or platform. This provides stability for the pump system and aids in locating and maintaining the pump station. Each pump station will be anchored to equalize the thrust or friction force. The conduit itself is anchored as required to maintain the proper depth and resist the drift forces created by winds, currents, or eddies within the reservoir.

2.2.1 Maintenance and Repair

The modular design of the FISP system makes it inherently easy to maintain and repair. Damaged conduit sections or malfunctioning pump stations that cannot be repaired in place, can easily be exchanged and towed to an on-shore or near-shore servicing area. The modular system also is easy to remove for cleaning and maintenance during the off-season months. Permanent marker buoys can be used to mark the anchoring attach points. If a material can be identified which resists the build-up of algae, the conduit could be sunk to the bottom of the reservoir for stowage or simply left in place during the off season.

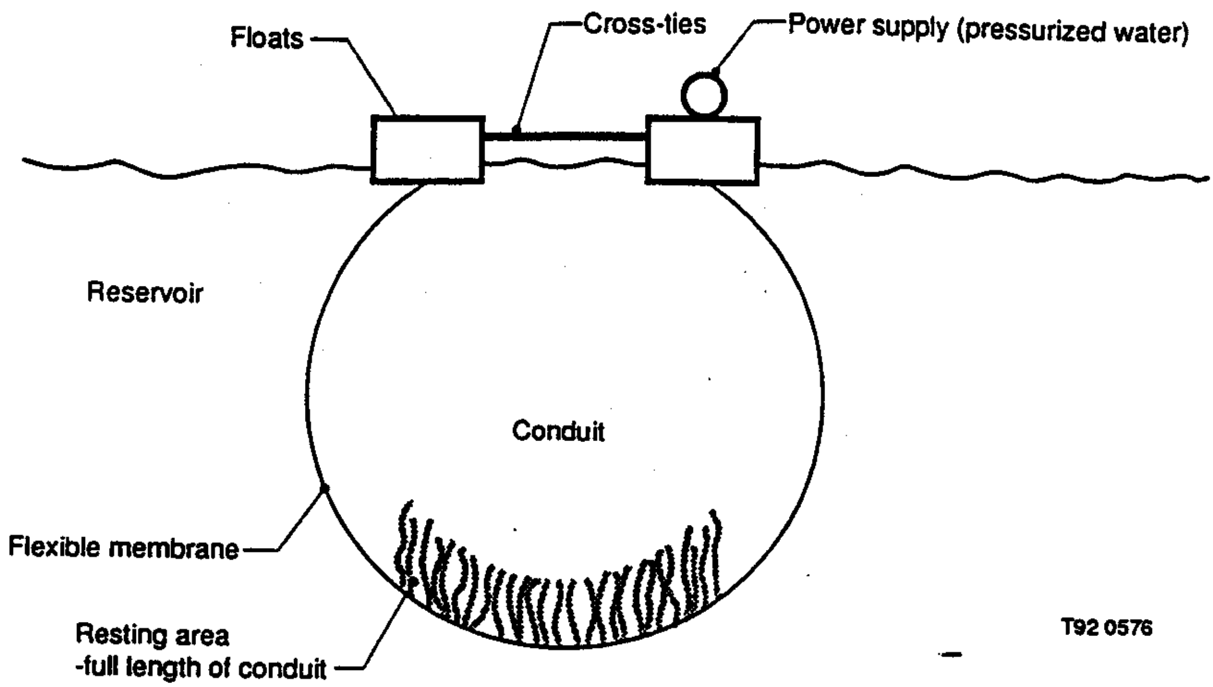


Figure 3. The conduit is a very light, flexible membrane which is supported in the reservoir by floats, which are held together by a series of crossties. The power supply carries high-pressure water for the pumping sections. A resting area in the bottom of the conduit will be provided the entire length of the conduit.

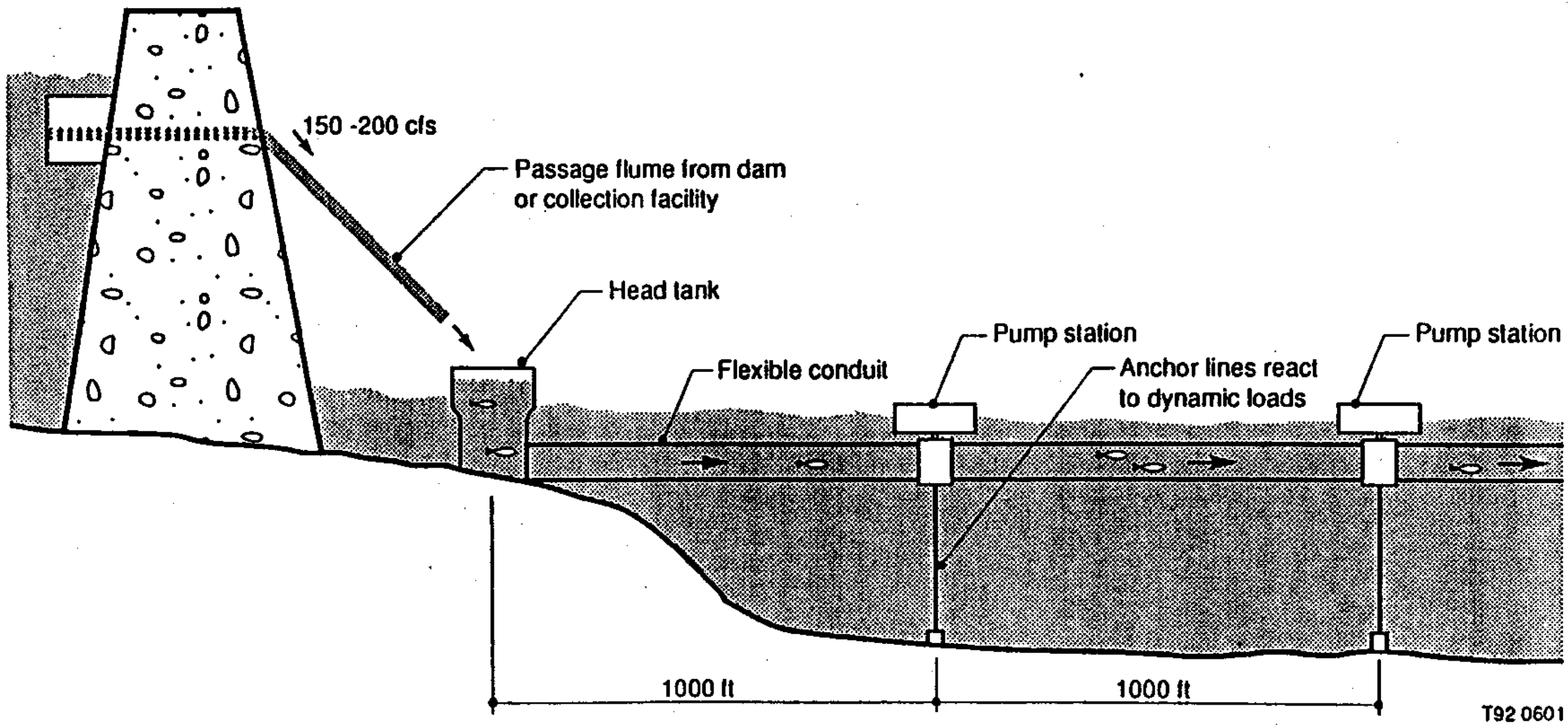


Figure 4. Fish and water are introduced into a head tank either at collection facility or at the dam passage flume.

CRITERIA FOR "RESTING" AREAS FOR MIGRATING SMOLTS

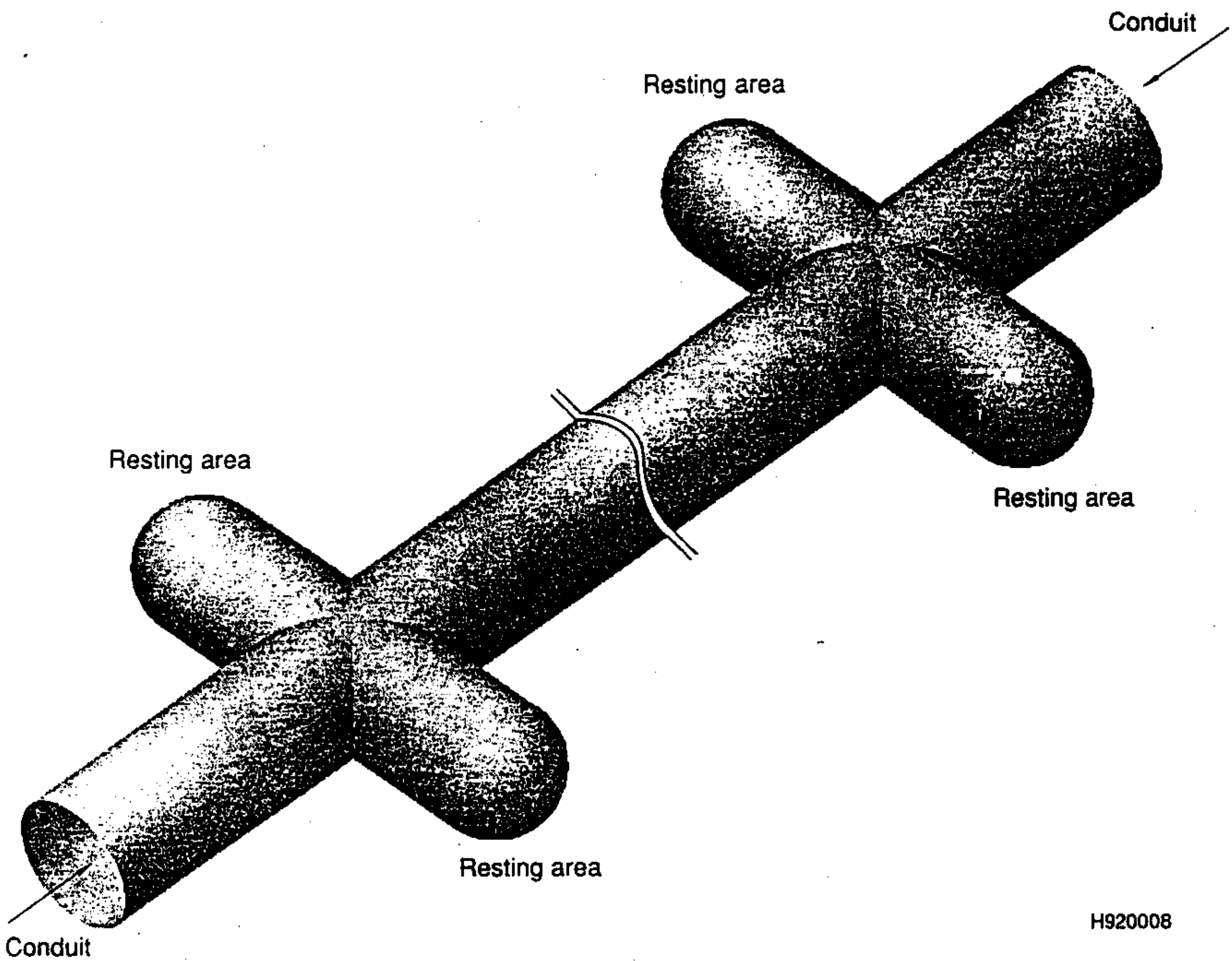
There are several criteria that need to be considered when providing resting opportunities for smolts migrating downriver in a submerged or surface conduit. Smolts migrate downriver in a diurnal pattern, that is, peak migration occurs between dusk and early morning (essentially during the light limited periods of the day. While daylight may not directly increase stress, it likely increases the effect of other stressors (e.g., predators). In a river or reservoir environment, during the daylight hours, smolts are seeking habitat with lower water velocities (< 1 fps) and adequate cover (e.g., substrate or water depth). This type of habitat provides refuge from predators, high water velocities and likely reduces stress to the smolt. Therefore, resting areas should be low velocity (< 1.0 fps) with some form of substrate or water depth for cover. Resting areas along the conduit should provide the same type of opportunity (e.g., reduced velocity, cover, diurnal pattern) that smolts find in the river and reservoir environment. The key to success will be the ability to offer cover and reduced water velocities in an environment with as little stress as possible. These areas need to be situated so as to allow:

- voluntary use by the migrating smolt
- low velocities (< 1 fps) to reduce the drain on energy reserves
- cover as either substrate or depth

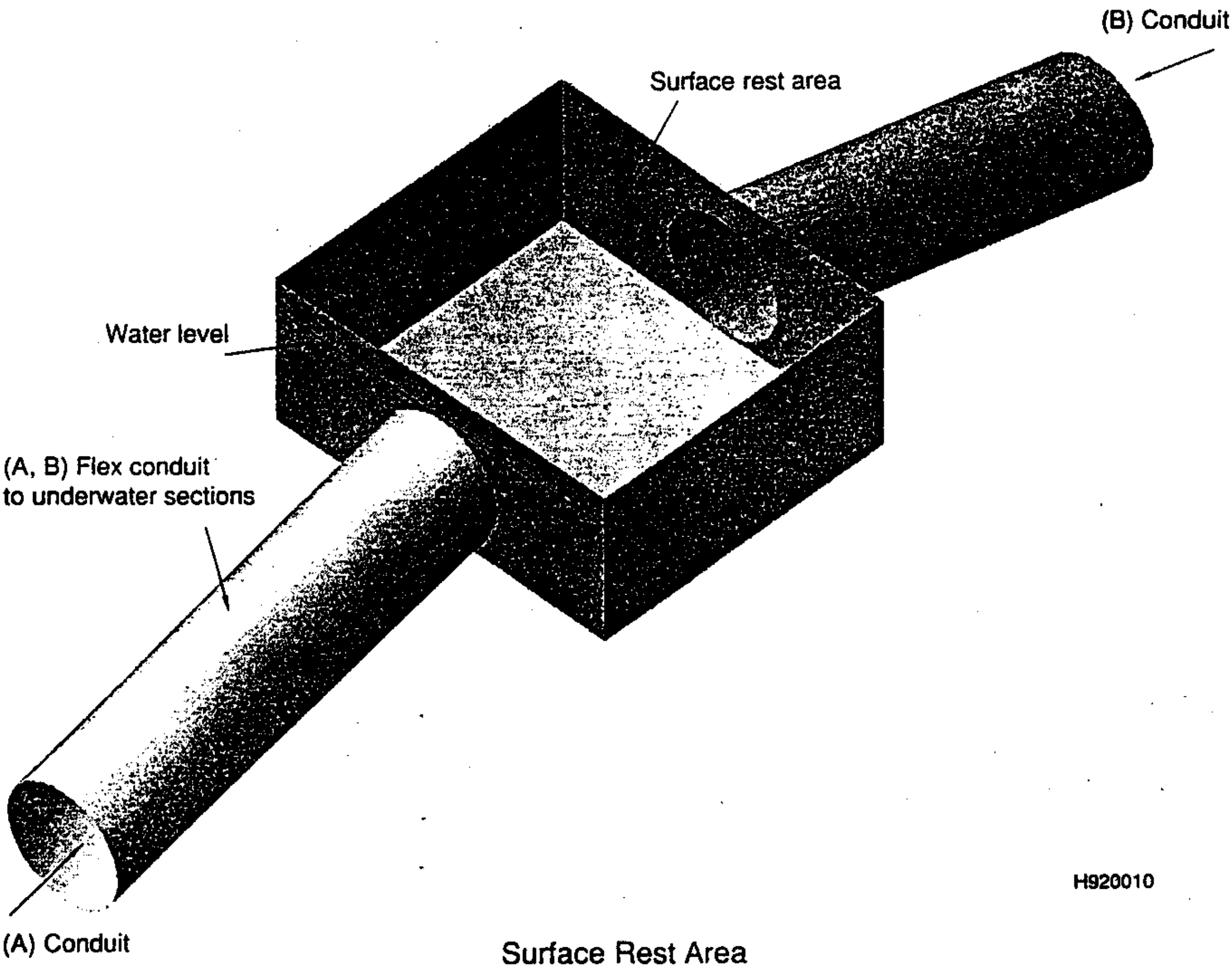
Several configurations have been suggested for providing resting areas along a submerged or surface conduit. These include:

- artificial turf along the bottom of the conduit
- a "pen" off the main conduit
- "flow-through" tubes off the main_conduit
- "blind" tubes off the main conduit

Any of these concepts are feasible. The key is to what degree they can be constructed and adapted to meet the resting requirements of migrating smolt. A combination of the configurations may also be possible. Further investigation will be needed to identify the best way to provide resting opportunities for migrating smolts. This should include a more extensive review of migrating habitat and criteria for smolts. It is obvious that providing the exact type of habitat with the proper environmental conditions is likely not possible. However, stress can still be minimized, by mimicking or creating the criteria that exist in a natural environment.



Underwater Rest Area



Surface Rest Area

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2.3 Conduit Design

The successful use of the flexible conduit depends upon finding a material that can meet all the requirements. The material must be strong, yet lightweight; it must be translucent and abrasion resistant; flexible, but limit stretch and deflection. It should be impermeable. It must do all these things in an aquatic environment. An ideal material will be algae and fungus resistant; materials of construction must have a very low water solubility and be chemically stable (no out-gassing) so as not to imprint water. Materials that are on or near the surface must be resistant to ultraviolet degradation.

Three potential materials for conduit fabrication have been tentatively identified: polyethylene, Kevlar® (Dupont), and Spectra® (Allied Chemical). All have excellent resistance to moisture and fungus attack. All can be obtained in translucent forms, and with proper additives or protective coatings are resistant to ultraviolet degradation. Available data indicate that they have very low solubility and are chemically inert in the aquatic environment. Both Kevlar® and Spectra® have excellent strength and stretch properties. (Both have been successfully used in bullet-proof vests.) Spectra® has already been used in the commercial fishing industry for fish nets. It has excellent strength and abrasion resistance and can be fabricated into fiber and fiber-reinforced sheets.

2.3.1 Open (Surface) Conduit Sections

As shown on Figure 3, the surface conduit section is an open channel fabricated from a suitable material (membrane) which is affixed to a semiflexible float. The float is constructed from a highly buoyant material that allows the walls to float high enough off the surface of the water to contain the flowing water within the channel. (The water level within an open channel must be at a slightly higher level than the surrounding reservoir.) The floats are held together by a series of crossties which keep the conduit channel from being spread apart by the flowing water. The crossties will likely be fabricated from polyethylene, Kevlar®, or Spectra® fiber. The top of the channel will be covered with a net to protect against predatory birds or mammals. (A properly fabricated net could double as a crosstie.) A resting area will be provided in the bottom of the water-carrying channel for the entire length of the section. The rest area consists of leafy, plant-like ribbons fabricated from the same material as the conduit wall and affixed to the bottom or a mat on the bottom of the conduit.

2.3.2 Closed (Submerged) Conduit Sections

Figure 2 illustrates the details of a submerged section of the conduit. The submerged conduit is completely closed to prevent juvenile fish from escaping and preclude predatory fish from entering. As in the surface conduit, an artificial "cover" is affixed to the bottom of the conduit to provide a rest area the entire length of the section. The buoyancy of the conduit will be controlled to preclude excessive settling or sagging due to particulates, debris, or organisms that collect within the conduit system. The anchoring system will be designed to be self-leveling—that is to keep the conduit suspended from the top or bottom at a nearly constant depth or elevation.

2.3.4 Power Piping for Pump Stations

Pressurized water may be used to power the pumps (see Figure 5). The pressurized water may be provided in one or two pipes running parallel to the flexible conduit. The pipes will be 12-in. in diameter and tied to the conduit. The pipe may be more rigid than the conduit to act as a stabilizing member to the conduit section if needed. The two pipe configuration may be particularly effective for this purpose (see Figure 2). The added stiffness may also offset excessive sagging or settling of the submerged conduit sections. Another option for transporting pressurized water is to fabricate a tube as an integral part of flexible conduit. The integral power tube would be fabricated from the same conduit material with additional wall thickness to provide the required strength.

2.3.5 Anchoring the Conduit

The conduit experiences many loads and forces. There are the loads due to the internal flow and the associated pressure head. The cross sectional load due to the internal flow alone has been calculated to be 1,045 lbf per 1,000 ft of conduit at a flow of 150 ft^3/sec. This results in a hoop stress of about 700 psi and an axial stress of roughly 350 psi in a 10 mil (.010 in.) thick 8 ft diameter membrane. At a flow rate of 200 ft^3/sec the thrust is 1,551.6 lbf. (Note: calculations are based upon a submerged conduit section.) The total axial thrust generated over a 30-mile reservoir is about 170,000 lbf. This must be reduced by tiedowns in small increments over the entire length.

The conduit is subjected to external forces from currents and eddies within the river/reservoir. Although the conduit should lie parallel to the flow of the river, the currents within the slack water behind a dam are the cumulative effect of those forces over many miles and can be very significant. Forces on the order of magnitude required to react the cumulative internal load (170,000 lbf) would not be wholly unrealistic. Surface sections will be subjected directly to wind forces and both surface and submerged sections will be subject to currents created by the wind. Almost all of these loads are dynamic. The exact reaction and behavior of the conduit will be evaluated in the next design phase.

In addition, there are buoyant forces acting on both the submerged and surface conduit. The materials used for fabrication are buoyant, and the conduits may tend rise and float. An anchoring system must be capable of holding the submerged conduit at a predesignated depth. As debris and organic materials collect in the bottom of the conduit, the buoyancy will change and in time the conduit may tend to sink or sag. The addition of buoyant material or suspension from barges or platforms could be required, and the system will have to be able to compensate for these changes in buoyancy.

Two methods will be used to react the various forces within the conduit system. The system will be anchored to the bottom of the reservoir periodically as needed. Anchor cables will be attached at each pump station and additional anchor points will be attached to the conduit at the stiffening rings (see Figure 2). The anchor cables will be fabricated from an impermeable, flexible fiber, such as polyethylene, Kevlar®, or Spectra®. In addition three axial cables or rib lines will run the length of the conduit. These axial cables will be of high-strength materials, such as polyethylene, Kevlar®, or Spectra® and may be bonded, woven, or an integral part of the conduit

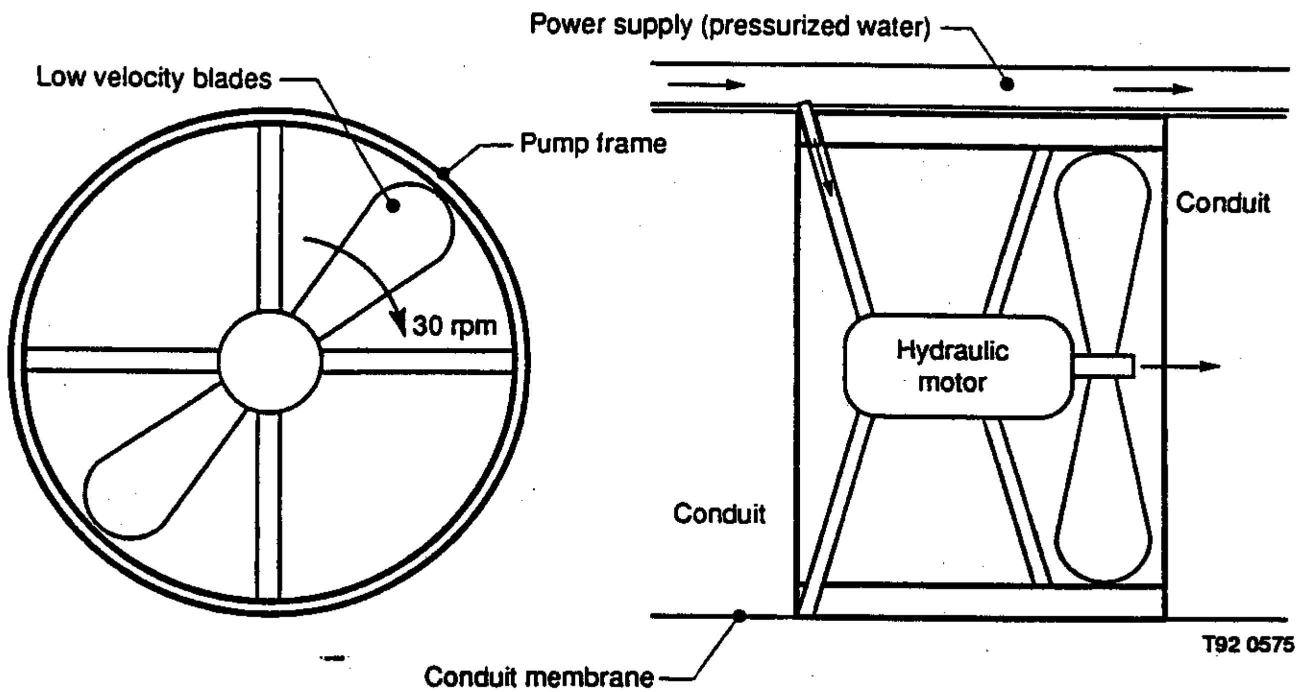


Figure 5. The pumping section of the conduit is a separate unit used to connect the individual membrane sections together. The unit is designed to operate on the surface or in the submerged sections, deriving its power from the pressured water line which runs the length of the conduit.

and anchored along the length and fixed at the end points of the conduit. (All reactive forces will be tensile.)

2.4 Pumping Unit

Several pumping configurations will be evaluated. The biological requirements imposed by the fish will be of primary consideration in selecting a final configuration. Pumping is needed to maintain the water velocity in all surface sections of the conduit and in some configurations of the submerged sections. Pumping will also be required to add reservoir water for imprinting and to oxygenate the water in all conduit configurations. The alternative configuration given the most attention to date is an axial flow pump that is discussed in the following section.

2.4.1 Axial Flow Pump Configuration

The pump arrangement and principal dimensions are shown in Figures 6 and 7. The pump provides a positive pressure to the flexible membrane conduit and adds energy to the fluid stream to keep the fish and water moving. The pump impeller is a two blade propeller rotating at 30 rpm. The number of blades, rotational speed, and blade spacing have been selected so as to minimize any detrimental effect on the fish. Previous studies of hydraulic turbines would indicate that an impeller of this design will have no detrimental influence on the fish. The impeller is driven by an integral water motor supported on hydrostatic water bearings. The water that is used to drive the water motor is also used to supply pressure to the hydrostatic bearings. The two lobes of the water motor are geared to each other with spur gears which run in water. The intent is to provide a completely submerged unit that operates on river water and requires no oil or grease. The water to drive the pump and support the bearing would be pumped out of the reservoir by an onshore pumping station. It is envisioned that one onshore pumping station would be provided for every 10 in-stream pump units or at approximately 2-mile intervals. A pump station would provide a flow of 1,600 gpm at 200 psig. The power to drive the pump station would be approximately 350 horsepower. The pump flow is transported in 12 in.-pipe out to the location of the conduit. At this point it joins a pressurized water header that is an integral part of the conduit structure. At each in-stream pump unit, 160 gpm would be tapped off the header to provide the necessary motive water to turn the impeller and support the bearings.

2.4.2 Pumping Requirements

A preliminary impeller design was performed using the following assumptions:

- Fluid—water
- Duct size—8 ft diameter
- Duct velocity—3 ft/sec
- Distance between pumping stations—1,000 ft

The flow rate is determined to be 150.8 ft^3/sec (67,680 gpm or 9409 lb/sec) and the Reynolds number is 2.2×10^6. The duct wall is assumed to be smooth with a friction factor of .01. The frictional loss for 1,000 ft of duct is 2.09 in. of water. Typical dynamic losses would be 1.5 velocity heads for entrance and exit losses. However, the pumping units are laid out in series and most of the dynamic energy would be preserved from one unit to the next. A dynamic loss of 1 velocity

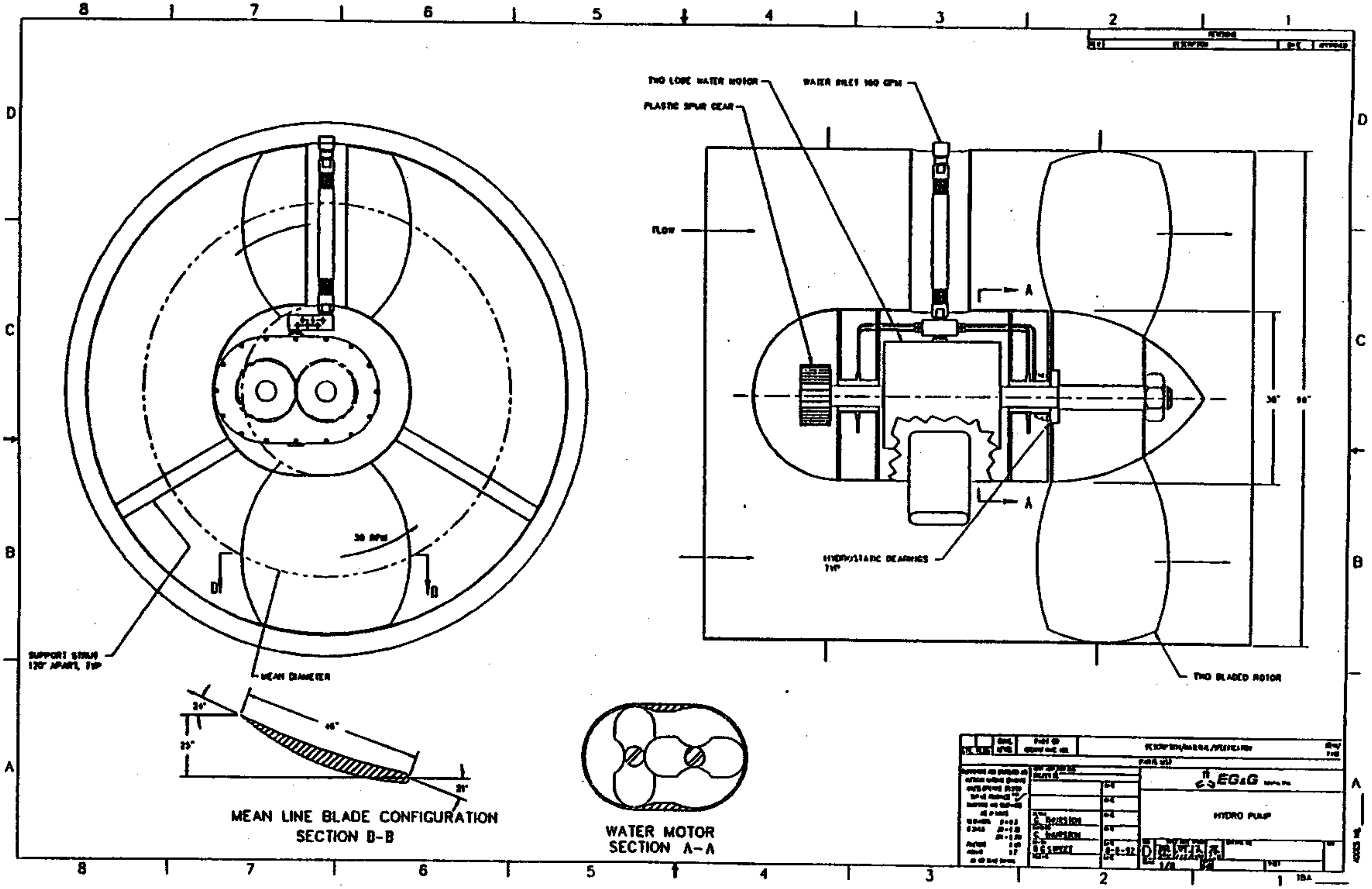


Figure 6. Pump arrangement and principal dimensions.

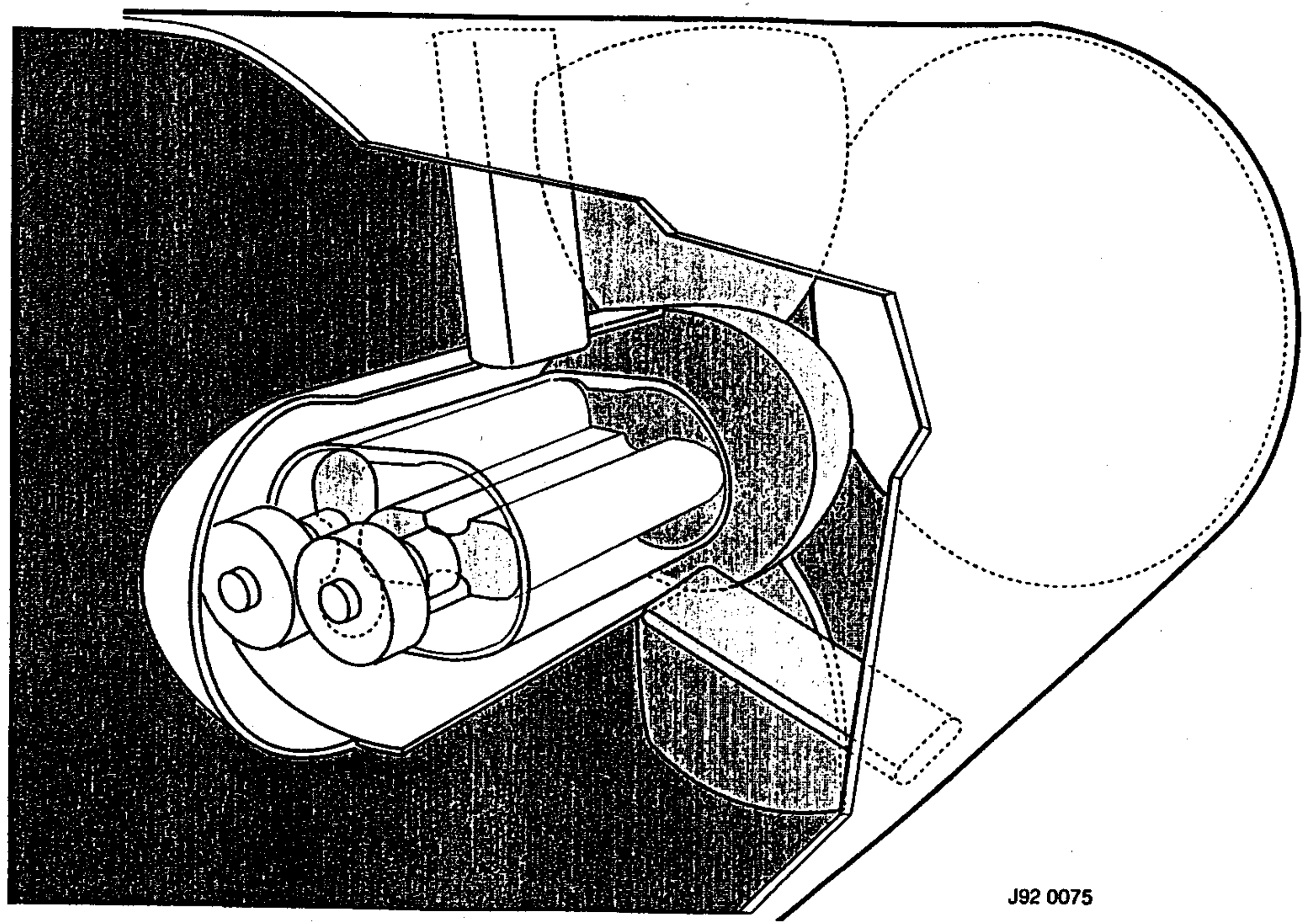


Figure 7. General configuration of pumping unit.

head has been allowed. This gives a total head requirement of approximately .333 ft (4 in.) of water per 1,000 ft of duct length.

2.4.3 Pump Type

For low head and high flow the most efficient type of impeller is an axial flow rotor. Preliminary impeller dimensions were determined by using specific speed design charts and velocity diagrams.[1,2,3] Geometrically similar turbomachines with the same specific speed will have the same fluid velocity triangles and approximately the same performance. Specific speed for pumps is typically defined as follows:

$$N_s = N x \sqrt{GPM} / H^{(.75)}$$

where

N_s = specific speed, rpm gpm$^{.5}$/ft$^{.75}$

gpm = flow, gallons/minute

H = head, feet

Using a specific speed of 18,000 gives a rotational speed of 30 rpm for a two vane propeller type impeller. The blade tip diameter is 96 in.; the hub is determined to be 38 in. and the mean blade diameter is 73 in. At the mean line the blade cord is 46 in. and the fluid inlet angle is 21.45 degrees; the exit angle is 24.13 degrees. A pump efficiency of 70% is assumed.

2.4.4 Power

The theoretical pumping power is head times flow:

$$Power = Head * Flow = (.333)(9409)/550 = 5.702 \ HP$$

The required input power to the in-stream pump impeller is the theoretical power divided by the pump efficiency; or 8.14 horsepower. This then becomes the output power of the water motor. The input power to the water motor is 11.62 horsepower, if an efficiency of 70% is allowed.

2.4.5 Thrust

The rotor thrust is reacted through a hydrostatic thrust bearing to the pump housing and its floating support structure. The structure itself must be anchored to the river bottom. The thrust is estimated to be approximately 1,000 pounds.

2.4.6 Drive Motor

The pump impeller is driven by a two lobe water motor. The water motor is similar to a lobe type compressor in configuration. One lobe of the motor is mounted on the same shaft as the pump impeller and the other lobe is geared to the shaft through spur gears. The inlet pressure to the drive motor is 200 psig and the outlet pressure is 0 psig. The estimated lobe dimensions are 10 in. diameter by 8 in. long. The drive motor is assumed to be 70% efficient, which results in a required flow of 100 gpm. An additional flow allowance of 60 gpm has been made for the hydrostatic bearings.

2.4.7 Materials of Construction

The impeller blade is a twisted tapered airfoil to provide maximum efficiency and minimum noise. The blade bending stress will be low and it is anticipated that the rotor blades would be constructed of fiberglass over a preformed urethane foam core. The shaft, water motor housing, water motor lobes, and other precision high stress parts would be made of 300 series stainless steel. The lobe gears will be made from a high strength plastic.

2.5 Alternate Design

2.5.1 Jet Pump

A jet pump is an attractive alternate concept because it removes the possibility of fish coming in contact with or being stressed by the rotating impeller. An additional advantage is the elimination of pump/motor development and the potential of using standard pumping equipment. This could allow for rapid development and testing with a minimum of cost and risk. Preliminary calculations and rough sizing were carried out using available data[2]. The general arrangement is shown in Figure 8. The motive water pumps would be barge mounted and only the impellers would extend below the surface of the water. The drive system could use conventional electric motors. One barge is provided at each in-stream jet pump location.

The motive jet nozzle is 26 in. in diameter. This is directed into a mixing section 67 in. in diameter. The maximum jet velocity is 13.7 ft/sec and the jet flow is 50 ft^3/sec. The fluid in the jet mixes with the surrounding fluid and drags it along by shear, adding its energy to the total flow stream energy. The mixed flow then passes to a diffuser section where the flow is slowly decelerated and the velocity is converted to static head. The combined flow at the pump exit is 150 ft^3/sec.

The principal disadvantage is that even the best jet pumps are only about 30% efficient. The proposed preliminary design requires about 30 horsepower per 1,000 ft where the axial flow pump needs only about 11 horsepower per 1,000 ft. The jet adds a substantial amount of reservoir water at each pump station. This allows for imprinting and fresh oxygen supply. Some water would be allowed to escape from the flexible conduit so that the average velocity and flow rate would remain approximately constant. The maximum jet velocity would be 13.7 ft/sec. This is not greater than velocities fish are naturally subjected to from time to time in open-river conditions.

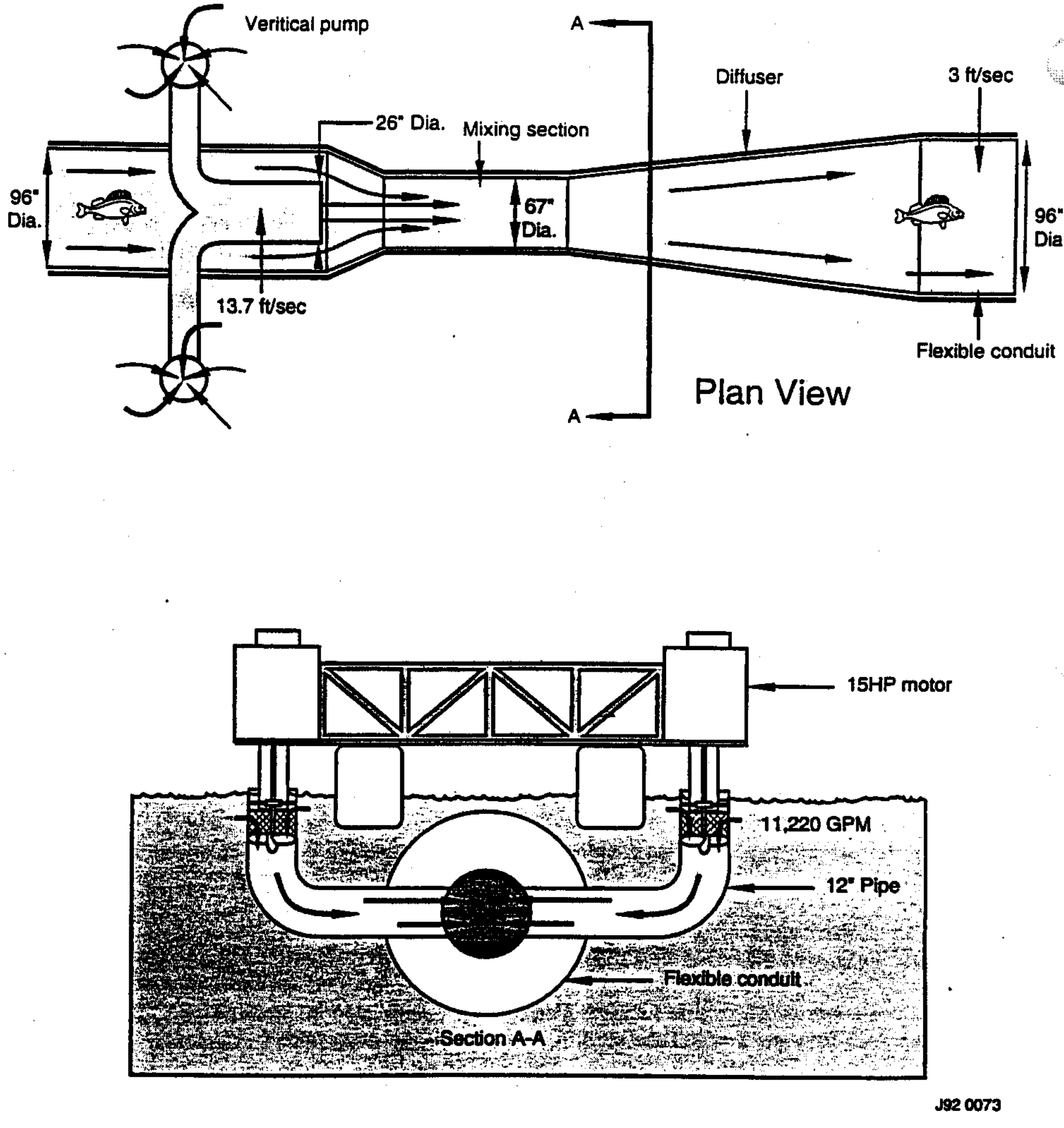


Figure 8. Jet pump general arrangement using preliminary calculations and rough sizing.

2.6 Gravity Flow Schemes

2.6.1 Head Tank

Water supplied to a head tank could allow gravity to propel the fish and water down the flexible membrane conduit. Water for the head tank could be provided from an upstream dam or it could be pumped locally. This concept is limited by the strength of the flexible conduit (which will not pose a problem with modern high-strength fibers) and the ability to get the fish into the head tank. This concept is probably appropriate for the first station downstream from a dam. The fish bypass the dam in a flume (see Figure 4) and at the point that the fish and water empty out of the flume, they would flow directly into a head tank that feeds the flexible conduit. The tank level would be adjusted with a weir.

2.6.2 Sequential Gravity Flow System

A variation on the head tank idea is to move the water and fish downriver by sequentially raising and lowering the level in a series of tanks connected to the flexible conduit (Figure 9). Each tank has an inlet and outlet connection to the next tank. The water and fish progress downstream driven by gravity and the elevation difference from tank to tank. The level difference from tank to tank is provided by pumping water into the upstream tank. An inlet check valve is provided on each tank so as to allow flow in only one direction. This valve would be power operated and sequenced to the pump operation. The pump is external to the conduit and isolated from the fish. New water is provided at each pump station to aid in imprinting the fish and providing a fresh oxygen supply. The fish would accumulate in the downstream tank as water is pumped into the upstream tank. If the tanks were placed at 1 mile intervals the approximate head difference would be 20 in. of water. The tanks would open at the top and would be shaped to minimize negative biologic effects. The sequence frequency and tank size would require additional study.

2.6.3 Peristaltic Pump

Figure 10 illustrates an option that could possibly be developed for pumping water through the conduit. This peristaltic pump moves water in the same fashion that the human digestive system moves material through the body (this is the process that allows humans to drink water while standing on their heads). The efficiency of this process as a pumping mechanism is not known at this time but should be evaluated as a possible option, since it would be gentle to the migrating fish.

Two concepts exist for inducing the waves within the conduit. The first concept would use a series of mechanisms such as a hydraulic ram or other device to pull the conduit walls together. By synchronizing the alternate closing and opening of these mechanisms, a wave motion like that shown in Figure 10 could be induced within the conduit. It is obvious that significant inefficiency will result since as much work is done on the reservoir as is done on the water within the conduit. The second concept would use a series of inflatable bladders within the conduit. This option could also be used to induce the desired wave option, but has the advantage of not expending energy on the reservoir.

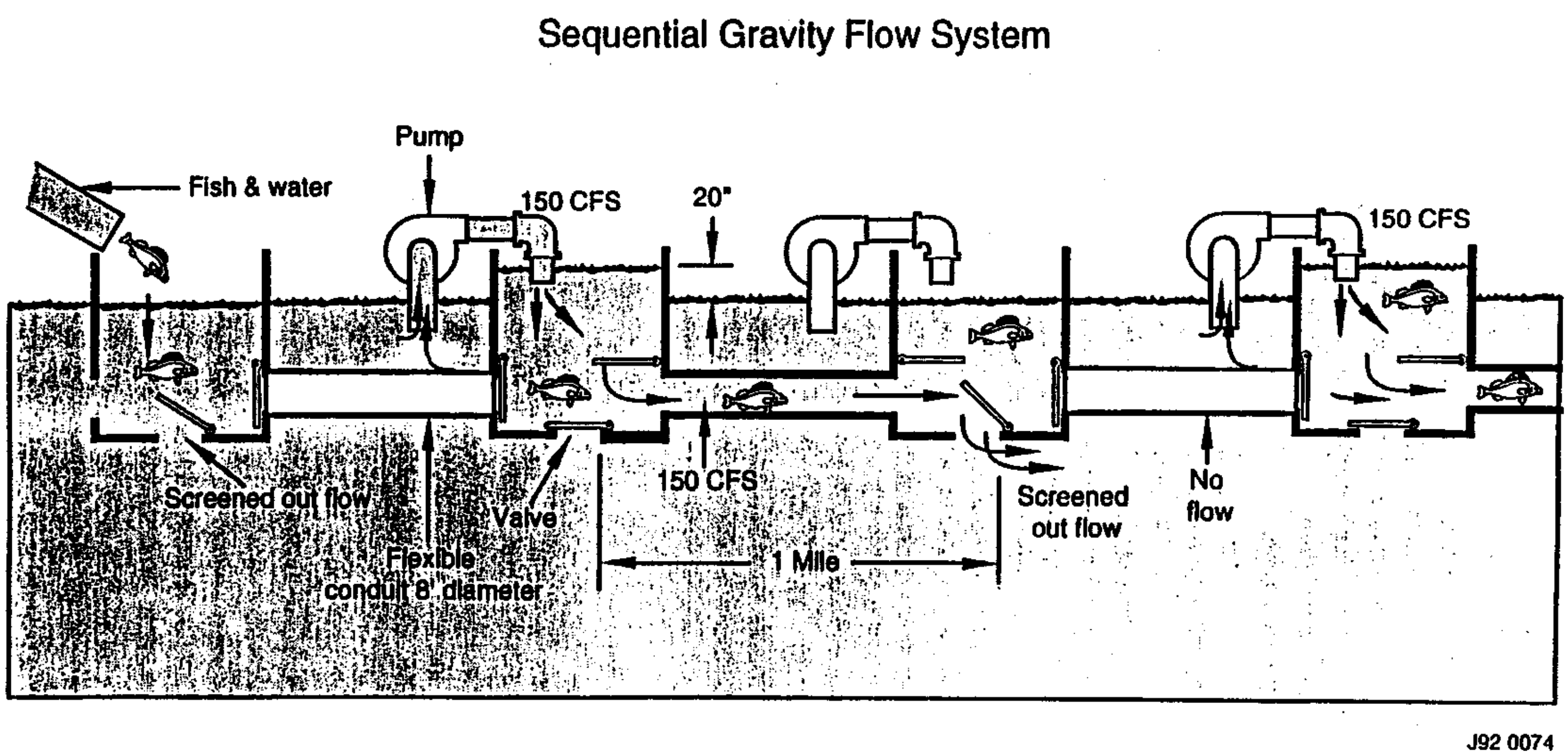


Figure 9. Series of tanks connected to the flexible conduit.

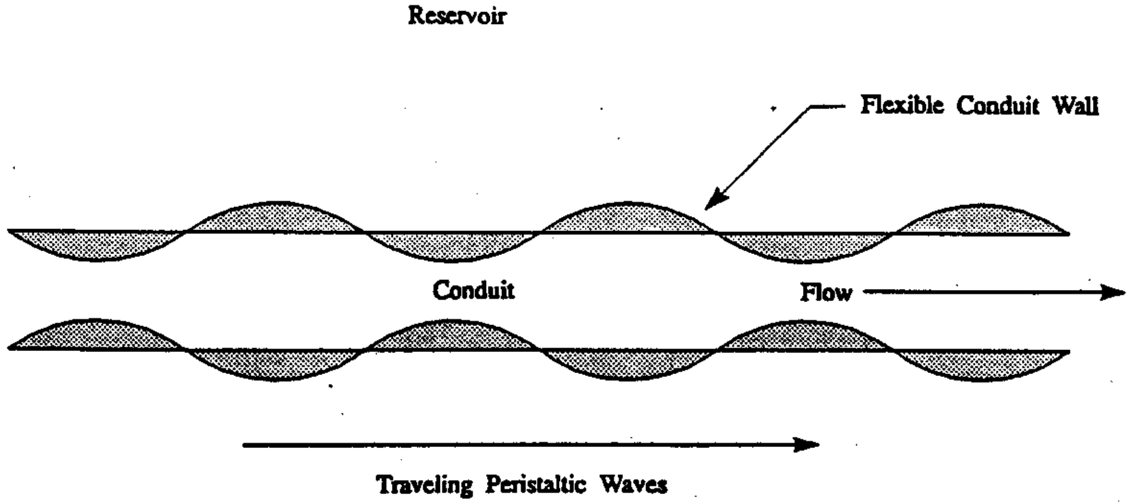


Figure 10. Peristaltic pump.

2.7 Biological Features

The conduit system has been designed to meet the biological requirements and concerns described in Section 2.1. Not all concerns can be adequately addressed in the initial design stages. As other concerns are identified, modifications will be made to the design. Some concerns may require testing of a prototype system to fully address all the issues. Description of engineering designs addressing specific biological concerns relate to the following:

- Feeding and resting opportunities
- Oxygen and temperature requirements
- Migration requirements
- Water velocities.
- Stress and injury
- Predator control.

Resting and feeding opportunities may be necessary in a conduit extending from the confluence of the Snake and Clearwater Rivers to the estuary waters of the Columbia River. Placing a mat (similar to artificial turf) along the bottom of the conduit would provide a refuge from water velocities and medium for food to attach and grow (see Figures 2 and 3). By placing this mat along the entire length of the conduit, smolts could rest and feed at any point. Other resting areas may be necessary along the length of the conduit. The Corps is presently designing these areas. The key to these resting and feeding areas is to allow the smolt to migrate volitionally. In addition, minimizing stress in these facilities and facilities that transfer the smolt to the conduit is critical to the success of the conduit system.

To maintain ambient water conditions (e.g., appropriate oxygen, temperature, and supersaturated gas levels), river water will be added at points along the conduit. This will also allow smolts to imprint on important homing cues while migrating through the conduit. In addition, the subsurface sections of the conduit would be constructed from clear material, thus allowing smolts to experience light/dark periodicity. Pump stations placed along the conduit will maintain water velocities at levels that will transport smolts downstream at or near historic (pre-dam) rates (3 to 4 ft per second). In addition, pump stations interject river water, providing imprinting opportunities and, if necessary, oxygen. Injury and stress resulting from encounters with pump impellers is a concern. Several types of pump designs are being considered, that *do not* use impellers, to move water through the conduit (see Section 2.4).

Predator control will be important within the confines of the conduit and associated systems (e.g., collection and dam by-pass facilities). Surface or open sections of the conduit will be screened with mesh material to exclude mammal and bird predators. Aquatic predators such as squawfish will present a challenge. Their numbers within the conduit and other facilities will need to be minimized to reduce losses. The use of screens at the collection facilities or other selective mechanisms could restrict or eliminate large predators (e.g., squawfish) from the conduit, thus decreasing or removing predation as a factor in downstream survival.

2.8 Engineering Design Issues

Several design issues must be resolved before the system can be installed into the reservoir system. The hydraulic response of a liquid flowing through a conduit within the reservoir is not known. This response needs to be better understood and quantified if the conduit is to be properly restrained and stabilized. Another issue is how best to transmit the power for running the pump mechanism. One option is the pump mechanism itself. The option chosen must not only be the most efficient option for moving the water, but also the best option for allowing the least amount of stress to the smolts.

All of the issues, except the issue of transporting the salmon, should be resolved by constructing and testing a prototype. The effects of transporting the wild salmon can only be measured in terms of adult salmon returning to their native streams to spawn.

3. PROJECT MANAGEMENT PLAN RENEWABLE ENERGY PROGRAMS FLEXIBLE IN-RESERVOIR SALMON PASSAGE

3.1 Statement of Work

3.1.1 Purpose

The purpose of the conduit design is to provide a environmentally-acceptable safe passage for juvenile fish down the Columbia River system.

3.1.2 Background[4]

The waterways of the Columbia River Basin have been the source of remarkable bounty for the Pacific Northwest. For centuries, they have provided habitat and migratory routes for fish and wildlife. In recent history the basin has also produced electricity, and provided water for irrigation, navigation, recreation, municipalities, and industry.

But even the richest resource has limits, and water—especially in the West—is a finite resource. Over the years competing demands for the Columbia Basin water have begun to converge into what in some cases is a deadly competition, especially for certain fish runs. This growing crisis has been evident for a number of years and there have been significant and, to some degree, successful efforts to deal with it. But time has not been on the side of the fish. The basin's salmon and steelhead runs that use the basin for their spawning beds, rearing areas, and corridors to and from the sea have been dwindling at alarming rates for over a century.

In 1991, only seven sockeye salmon were spotted making the grueling 900-mile migration from the Pacific Ocean to their spawning grounds in Idaho's Redfish Lake. Of the four that made it to the lake, only one was a female. In mid-November 1991, the National Marine Fisheries Service officially declared these Snake River sockeye salmon an endangered species.

This declaration triggers a set of actions required under the Federal Endangered Species Act of 1973. One of these actions is the development of a recovery plan. The Endangered Species Act sends a clear message—the region does not have the option of taking no action.

Fortunately, the Pacific Northwest has not lost time simply debating whether the sockeye and other fish runs proposed for listing (spring, summer, and fall chinook) are in fact threatened or endangered. Building on its decade of experience in dealing with salmon, the Northwest began developing its own plan more than a year ago. The National Marine Fisheries Service has sent strong signals that it will use a regional plan as a basis for developing its own recovery plan.

Important groundwork for the regional plan was laid during the Salmon Summit, convened in late 1990 by the Northwest's Governors (Idaho, Montana, Oregon, and Washington), and Senator Mark Hatfield (Oregon). The summit, made up of users, policy, and interest groups connected with the Columbia Basin's waterways, developed critical short-term measures that were implemented in 1991 to stem further decline. These measures bought the region some time. From there, development of a regional salmon rebuilding plan moved to the arena of the

Northwest Power Planning Council (NWPPC), the interstate body that has provided a regional forum for the past 10 years through its Columbia River Basin Fish and Wildlife Program. The NWPPC, whose members are appointed by the Northwest Governors was directed to develop its program under the Northwest Power Act.

The NWPPC took up where the Salmon Summit left off, in early 1991, by initiating a process to amend its fish and wildlife program in four phases. The first three phases will constitute a salmon rebuilding plan aimed not only at rebuilding the three stocks proposed for listing under the Endangered Species Act, but also at aiding all weak salmon stocks. The fourth phase of the amendment process will address resident fish and wildlife.

This plan, developed with regional input, is an essential guide for the National Marine Fisheries Service. Without it the Federal government or the courts would impose an action plan of their own. A regional plan, based on extensive input from all the basin's interest groups as well as Northwest citizens, has the advantage of reflecting the unique values, perspective, and interests of the Northwest.

3.1.2.1 Historical Perspective. The problems for the basin's fish have been more than a century in the making. The Columbia River Basin Fish and Wildlife Program is not quite 10 years old, about the age of two generations of salmon. While a decade has not been sufficient time to arrest the salmon's decline, it has been adequate time to teach the region some important lessons. Any approach to fisheries recovery will require contributions from all who benefit from the river. A rebuilding plan must be comprehensive; piecemeal efforts simply have not been effective.

The scope of the recovery challenge is best illustrated by comprehending the salmon's extensive habitat; an environment defined by migratory habits that recognize no governmental boundaries. Salmon are born in inland headwaters and travel downstream to mature in the ocean. Depending on the species, they return to the river after 3 to 5 years in the ocean. Thanks to an extraordinary homing instinct, they make their way to their home tributaries where they spawn and die. This extensive habitat, sometimes involving 1,000 miles, became the arena for salmon recovery efforts in the 1980s.

During the 1980s, for the first time, the region looked at a coordinated approach involving the salmon's habitat; their passage down the rivers, particularly the main-stems of the Columbia and Snake; their harvest; and their production (both natural and artificially-aided). This approach echoes pleas to take an ecosystem approach to recovery under the Endangered Species Act, and it remains the foundation for a recovery plan in the 1990s.

While the foundation laid in the past decade for a system-wide approach was sound, the focus of the 1980s proved too narrow. The fish and wildlife program's interim goal was to double runs, but not at the expense of genetic diversity. Overall runs ranged between about 1.5 and 4 million in the 1980s. However, some weaker runs continued to decline, thereby threatening genetic diversity and fitness. It became apparent that the diversity of the runs, not just the number of fish, is a significant consideration.

Despite some gains made in the early 1980s, overall salmon and steelhead populations are only about one-fifth of their original run size, before the influence of man's development. Only about 20% of the remaining fish spawn naturally in area rivers. Most naturally spawning stocks are declining, and some, such as the Snake River spring, summer, and fall chinook and sockeye, have declined persistently to critical levels.

3.1.2.2 An Expanded Focus. The endangered species petitions dramatically underscored the need to make preserving the diversity of the runs a higher priority. This renewed focus also affected NWPPC's own role. Previously, NWPPC's fish and wildlife program had addressed primarily the effects of the hydropower system on salmon and steelhead.

With the endangered species listings, it became clear that a realistic recovery effort had to be broader, involving all the river uses: power production, flood control, irrigation, navigation, water supply, recreation, land development practices, and fishing. When the Northwest Governors, a Congressional delegation, and the National Marine Fisheries Service looked to NWPPC to come up with a comprehensive recovery plan, they also asked NWPPC to consider all of these river uses.

NWPPC is in the process of developing an integrated plan that seeks contributions from all river users; however, NWPPC recognizes it has limited authority. In those areas where it has authority, this plan *must* be implemented by the appropriate agencies. In those areas where NWPPC lacks explicit authority, the plan is a strong recommendation. NWPPC urges implementing of even advisory measures on the grounds they make sense and could forestall more stringent measures that could be imposed from outside the region.

3.1.2.3 Phased Recovery Effort. NWPPC is instituting a regional salmon rebuilding plan through amendments to its Columbia River Basin Fish and Wildlife Program. Existing measures in the program, as well as additional measures described below, will be integrated into an overall framework. Because of the size of the task and because some measures needed immediate implementation, NWPPC has broken down its effort into the following phases.

- **NWPPC Phase One: High Priority Production and Habitat Measures**

  In this phase, competed in August 1991, NWPPC approved high-priority measures aimed at improving production and habitat for weak salmon stocks. NWPPC selected measures to be funded in the current year's budget that showed the greatest promise for aiding weak stocks in the short term. As a result, the region launched a large-scale program to screen water diversions, initiated measures to protect the genetic integrity of weak stocks, and endorsed an emergency captive brood stock program for the severely depleted Snake River sockeye. These measures are already being implemented.

- **NWPPC Phase Two: Main-Stem Survival and Harvest**

  Phase two began in late summer of 1991 and was completed in December 1991. NWPPC took two approaches in this phase. First, it identified main-stem survival, harvest, and some production and habitat measures that needed to be implemented for the 1992 salmon migration. Second, it committed the region to implement additional measures to further improve salmon and steelhead survival as soon as they are evaluated for feasibility, biological soundness and compliance with the Northwest Power Act.

NWPPC also began developing a framework that will tie all the new and existing program measures together. The framework includes objectives and performance standards. Because this document embodies conduit development as a part of phase two, it is discussed more fully below.

- **NWPPC Phase Three: System Integration**

  This phase began in late 1991 and should be completed by late spring 1992. In this phase, NWPPC will consider issues raised in connection with the Integrated System Plan developed by the Columbia Basin Fish and Wildlife Authority. This is a proposed plan that coordinates efforts to produce more salmon and steelhead in the nearly three dozen subbasins that produce these fish. NWPPC also will consider broad issues of fish production and habitat policy, including the connection between recovery efforts for weak stocks and efforts to increase other stocks. This phase will also address passage issues in such areas as the mid-Columbia and Williamette Rivers.

  The framework started in phase two will be completed in phase three. It will include rebuilding schedules, biological objectives, and performance standards. If necessary, particularly if new information emerges, NWPPC may revisit areas addressed in the previous two phases.

- **NWPPC Phase Four: Resident Fish and Wildlife**

  The first three phases will constitute a regionally proposed salmon and steelhead recovery plan. However, the Columbia River Basin Fish and Wildlife Program is even broader. Congress directed it to protect and enhance all the fish and wildlife in the Columbia Basin that have been affected by hydropower. Phase four will take up issues related to resident fish (fish that do not migrate to the ocean) and wildlife. NWPPC has asked interested parties to submit recommendations for amending the resident fish and wildlife portions of the program by September 1992. This phase, which will complete the overall updating of the fish and wildlife program, is expected to be finalized during 1993.

A Closer Look at Phase Two

NWPPC had three purposes in developing amendments for phase two. It was seeking to take major steps toward a long-term comprehensive plan for recovery of weak salmon and steelhead runs that will:

1. Maintain the genetic resources and biological diversity of wild, naturally-spawning, and artificially-propagated populations

2. Preserve, wherever possible, the number and character of remaining runs

3. Increase, over the long term, sustainable fish populations sufficiently to provide an adequate harvest for tribal, sport and commercial fishers.

Phase two calls for a wide variety of immediate actions, including increased flows in the Columbia and Snake rivers, fish passage improvements at federal hydroelectric dams, measures to improve survival between dams, better juvenile fish transportation methods, predator controls, and controls on harvest.

Many of these actions are directed at minimizing the time it takes juvenile fish to travel to the ocean. Because survival increases as travel time decreases, reducing travel time by increasing flows is expected to increase survival, particularly in low-water conditions. A key immediate action calls for storing more water behind the dams during the fall and winter, and releasing it in the spring during the critical juvenile salmon and steelhead downstream migrations. The increased flow would help speed the fish to the ocean and reduce their exposure to predators and disease. The phase two amendments make it clear NWPPC is committed to substantially shortening spring salmon migration times through immediate steps; including, improved flows and water velocity, improved bypass and transportation, as well as other measures designed to aid fish migration. NWPPC has employed all the feasible steps it can identify to achieve the existing water budget, plus, allocating substantially more water for flow regimes that aim for at least 85,000 ft^3/sec in the Snake River and over 200,000 ft^3/sec in the Columbia River. These flows should increase the survival of Snake River spring and summer chinook and sockeye salmon.

But even these steps, along with other measures adopted in phases one and two, do not appear to be enough to stem the decline of certain stocks. Flow augmentation is only one way to reduce travel time. Another way is lowering reservoirs so water flows faster and fish spend less time in slack reservoir pools. NWPPC has called for a reservoir drawdown plan for the lower Snake River and has set aggressive schedules for operations, design, mitigation and biological plans. This drawdown, along with water conservation, new storage, innovative power operations, and other measures to improve in-river migrations, will be implemented unless they are shown to be structurally or economically nonfeasible, biologically unsound, or inconsistent with the Northwest Power Act.

NWPPC also included measures aimed at protecting adult fish so that a sufficient number can return to spawn and rebuild salmon and steelhead populations. These included commercial and sport harvest reductions, new techniques to enable selective harvests, and a program to reduce commercial fishing in the short term. NWPPC is calling for a harvest reduction of fall chinook to 55% of the annual run, down from a high of 77% in recent years, and a halt to the commercial harvest of sockeye below the confluence of the Snake and Columbia Rivers. Only a limited ceremonial and subsistence fishery, as provided by treaties, should be permitted in order to protect any remaining adult Snake River sockeye. Measures were also adopted that provide for temporarily leasing commercial fishing licenses to further enhance the survival of adult fish returning to their spawning beds. A measure also was included to continue evaluation of cool water releases from behind Dworshak Dam to provide healthier water temperatures for adult fall chinook.

How Survival will be Affected

If all of the immediate measures are implemented in time for the Snake River spring migration, they would lead to a slow and steady rebuilding of several stocks. For some stocks, these measures may do little more than stabilize their populations. For a few stocks, these actions will not be abundant on their own. It is certain that more effort will be needed and it is also clear that expanded efforts to improve habitat for every stage of the salmon's life cycle are critical.

This is illustrated in NWPPC's modeling analysis for Snake River spring chinook. In this analysis, NWPPC modeled improvements in flow and velocity, extended-length screens at several main stem dams, and reduced reservoir mortality resulting from the control of predators. The analysis evaluated the effects of these measures on naturally spawning spring chinook stocks with low, moderate, and high productivity. This allowed the analysis to cover the range of habitat quality and biological characteristics for spring chinook in different parts of the Snake River drainage.

The measures should provide the largest benefit in the driest years when fish are at greatest risk. For such years, with all the measures in place—improved flows, reservoir drawdowns, extended screens, and a reduction in reservoir mortality—the survival rate for all juvenile spring chinook should increase from just under 30 to 39%, and the rate for nontransported fish should jump from 4 to 22%.

The importance of appropriate main stem and harvest improvements in rebuilding weak stocks is obvious, and NWPPC has focused on these factors in phase two of this process. However, one of the insights that has emerged from analysis of these measures is the role of good habitat and other conditions that improve productivity in tributary watersheds. In NWPPC's modeling analysis, the more productive stocks (stocks which come from subbasins with better habitat and environmental conditions) will increase in numbers over the coming decades, provided the measures contained in the amendments are implemented. On the other hand, less productive stocks, which typically come from subbasins with degraded habitat, do not fare as well, and the least productive stocks trace a dark line toward extinction. Thus, while main stem and harvest measures remain important, improved habitat for low productivity stocks is essential.

The situation for Snake River fall chinook reflects the most uncertainty. Even when all measures in these amendments and the existing program are implemented, it will be difficult to rebuild the fall run. Supplementation, additional measures addressing habitat, and further evaluation of flows appear to be critical. NWPPC has established a rebuilding schedule for this severely depressed stock.

Even the more promising numbers for spring chinook do not take into account the vagaries of nature. Because some runs are so precarious another El Nino, sustained drought, or other unpredictable events could deal irreversible setbacks. While the timing cannot be predicted, it would be naive not to expect such an event. The more the runs can be strengthened in the meantime, the more likely they will survive uncontrollable and random catastrophes.

3.1.3 Tasks

3.1.3.1 Preliminary Conduit Concept Analysis.

- Review design requirements.

  Requires INEL and its subcontractor personnel to review fish habitat, materials and equipment requirements for designing a Columbia River downstream fish passage conduit system.

- Prepare review questions and discussion items to bring before the conduit team members.

  Requires both INEL and subcontractor personnel to meet and prepare a list of questions and discussion items to present to the Corps at a preliminary meeting.

- Prepare conceptual drawings and equipment specifications.

  Requires the INEL Engineering Department to prepare conceptual drawings and equipment specifications for the downstream fish conduit for submittal to the Corps through the project manager.

- Transmit conceptual drawings to the conduit team for review.

  Requires the project manager to transmit the conceptual drawings and equipment specifications to the Corps in the shortest and most economical manner for review.

3.1.3.2 Prototype Design.

- Prepare conduit prototype design (CPD) drawings and equipment specifications for review by conduit team members.

  Requires the INEL Engineering Department to prepare drawings and equipment specifications for the downstream fish passage conduit for submittal to the Corps through the project manager.

- Transmit CPD drawings and equipment specifications to the conduit team for review.

  Requires the project manager to transmit the CPD drawings and equipment specifications to the Corps in the shortest and most economical way for their review.

- Review and incorporate the CPD reviewers' comments.

  Requires the INEL Engineering Department to review comments received and correct the final drawings and equipment specifications for the downstream fish passage conduit for submittal to the Corps through the project manager.

- Transmit final CPD drawings and equipment specifications to BPA through the Corps.

  Requires the project manager to transmit the final CPD drawings and equipment specifications to the Corps in the shortest and most economical way for their review.

3.1.3.3 Prototype Demonstration Installation and Testing.

- Prepare test plan for test sections of conduit to be installed in the Gem Lake section of the Snake River.

  Requires INEL to prepare a test plan and submit it to the conduit team for review and comments.

- Install demonstration section (3,000 ft) in Gem Lake.

  Requires INEL to purchase material and equipment for the conduit and install three 1,000 ft sections in the Gem Lake for testing.

- Test demonstration section for a period not to exceed 90 days.

  Requires INEL to take readings, examine, and observe the conduit prototype's test attributes while the conduit is in Gem Lake.

- Report findings from the demonstration test to the conduit team.

  Requires INEL to write a report on the test results and submit to BPA through the Corps.

- Make design changes resulting from the demonstration test.

  Requires the INEL Engineering Department to review the test report findings and modify the conduit drawings and equipment specifications for submittal to the conduit committee for final approval.

- Submit final drawings for an in-place full scale conduit test in the Columbia River.

  Requires the project manager from the INEL Engineering Department to review comments received and to modify the final drawings and equipment specifications for the downstream fish conduit.

- Submit the final conduit drawings and equipment requirements to the BPA through the Corps by the project manager.

3.1.3.4 Subcontract Administration.

- Manage any subcontracts while in progress, assuring that the schedule is maintained.

Requires the project manager to work closely with the contract administrator and any subcontractors to assure the schedule is maintained.

- Coordinate the subcontract deliverables.

  Requires the project manager to work closely with the contract administrator and any subcontractors to assure the deliverables are in a timely manner.

- Coordinate the subcontract closeout.

  Requires the project manager to work closely with the contract administrator and any subcontractors to assure an orderly closeout.

3.1.4 Scope of Work

The Support Team (INEL and any subcontractors) shall provide support services in the areas of technical, cost, design, evaluation of biological/environmental compatibility with fish and assessment of fish conduit. These services will be in support of the conduit team.

INEL/subcontractor support services work tasks will consist of the following (given in chronological order):

- Review of fish habit requirements.

  Any inconsistencies and exclusions will be noted as questions. Items requiring additional clarification will be noted for discussion with the conduit team. The INEL Conduit Support Project Manager will then forward the review questions and discussion items to the conduit team.

- Review trip to Corps' office in Portland, Oregon two weeks after the review questions have been submitted to the conduit team.

  A meeting will be held at the Corps' office to go over the review questions and discussion items previously submitted. This meeting typically should last one full day, the morning will be devoted to an overview and a review of technical details and the afternoon will be devoted to cost and schedule details.

- Development of conduit design drawings.

  The final design drawings, equipment specifications, and maintenance information will be the second major end product of this task.

- Install the 3,000-ft test section.

  Three 1,000-ft test sections will be placed in Gem Lake for testing of wave action on the conduit, material suitability, equipment workability, and maintenance requirements. This will be the third major end product of this task.

- Rework the final drawings.

  The final drawings will be modified to reflect any changes that the test section results require. These would be submitted to the conduit team for review.

- Development of final design drawings, equipment specification, and maintenance requirements. This would be the fourth major end product of this task, and the last unless requested to perform additional work.

3.1.5 Materials Handling

All materials and equipment connected with the fish passage conduit project will go through the standard company review process. Confidential business information will be handled according to established policies and procedures.

3.1.6 Deliverables

The subcontractor shall deliver the following information (but not limited to), as delineated above during the contract period:

- A list of fish habit review questions and discussion items
- Preliminary Report on the questions and discussion items
- Final Report on the questions and discussion items.

3.1.7 Schedule

A schedule of activities is listed below in the sequence that they will be conducted. Start and end dates are to be determined.

1. Review Design requirements

2. Prepare review questions and discussion items to bring before the conduit team members

3. Prepare preliminary drawings and equipment specifications

4. Transmit preliminary drawings to the conduit team for review

5. Prepare final drawings and equipment specifications for review by conduit team members

6. Transmit final drawings and equipment specification to the conduit team for review

7. Review final drawing review comments and make changes

8. Transmit drawings and equipment specifications to BPA through the Corps

9. Prepare test plan for test sections of conduit to be installed in Gem Lake

10. Install demonstration section (3,000 ft) in Gem Lake

11. Test demonstration section for a period not to exceed 90 days

12. Report findings form demo test to conduit team

13. Make design changes that resulted from demonstration test

14. Submit final drawings for a in-place full test

15. Manage the subcontract while in progress, assuring that the schedule is maintained

16. Coordinate the subcontract deliverables

17. Coordinate the subcontract closeout.

3.1.8 Key Milestones

See the Work Breakdown Structure listings (see Section 3.2.1). Milestone dates are to be determined.

3.2 Work Breakdown Structure

3.2.1 Work Breakdown Structure

- Review questions and discussion items
- Preliminary drawings
- Preliminary equipment selection and specifications
- Final drawings
- Final equipment selection and specifications
- Test demonstration installation
- Write test report
- Make corrections to final drawings per test results
- Make corrections to final equipment selections and specifications per test results
- Submit final drawings to BPA through the Corps.

3.2.2 Work Breakdown Structure Numbers

Each phase of this Project shall be assigned a separate work task number.

3.3 Organization and Responsibilities

DOE-ID has the responsibility for the managing and administrating the DOE Hydropower Energy Program. Because of the scope and the sometimes unpredictable schedule of this program, it is sometimes necessary for INEL to provide a broad spectrum of support services to DOE-ID to assure timely and efficient administration. Because of the elasticity of schedules, a broader spectrum of talent requirements, and the priority of the Hydropower Energy Program, INEL has in place a standard procedure ability to engage the assistance of support service subcontractors. Figure 11 is an organizational interface chart.

The main responsibilities by position are:

3.3.1 Program Manager DOE-ID

- Coordinates, directs, and monitors all support team work
- Main point-of-contact with DOE-Headquarters (HQ), INEL, BPA, and Corps
- Main point-of-contact with INEL Project Manager
- Reviews all submittals to conduit team
- May appoint someone to act in her/his place by verbal notification to project manager.

3.3.2 Project Manager—INEL

- Coordinates and monitors all support team work
- Main point-of-contact with subcontractor personnel if one is used
- Main point-of-contact with DOE-ID Program Manager
- Coordinates all submittals to conduit and support team
- May appoint someone to act in his place by verbal notification to program manager and engineering manager.

3.3.3 Subcontract Administrator—INEL (If subcontractors are used)

- Reviews subcontract packages for administrative efficiency.
- Makes award regarding subcontracts.
- Issues subcontracts.
- Acts immediately on subcontract administrative issues that surface during execution of the subcontracts.
- Modifies or terminates subcontracts—all desired changes to subcontracts must be submitted to contracts in writing. Only the subcontract administrator is authorized to modify a subcontract in any way or terminate the subcontracts in their entirety.

3.3.4 Engineering Manager—INEL

- Coordinates and monitors all engineering work
- Main point-of-contact with engineering department
- Coordinates all engineering submittals to project manager
- May appoint someone to act in her/his place after notification of the project manager.

3.3.5 U.S. Army Corps of Engineers

- Will specify what work should be performed
- Will approve all drawings and equipment specifications

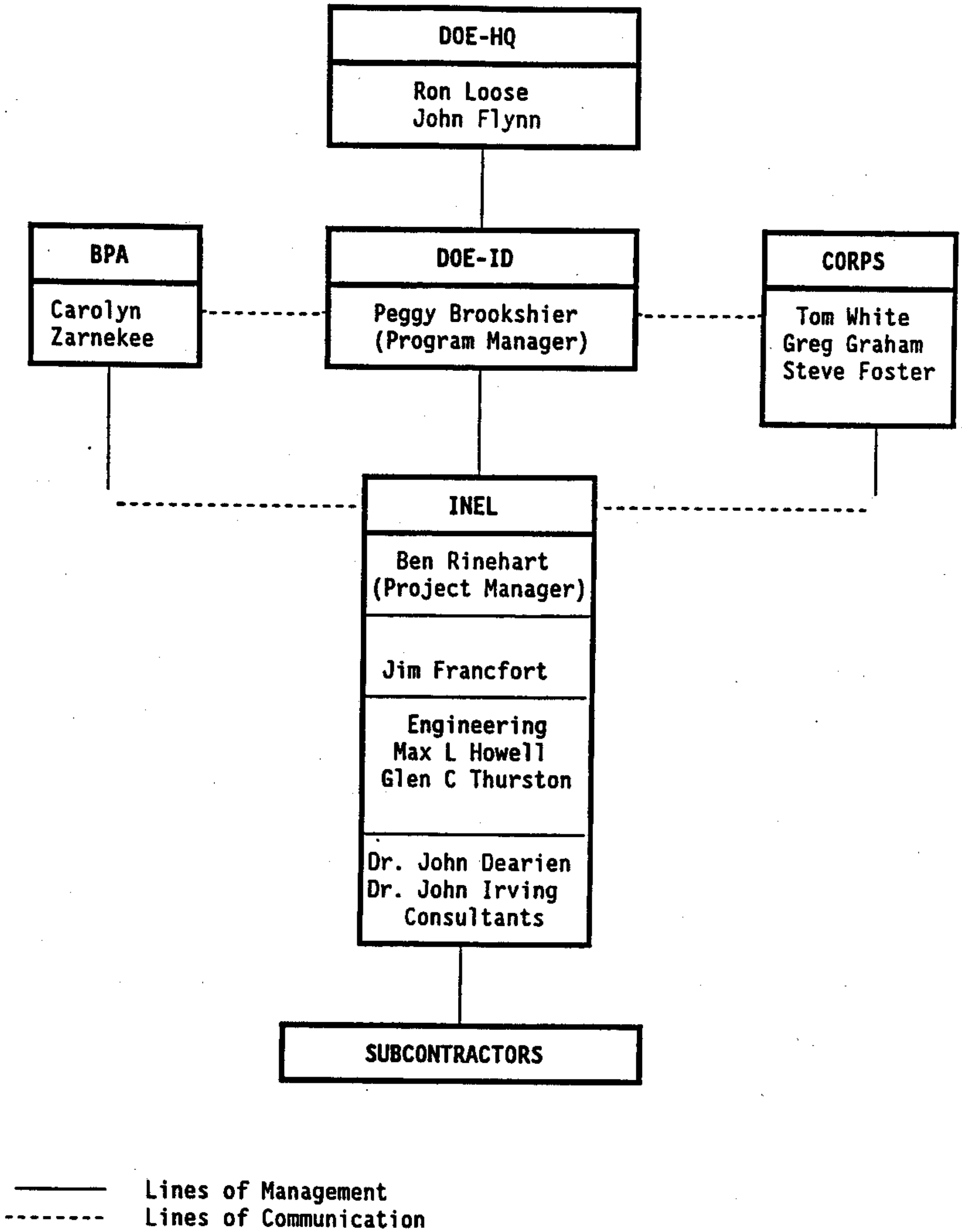


Figure 11. Organizational interface chart.

- Will hold progress meetings.

3.3.6 Consultants (INEL and Subcontractor)

- Will attend project meetings and be available to answer questions and make suggestions
- Will submit written documentation, if requested.

3.4 Preliminary Resource Allocation Plan

Tables 1 through 4 are cost estimates for the conduit prototype project.

3.5 Basis of Cost Estimate

3.5.1 Total Cost:

The task total cost is given in loaded dollars.

3.5.2 Permanent Installation Cost

The total cost for an installation in a reservoir will be made after the prototype test has been completed.

3.5.3 Subcontractor Cost

The subcontractor cost is only for travel expenses. It is assumed the subcontractors will consist of universities that do not charge labor hours.

3.5.4 Assumptions for Developing the Cost Estimate

Note: It is not the intent that the details of the Project Management Plan cost estimate be considered only as a preliminary cost estimate. A detailed cost estimate will be provided after the 3,000 ft test has taken place.

- The FISP Program will be funded through an inter-agency agreement and will be managed as a DOE program. (It is not Work for Others).

- INEL will fund travel expenses only for U of I (Dr. Ernest Brannon) and U of W ichthyologists.

- There will not be a separate Quality Program Plan (QPP) for the project; the INEL Engineering Department QPP (-044) will be used. Any project-specific quality assurance provisions will be included in the design requirements document (DRD). The DRD will be reviewed and approved by the "Conduit Team".

- Prototype hardware and engineering evaluation test hardware will be built during the Demonstration Phase.

Table 1. Total cost estimate summary for conduit prototype design stage (loaded dollars).

Item		Dollars
Administrative and Management Costs (i.e. PM) assumed 70% @ 6 months		$54,375
PMP, Work Packages, Project File		$12,000
Design Requirements Document (DRD)		$18,000
NEPA Environmental Assessment; State and/or County/City permits (for prototype)		$50,000
Studies and Analysis imprinting	Security Pumping/Motive Force Options Failure/Damage Detection Repairs O_2 injection Wave, Wake, Wind and Current Forces Tube Fabrication Placement/Installation/Anchoring Site Selection Surface Lighting	$36,000
Evaluation Tests	Tube Material (durability/fungus (hours + 100k) Resistance/Hydraulic Properties Pump Design (peristaltic, vaneaxial, etc.) Smolt/pump station compatibility	$121,000
Vendor Identification and Support (Tube Material)		$18,000
Drawings Specification	40 drawings 5 specifications	$143,000
Water Safety Analysis/Work Plan (for installation and test of prototype)		$12,000
Prototype Test Plan		$9,000
Fabrication/Installation/Removal Cost Estimate		$9,000
Internal Review(s)		$12,000
Final (External) Design Review		$15,000
Travel (meetings, etc)		$15,000
Contingency or Management Reserve (30%)		$157,500
	Total	$682,000

Table 2. Hardware cost estimate for 3,000 ft conduit prototype demonstration installation and testing stage.

Item	Unit Price	Total $$
Tubing material (Spectra - 8 ft dia. X 3,000 ft)	$1/ft^2	$75,500
Bond material into cylinder	$2.50/ft	$7,500
Tubing interconnection flanges - each section end @ 100'/section	30 pair $250 each	$7,500
Power Piping	2,000' @ $10/ft	$20,000
Floats, etc.	ft	$25,000
Pumping Station (3 each) Provide motive force Imprint water Water oxygenation	built @ INEL $45K each	$135,000
Drive pump		$6,000
Cables; Anchoring material	10,000 ft @ $3	$30,000
Miscellaneous Hardware		$25,000
Total		$331,500

Table 3. Total cost estimate for conduit prototype demonstration stage (3,000 ft prototype).

Item	Unit Price	Total $$
Administrative and Management Costs (PM @ 6 months)		$45,000
Hardware Costs	from table 2	$331,500
Procurement/Subcontracts Support	7½% Hardware; 2% Installation	$24,500
Engineering/Technicians (4 months @ 75% X 10 heads)		$390,000
Test Equipment		$10,000
Installation (Barge/Boats/Divers)		$50,000
Final Test Report		$9,000
Updates to Drawings and Specifications		$6,000
Contingency/Management Reserve (30%)		$254,000
Total		$1,120,000

Table 4. Total cost estimate for conduit fish passage prototype.

Item	Total $$
Conduit Prototype Design	$682,000
Conduit Prototype Demonstration Installation and Testing	$1,120,000
Total	$1,802,000

INEL DOWNSTREAM FISH PASSAGE CONDUIT SYSTEM CONCEPTUAL LIFE-CYCLE COST (LCC) ESTIMATE

Attempts to estimate the cost of the Idaho National Engineering Laboratory's *Proposal For A Flexible In-reservoir Salmon Passage* conduit system at this time encounters several unknowns. Greater knowledge identifying the total conduit length, conduit materials and pumping station mechanism would ensure a more accurate estimate of future conduit costs. However, a cost estimate has been prepared and is of value when used with an understanding of the unidentified issues and uncertainties that could impact (higher or lower costs) this estimate. Completion of the prototype test phase will provide proof of principle and this information will drive the full scale in-reservoir design requirements. When the prototype phase is completed a definitive cost estimate will be provided.

This analysis only considers the main river stem, from the Lower Granite Dam and its reservoir backwater on the Snake River, downstream to the Bonneville Dam on the Columbia River; a distance of approximately 320 miles. Additional conduit sections required for incoming tributaries, including the Colombia River above its confluence with the Snake River, have not been identified and are not considered in this analysis. The potential costs of environmental and other permitting were not considered and assumed to be a U.S. Army Corps of Engineers responsibility. Specific material selection has not occurred but informal discussions with material suppliers suggests a cost of one dollar per square foot for conduit fabric. Bulk purchases would most likely lower this cost and other costs, however, a value of one dollar per square foot for conduit fabric was used in the analysis. Additional unknowns include the possible pumping station configurations which range from a pressurized hydraulic water powered pump to an electrically driven jet pump system. A conceptual underwater electric jet pump scenario was assumed for the estimation of pump station costs. (The attached spreadsheet contains additional defined cost assumptions).

This preliminary cost analysis has attempted to take a conservative approach in that when costs are estimated within a range, the highest estimated cost within the range is used. This is done to reflect the uncertainty associated with this "one-of-a-kind", never before attempted construction of a fish passage system of this magnitude. Additional cost estimate consideration was given to the fact that unlike conventional present value analysis of competing alternatives, the lowest-cost alternative will not have priority, rather, the fish passage system configuration with the greatest biological benefits, public acceptance, minimal impact, and technical feasibility of success will be chosen.

This estimate can only be considered as a rough order of magnitude estimate. When all of the viable options are identified, selected and costed, a more definitive analysis, with conclusive results, will be preformed. Additional unknowns that would effect costs include the issues of cleaning and storage of the conduit. Previous use of potential conduit materials suggests algae will not grow on the material, which drives down cleaning costs. The prototype development stage would most likely answer questions as to the best storage methods, anchoring systems, installation methods and other considerations. Monitoring, study, reporting, environmental and other operational requirements have not been identified at this point.

The 20 year LCC assumed an approximate accelerated design, testing and construction schedule. The actual implementation and construction schedule for the entire 320 mile system is undefined at this time. Prototype design work is assumed to start during October 1992 in order to demonstrate the prototype during 1993. This analysis has considered prototype design and demonstration costs, and full scale in-reservoir design, installation, construction, and operations and maintenance costs over a 20 year period. Costs also include power, annual material replacement and pump station overhauls. All of the costs are considered in a 20 year LCC analysis, including the influences of inflationary and discounting factors. A four percent inflation factor was applied to all annually occurring costs beyond their inception year, and a seven and one-half percent discount rate was used for the present value (1993) analysis. The total 20 year estimated cost to construct and operate the proposed system is ~$520 million (1993 dollars).

09/10/92

INEL DOWNSTREAM FISH PASSAGE CONDUIT SYSTEM
CONCEPTUAL LIFE–CYCLE COST ESTIMATE

Discount Rate 7.5%
Inflation Rate 4.0%
Cost Base Year 1993

(ALL COSTS ARE IN THOUSANDS)

	0	1	2	3	4	5	6	7	8	9
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Prototype Conduit										
Design Stage	$682									
Construction/Demo	$1,120									
In-reservoir Conduit Capital Equipment										
Design Stage		$6,820								
Pumping Station		$42,250	$42,250							
Conduit Material		$20,275	$20,275							
Installation		$32,000	$32,000							
Anchor Materials		$16,000	$16,000							
Power Supply Syst.		$32,000	$32,000							
In-reservoir Conduit Annual O&M										
Pump Overhauls			$16,900	$17,576	$18,279	$19,010	$19,771	$20,561	$21,384	$22,239
Conduit Cleaning			$1,014	$1,055	$1,097	$1,141	$1,186	$1,234	$1,283	$1,334
Power		$2,765	$2,876	$2,991	$3,110	$3,235	$3,364	$3,499	$3,639	$3,784
Conduit Material			$406	$422	$439	$457	$475	$494	$514	$534
Totals	$1,802	$152,110	$153,721	$22,043	$22,925	$23,842	$24,796	$25,788	$26,819	$27,892
Total Discounted Present Value Cost	$1,802	$141,498	$141,673	$17,744	$17,166	$16,607	$16,067	$15,544	$15,038	$14,546

	10	11	12	13	14	15	16	17	18	19	
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTALS
Prototype Conduit											
Design Stage											$882
Construction/Demo											$1,120
In-reservoir Conduit Capital Equipment											
Design Stage											
Pumping Station											
Conduit Material											$84,500
Installation											$64,000
Anchor Materials											$84,000
Power Supply Syst.											$64,000
In-reservoir Conduit Annual O&M											
Pump Overhauls	$23,129	$24,054	$25,016	$26,917	$27,057	$26,140	$29,285	$30,436	$31,653	$32,920	$433,407
Conduit Cleaning	$1,386	$1,443	$1,501	$1,561	$1,623	$1,688	$1,756	$1,826	$1,899	$1,975	$26,004
Power	$3,935	$4,093	$4,257	$4,427	$4,604	$4,788	$4,980	$5,179	$5,386	$5,601	$76,511
Conduit Material	$556	$578	$601	$625	$650	$676	$703	$731	$760	$791	$10,412
Totals	$29,006	$30,168	$31,375	$32,630	$33,935	$35,292	$36,704	$38,172	$39,699	$41,287	$840,007
Total Discounted Present Value Cost	$14,074	$13,616	$13,173	$12,744	$12,329	$11,928	$11,539	$11,164	$10,800	$10,446	$519,501

PV TOTAL COST

COST ASSUMPTIONS

It is unknown at this time what configuration and length the final conduit system would be like. This LCC analysis has required the liberal use of engineering and cost judgements and assumptions. When the final system design is choosen and designed, greater certainty and accuracy will enable a more exact LCC analysis. The following costs are in sinige dollars, unless specified as thousands (k). System length is 320 miles, pumping stations every 1000 feet, 5.28 pump stations per mile, 320 X 5.28 = 1690 pump stations length of conduit system.

Dam Name	Length
Bonneville	45.4
The Dalles	24.1
John Day	76.4
McNary	42.7
Ice Harbor	31.9
Lower Monumental	24.2
Little Goose	37.2
Lower Granite	37.5
Reservior Length	319.4 Miles
Round to 320 miles	

Prototype Conduit

$682 k Design Stage – INEL Proposal For A Flexible In–reservoir Salmon Passage proposal, Table 1
$1,120 k Construction/Demo – INEL Proposal For A Flexible In–reservoir Salmon Passage proposal, Table 3

In–reservoir Conduit Capital Equipment

$6,820 k Design Stage – (prototype design cost X 10)
$84,500 k Pumping Station – $50,000 per station X 1690 statons – 1/2 installed 1994, 1/2 installed 1995
$40,550 k Conduit Material – $1 sq. ft. X 24' circumference X 5280' X 320 miles – 1/2 installed 1994, 1/2 installed 1995
$64,000 k Installation – $200,000 per mile X 320 miles – 1/2 installed 1994, 1/2 installed 1995
$32,000 k Anchor Materials – $100,000 per mile X 320 miles, 1/2 installed 1994, 1/2 installed 1995
$64,000 k Power Supply System – $200,000 per mile X 320 miles (assumes subsurface electrical power supply system) – 1/2 installed 1994, 1/2 installed 1995

In–reservoir Conduit Annual O&M

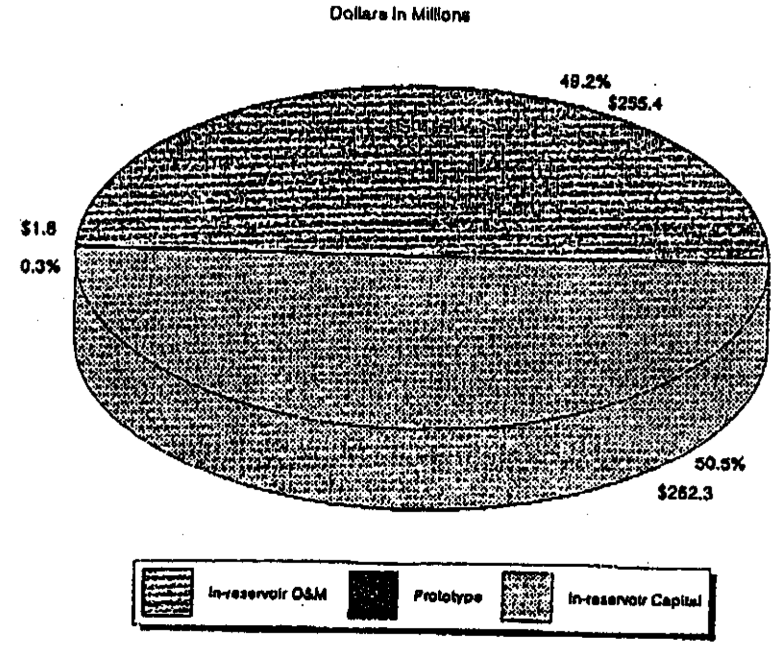
$16,900 k Pumping Station Overhauls – $10,000 per station X 1690 pump stations
$1,014 k Conduit Cleaning – (Cleaning thousand conduit feet per day) 2 personal X $300 per day X 5.28 thousand feet per mile X 320 miles
$2,765 k Electrical Power – 120 kW per mile X $02.5 kWh X 24 hours X [illegible]ys X 320 miles
$406 k Conduit Material – Normal wear & tear conduit replacement [illegible] conduit material cost X 1%

Interest Rates

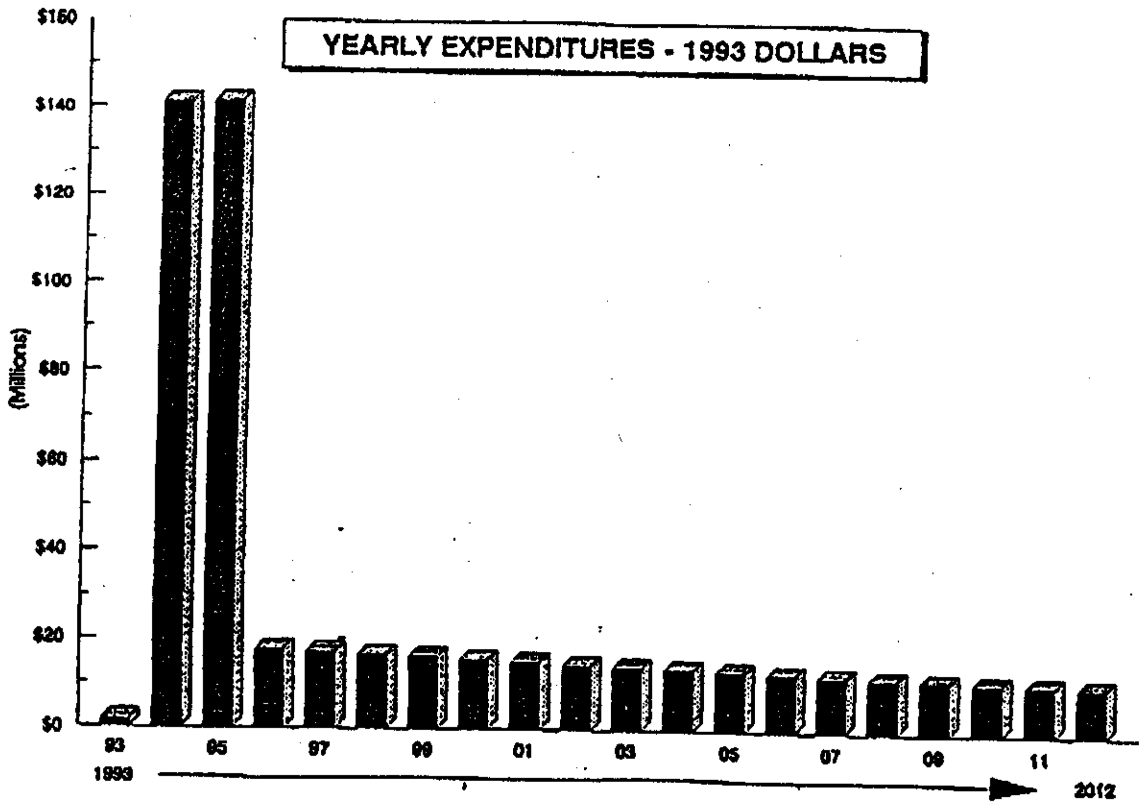
7.50% Discount Rate – 30 year treasury bond @ 7.28, WSJ 9/8/92. Round to 7.5%
4.00% Inflation Rate – Consumer Price Index approximate average

INEL DOWNSTREAM FISH PASSAGE CONDUIT SYSTEM

EXPENDITURE ALLOCATION - 1993 DOLLARS



YEARLY EXPENDITURES - 1993 DOLLARS



- Wave, wake, wind, and flow force data will be provided by the Corps—INEL will analyze, interpret, and apply data. Derived requirements will be included in the DRD.

- There will be internal reviews and external reviews. Internal reviews will be conducted informally; external reviews will be conducted formally. External reviews will be conducted prior to the commencement of the demonstration phase in the Snake River. (Participating organizations BPA, Corps, U of I, U of W, etc., should all participate in the review process).

- The Corps have the responsibility for collecting and releasing the smolts. The INEL system will be designed to connect to collection point and transport smolts to the release equipment.

- Since this is not a construction project, it is exempted from Davis-Deacon; make/buy decisions will be made as the design progresses (hopefully at a project level).

- Hardware items may be either procured outside or fabricated by INEL. Specifications and drawings will be done accordingly. Special purpose drawings may be considered for installation, if appropriate.

- No construction package will be required. The actual installation, testing, and removal of the prototype will be performed and/or managed by INEL personnel. Work will be planned using SWRs or small subcontracts.

- Costs for the prototype hardware are based on the original concept shown in Figures 1,2,3, and 5.

3.6 Quality Assurance Plan

Due to the complexity of the process, formal engineering reviews and formal quality checks will be made prior to the delivery of each product to BPA/Corps.

- Spell Check: All material will be generated with word processing software (Word Perfect®) on a computer which has the capability of performing a spell check.

- Proof Reading: Material will be proof read for numeric accuracy and proper sentence formation.

- Drawings: All drawings will be checked, ensuring that standard symbols and drafting standards are adhered to.

- Materials and Equipment: Quality checks will be per INEL standards.

3.7 Management, Planning, and Control

3.7.1 Management

The program manager (DOE-ID) and the project manager (INEL) will be responsible for this. The INEL project manager will be responsible for any subcontractors used.

3.7.2 Planning

The program manager (DOE-ID) and the project manager (INEL) will be responsible for this. The INEL project manager will be responsible for any subcontractors used.

3.7.3 Control

The program manager (DOE-ID) will be responsible for this.

3.8 Reporting Requirements

Reporting requirements for this task will be to INEL Energy Programs standards: weekly highlight report and a monthly report. If a subcontractor is used, they will submit the same reports to the project manager.

3.9 Program Compliance

- The conduct of programs in compliance with federal regulations is a primary priority of the DOE. All laboratory operations are mandated to comply with OSHA and EPA regulations as well as the numerous DOE orders regarding quality and conduct of operations. The tasks associated with these compliance activities are categorized into the following areas: Environment, Safety, Health Compliance, Quality, and Conduct of Operations Compliance.

- INEL will only be responsible for a EIS/EA for the placing of the 3,000 ft test section to be placed in a local stream/lake. All other environment considerations will be performed by the Corps who would be the entity placing the conduit in the Columbia River for the transportation of the fish.

3.10 Special Considerations

- The INEL project manager must work closely with the DOE-ID program manager, INEL engineering representative, all subcontractors, the Corps, and BPA.

4. INEL CAPABILITIES

The INEL is the engineering laboratory for the DOE and has been involved with hydropower programs for 15 years. Appendices A,B, and C contain information that provide an overview of the experience the INEL has in the hydropower field and related environmental effects. Appendix A is a series of informative slides; Appendix B contains the report: **DOE Hydropower Program-Biennial Report 1990-1991 (DOE/ID-10237(90-91)**; while Appendix C contains the report **ENVIRONMENTAL MITIGATION AT HYDROELECTRIC PROJECTS-VOLUME 1. Current Practices for Instream Flow Needs, Dissolved Oxygen, and Fish Passage (DOE/ID-10360)**,

5. REFERENCES

1. Balje, O. E., 1981, *Turbomachines*, New York, John Wiley & Sons.

2. Stepanoff, A. J., 1957, *Centrifugal and Axial Flow Pumps*, New York, John Wiley & Sons

3. Salisbury, J. K., 1954, *Kent's Mechanical Engineers' Handbook* , Power Volume, New York, John Wiley & Sons

4. *Amendments to the Columbia River Basin Fish and Wildlife Program (Phase Two)*, Northwest Power Planing Council, December 11, 1991. No. 91-31.