Report and Proposal to Study the Boylan Smolt Transport System

By

John R. Woodworth
Fish Passage Inc.

The current losses of salmon and steelhead smolts migrating down the Snake and Columbia Rivers is estimated at up to 15% per dam. With eight dams and reservoirs to navigate, smolt survival to the ocean is unacceptably low. Means to improve their survival have or will include screening and bypassing the powerplants, reducing transit time by improving flow velocity reducing predation, and continuing barge or tanker truck transportation of smolts downstream. This report addresses a closed conduit pipeline system to reduce transit time and reduce other hazards to the smolts.

The Need for Improved Transport

The hazards to smolts during downstream migration through the slack water of reservoirs, powerplant turbines, supersaturated water below dams, and predator-infested waters are the major causes of their reduced populations. Some species are near extinction from these impacts, along with overfishing.

Efforts to reduce smolt damage at powerplants is centered on new or improved screening and bypass systems. It is assumed this program will continue. The low water velocity in the eight reservoirs (about 270 miles of water) adds many days to the natural migration time, and the resultant losses are apparently in the order of 10% per reservoir. High natural runoff, deliberate upstream storage-reservoir water releases, and now reduced reservoir operating levels during the smolt migration season will contribute to higher water velocity and, presumably, better survival. However, these measures may also result in significant costs to power production, agricultural water supplies, and navigation and recreation (the latter two, in the case of altered reservoir operations). Reducing the transit time by collecting and transporting the smolts downstream by barge or truck has given good results with some species, but appears to disorient others and result in poor adult return rates. Alternative transportation is currently being examined by a small group who are concentrating on the open channel or canal approach.

1 A pipeline transport alternative is described in this report. This alternative will require a series of tests and exploration to validate its feasibility from a biological, engineering and cost standpoint. Water velocity for the pipeline system could be in the range of 2 to 4 feet per second or 1.4 to 2.7 mph which would result in water particle transit times of between 4 and 8 days for 270 miles. There is also a potential for the combined application of the canal and the pipeline methods of transportation.

Features of the Proposed System

The key features of the Boylan system is a semi clear plastic pipeline provided with flotation and anchoring at a fixed elevation within the river-reservoir system. Submerged pumps would be strategically placed along the line to overcome pipe friction losses and provide the energy to accelerate the pipeline water column. Injection of air or oxygen, food and exchange water for imprinting could also be provided at intervals along the line. Ejections of sand, silt, detritus and exchange water could also be provided.

It is envisioned that a reach of this pipeline would be from dam to dam with inspection and small resting terminals at the sending and receiving ends. The collection and transport at the dams would be integrated with the existing and planned screening and collection systems. Discharging of fish would be below Bonneville Dam at a single point or distributed over several miles by a pipeline with turnouts. Predation should be reduced greatly by having turnouts distributed over several miles below Bonneville Dam.

Figure 1 shows the overall concept of the system and Figure 2 the details of the pipeline suspension system. Figure 3 shows a pump module and Figure 4 shows the exit and entrance pipeline terminals.

1 cont.

If smolt losses between Lewiston and Lower Granite Dam prove excessive based on current testing, the pipeline reach could be extended upstream to a new collection facility near Lewiston. It is expected that the need for this new facility will be the subject of a separate study. Also, if further experience shows smolt damage due to passage from the dam collection channels to the tailwater facilities is excessive, a 10 cfs fish ladder dedicated to smolt transport to the next pipeline terminal could be incorporated into the design as Figure 7.

A new and promising method for collection of smolts is the use of sonic guidance. Sonalyst Inc., in Waterford Connecticut, has been using sonic guidance to keep fish out of the turbines at power plants and to herd them for various other reasons. It is probable the sonic characteristic needed to collect salmonids can be perfected and used in the Northwest for fish passage, predator control, and many other problems that impact our various fisheries Figure 8.

The Need for a Development Program

Several concepts behind this plan have not been reduced to practice and a search of existing experience, application of theory and modeling, prototype testing, and the application of seasoned judgment is needed before the feasibility can be confirmed. These key factors and suggested means to obtain answers follow:

Biological

The smolts willingness to enter and stay in the semi transparent pipeline should be greatly improved over opaque pipelines. Final proof of this would be with a prototype test but preliminary work could be with a smaller test section. Smolt ready for downstream migration would be needed for the final proof but other species might be suitable for earlier testing.

The effects of the pressure change across a pump module can be reduced by having a larger number of smaller pumps distributed down the pipeline. For example, the friction loss which must be accounted for per 10 miles section of 24" plastic pipe, flowing at 2.5 ft/sec or 1.7 mph would be about 42 feet of head or 18 psi. If this change is too large for low smolt mortality, a closer pump spacing could be provided.

The possibility of abrasion or other contact damage to the smolt is somewhat offset by the natural velocity profile across a flowing pipe where the velocity as the center is the highest and drops off sharply near the wall. Tending the other direction would be the pressure change through the pump module which may cause the smolts to rise in counteraction to the increase in pressure. A continuous prototype test loop of near operation size and pressure
2,3 change may be needed to obtain facts on these questions.

The allowable density of fish in a line with uniform flow is another facet that will impact the feasibility of this concept. For example with a 24" line flowing at 2.5 ft/sec. or 3,500 gpm and an input of 20,00,000 fish over 90 days the average water per fish would be 22 gallons. The importance of this is unknown but high density is suspect as a problem for some species at least in a near zero-flow environment of a fish tanker or barge. Field experiments may shed light on this item.

The need to add food or oxygen to the pipeline is unknown but provision to do so would not be prohibitive in a prototype or final design. Dissolved oxygen monitoring would be a part of the final design.

Orientation and homing urge after a pipeline transit of several days may be the most difficult to answer and may take a long duration, large test program. A simple initial test for this factor should be a priority matter.

Mortality rate in the pipeline system can be determined in the same manner as with tankers or barges. A prototype test should show what to expect for the full application.

Water mix or exchange along the pipeline could be from none to 100% or more per reach if the pumps are sized to accelerate the added water and still overcome the friction losses.

Direct collection and injection of major tributary stream smolts would be possible if there is a biological advantage over picking them up at the next dam downstream.

2,3 cont.

If rest stops of large volume are needed, they could be constructed near shore away from the dams and either dikes and screens or curtain nets used to form an enclosure. Terminals for incoming and outgoing pipelines would be needed along with decking and baffling to create attraction currents to guide smolts back to the pipeline after a rest.

The relationship between pipeline velocity, needed rest areas, willingness to travel day and night, and how the species differ will need biological and engineering attention in arriving at a practical design.

Engineering

The suspension system would keep the pipeline at a depth satisfactory for the smolts and below the expected reservoir water fluctuations. The pipeline would be free between anchor points and anchor point spacing would be dependent upon further engineering work and specific site condition with special attention to reservoir water velocity. The pipeline should be very near naturally buoyant but to insure stability, flotation will be needed to keep the cable suspension under tension at all times. The effect of air or gas collection and differing water density due to temperatures should be addressed.

Pipeline wall thickness would be determined by maximum operating pressure differential and over pressure relief valve settings, along the stress of installation and external forces acting on it.

4,5

Pipeline plastic material would be selected on cost, durability, life, freedom from slime and algae growth buildup and other factors. Polybutalene looks promising.

Pump design must consider that no fish damage is allowed due to impeller contact with the smolts, and an effort should be given to distributing the pressure changes within a module to reduce damage to fish. At the same time reasonable pump efficiency should be obtained. These trade offs will call for pump evaluation tests which could proceed in a hydraulics laboratory in advance of field pipeline tests.

This system will have a ready backup in place with the powerplant screening and collection facilities. If any pipeline reach becomes inoperable for any reason, the smolts would be discharged to the reservoir. Pumps within a module would be in multiple units and failure of any one would not cause pipeline shutdown.

System data such as flow, dissolved oxygen levels and pressure will be transmitted to key operation points, probably the powerplant control rooms. Control of pump motor speed, valves and other items would also be remotely operated and indicated. Computer control of pipeline operation would be provided for all reaches.

Breaks or failures would require underwater repair. Unitized repair kits would be ready for this contingency. Divers trained in the techniques would carry out the work.

4,5 cont. Since there is a long period of non-use it should be possible to thoroughly rinse the line and even inject chlorine or other algae cleaning agents that would be acceptable for river release once the line was cleaned.

Costs and Construction

Morrison Knudson Engineering Corporation has completed a preliminary feasibility study of the Boylan Pipeline Concept and says it can be built as outlined in our concept and would cost approximately $400,000,000, which is less than one-tenth the cost of most other proposals. Construction would be relatively easy. No Right of Way, No Excavation construction time would be fast compared to other concepts.

6 It is envisioned that through modular design of pumps and line sections much of this construction would be done on shore and then barged and located on the alignment. Field coupling of pipeline sections would be simple and achievable underwater.

Power losses for water lost to generation would be nil. Pipelines use would be about 2,000 acre feet for a 24" plastic pipeline with velocity at 2.5 ft/sec. operating for a 120 days. Power consumption for his pipeline will be greatly dependent on pump efficiency, but with hydraulic loss per mile at 4.0 horsepower and a pump efficiency at 10%, the electric input would need to be about 40 hp per mile or with 270 miles of pipeline an aggregate of about 11,000 horsepower or 8,200 kw.

Proposed Program

Phase I

The initial work on this transport system would be for a small team of biologists and engineers to review the concept for feasibility and cost. Key questions regarding system. Life expectancy and other matters would be answered.

Phase II

7 If the initial review is positive, a prototype design and test program would be developed to outline laboratory and field test requirements needed to further confirm and/or modify program. Fisheries agencies and operating agencies would be involved in this and subsequent phases.

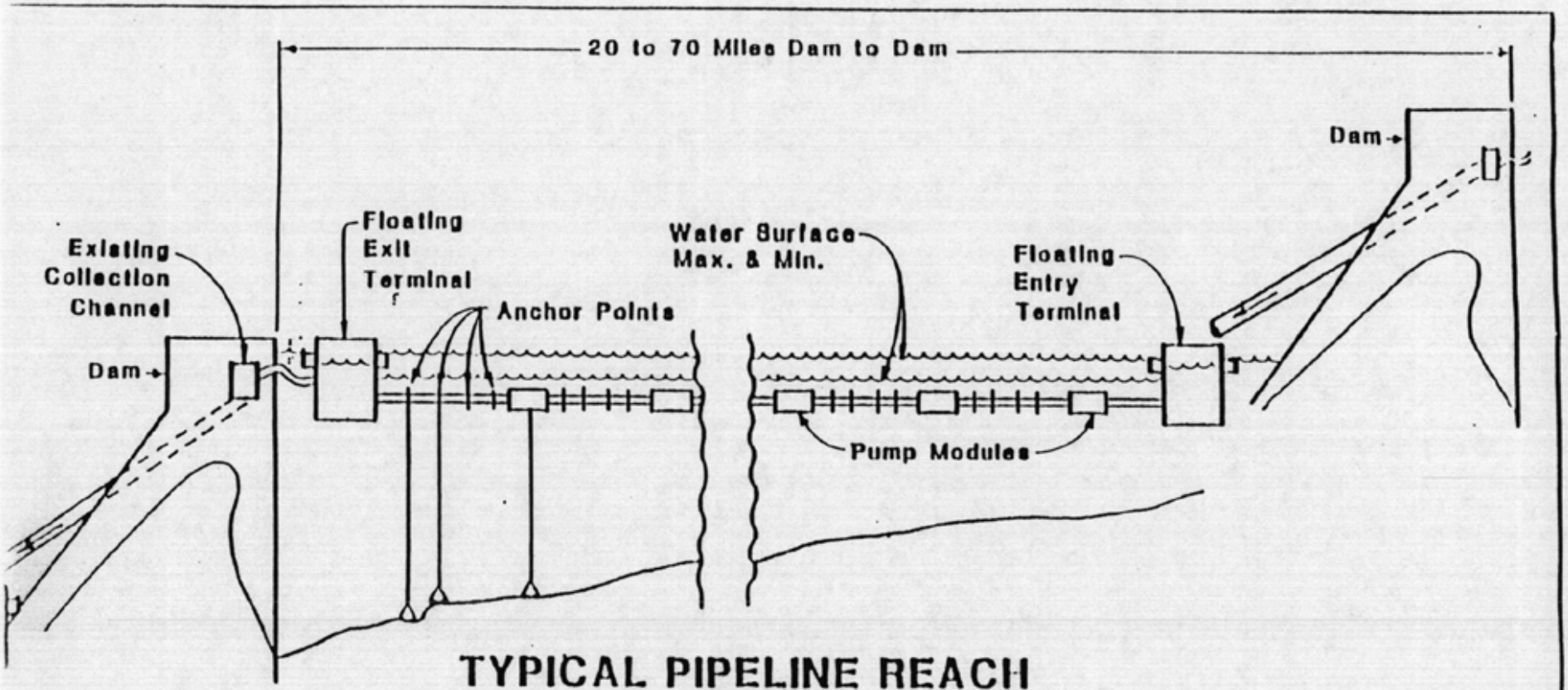
Phase III

Next the field and laboratory tests would be funded and carried out. The prototype test loop would be installed and tested (see Figure 5). Provided all indicators - biological, engineering and economic - are supportive, the Program would move to Phase IV.

Phase IV

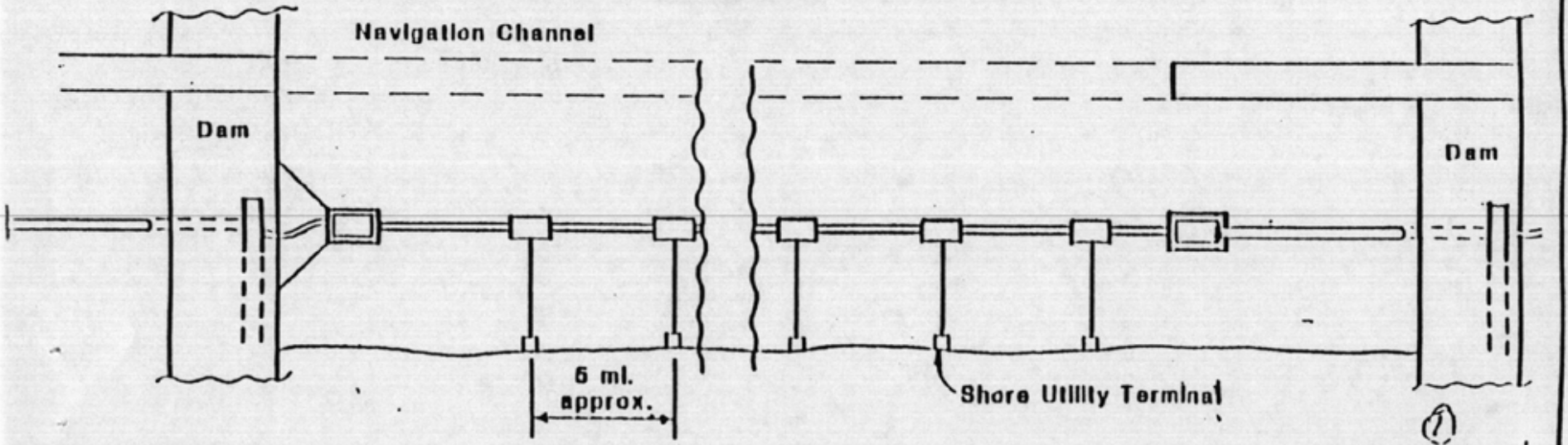
7 cont. Future phases would be for the construction of one or more of the dam to dam reaches.

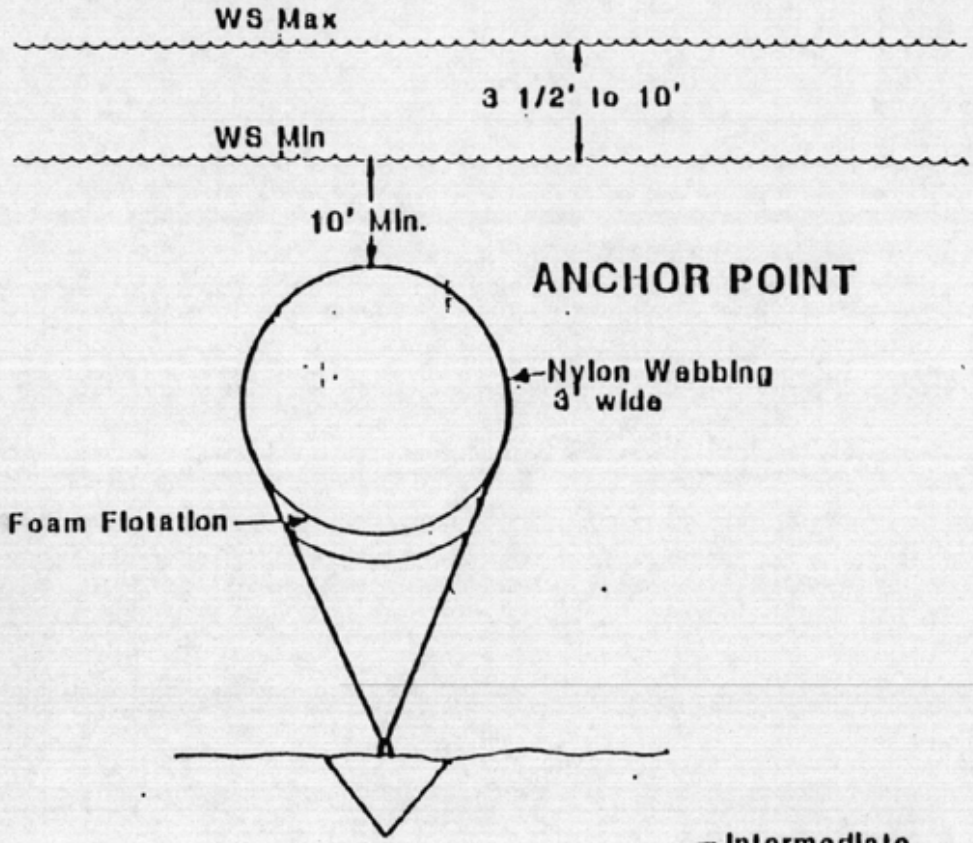
Estimated initial review for Phases I should be completed in 6 months. Several universities in the Northwest are researching now, and it is recommended they perform this review, in concert with a registered engineering/construction firm.

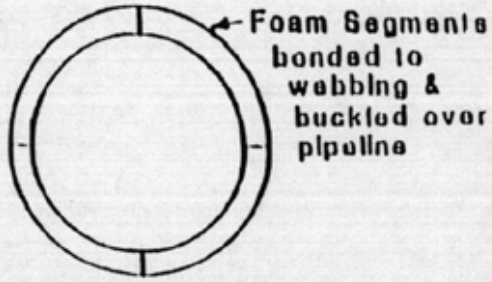


TYPICAL PIPELINE REACH

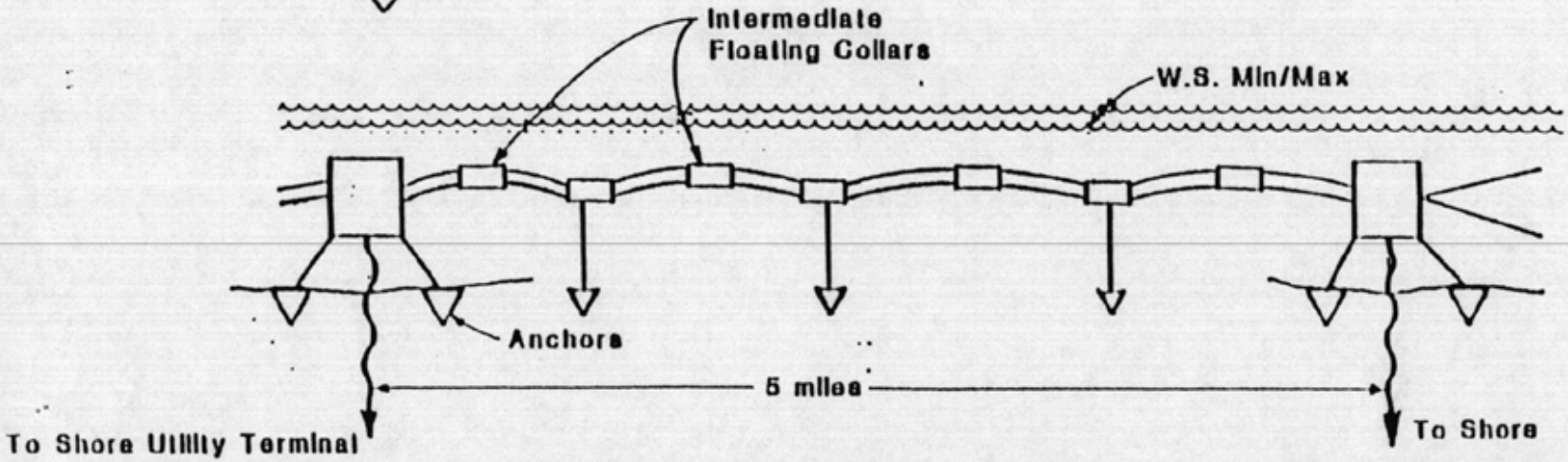
FIGURE 1







FLOATATION COLLAR

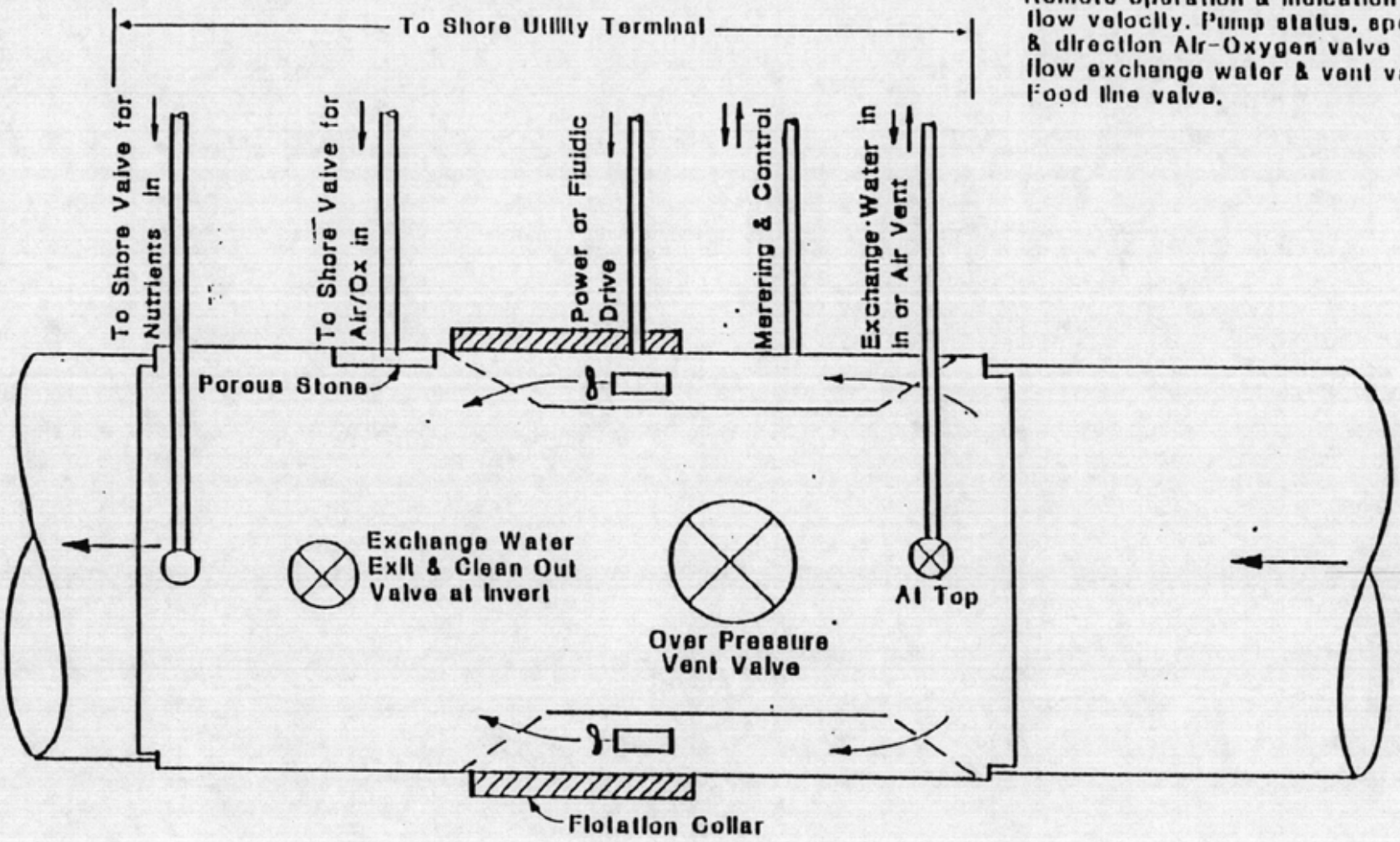


LINE SUSPENSION SYSTEM

Figure 2

NOTE:

Remote operation & indication for flow velocity. Pump status, speed & direction Air-Oxygen valve & flow exchange water & vent valve Food line valve.



NOTE

Fan-ducted propeller pumps – adjustable speed, screened to protected fish from entry, individualy reverseable for screen cleaning.

PUMP MODULE

Figure 3

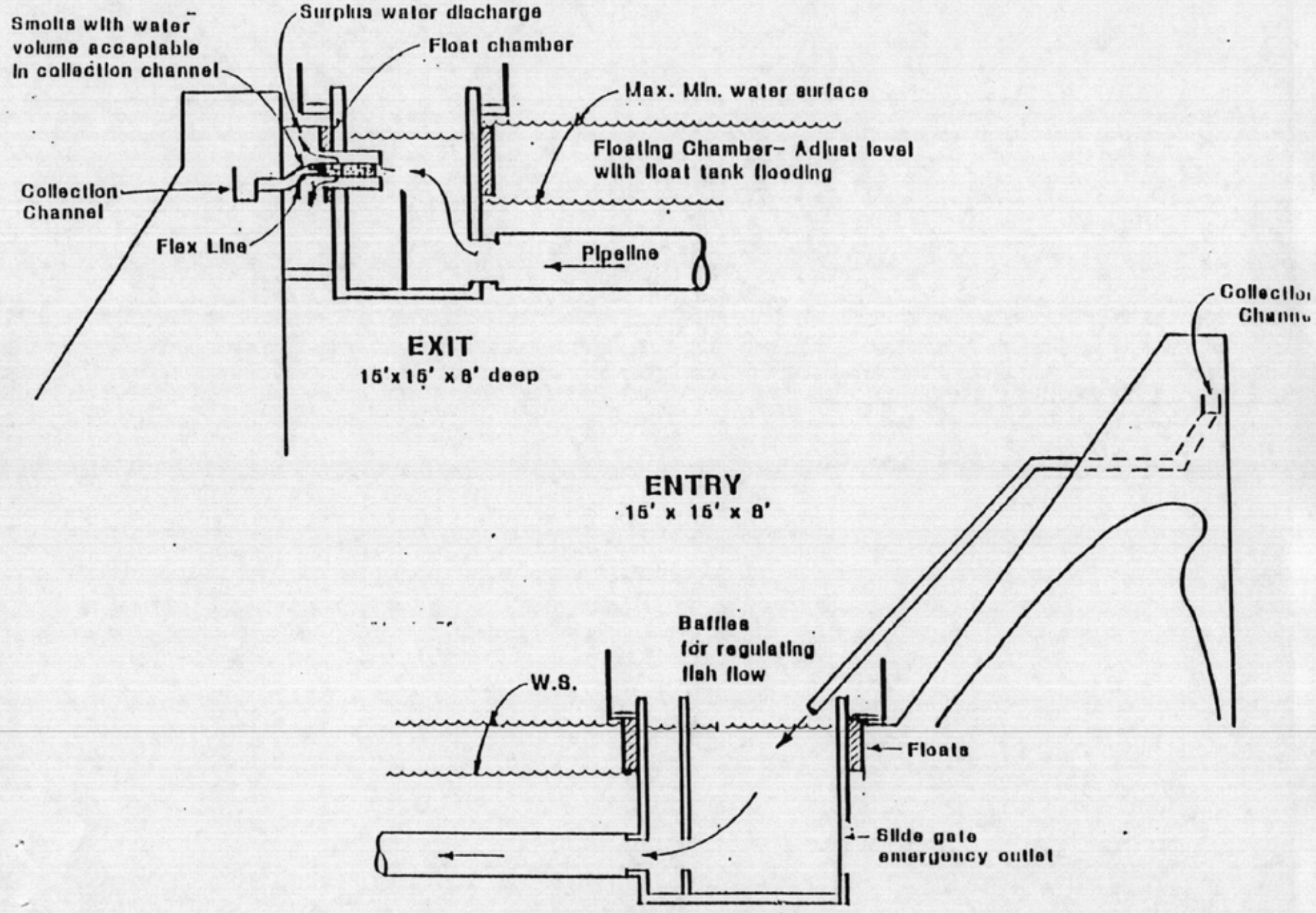


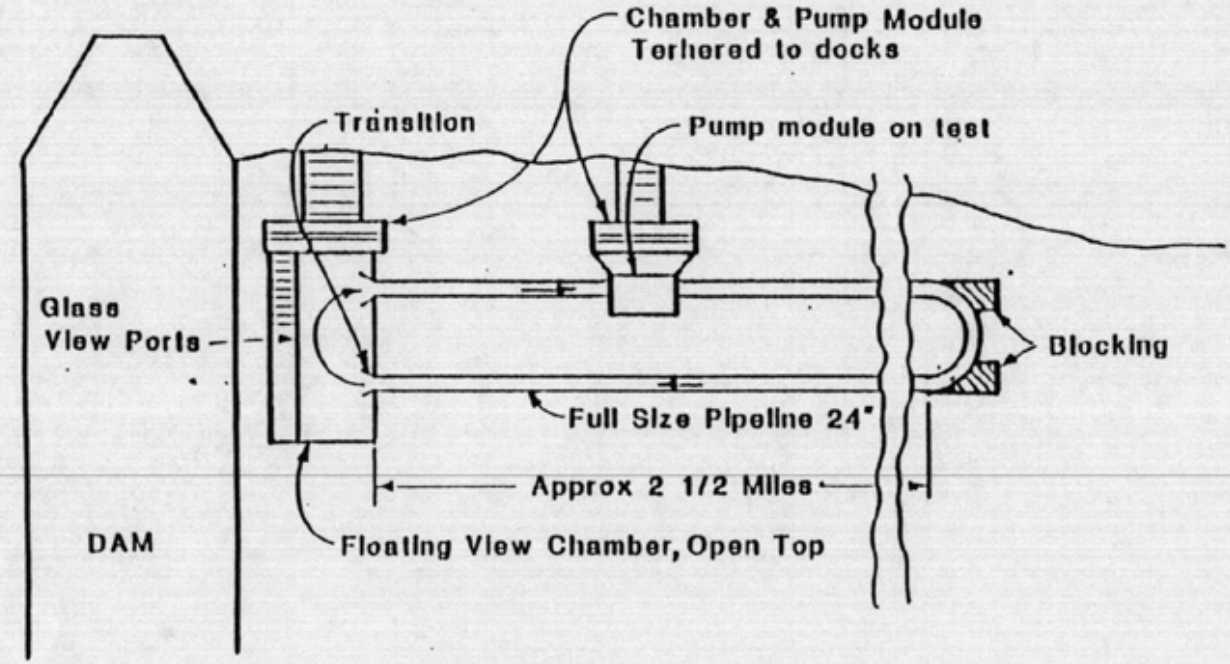
Figure 4

PIPELINE TERMINALS

NOTE:
At reservoir location where access is good & away form C.O.E. operations

Tests for :

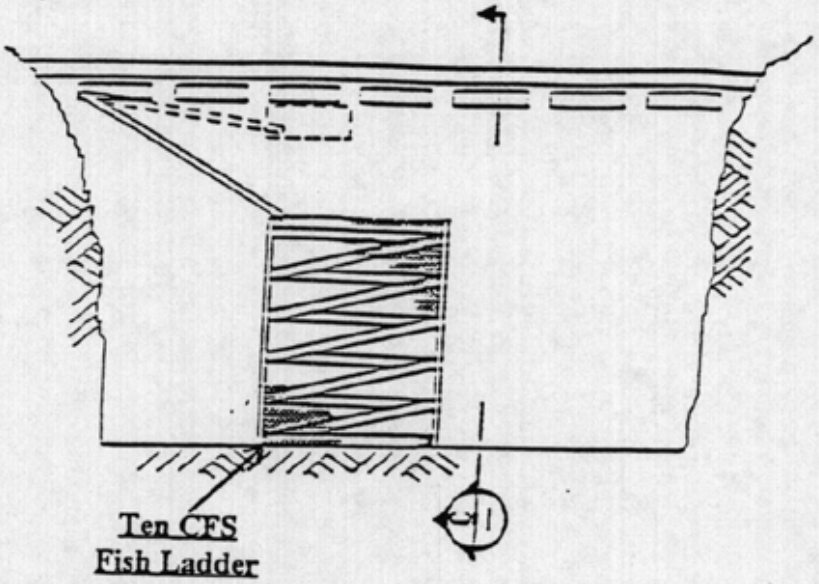
- Pump characteristics
- Overall loss determination
- Fish reaction to repeated trips up to 200 hrs.
- Injection & ejection system operations
- Over pressure testing
- Ancoring & floatation performance
- Transition tests



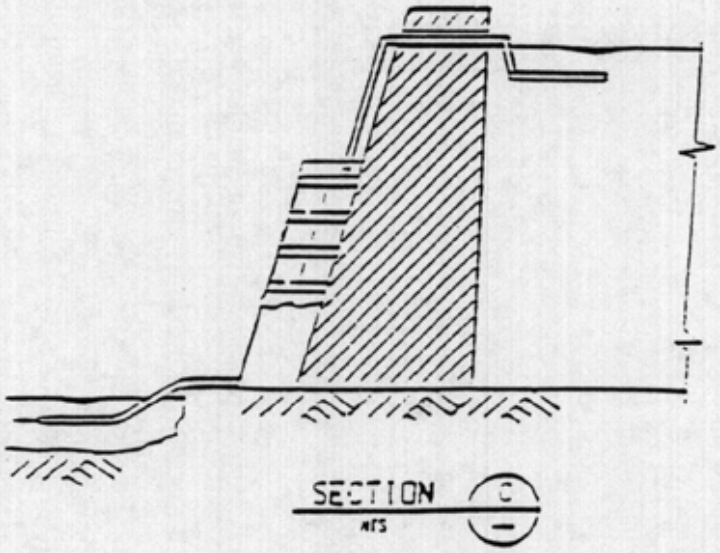
PROTOTYPE TEST LOOP

FIGURE 5

DAM



TYPICAL FLUME
NTS



SECTION C
NTS

PRELIMINARY CONCEPT
(NOT DETAILED OR DESIGNED)

FIGURE 7

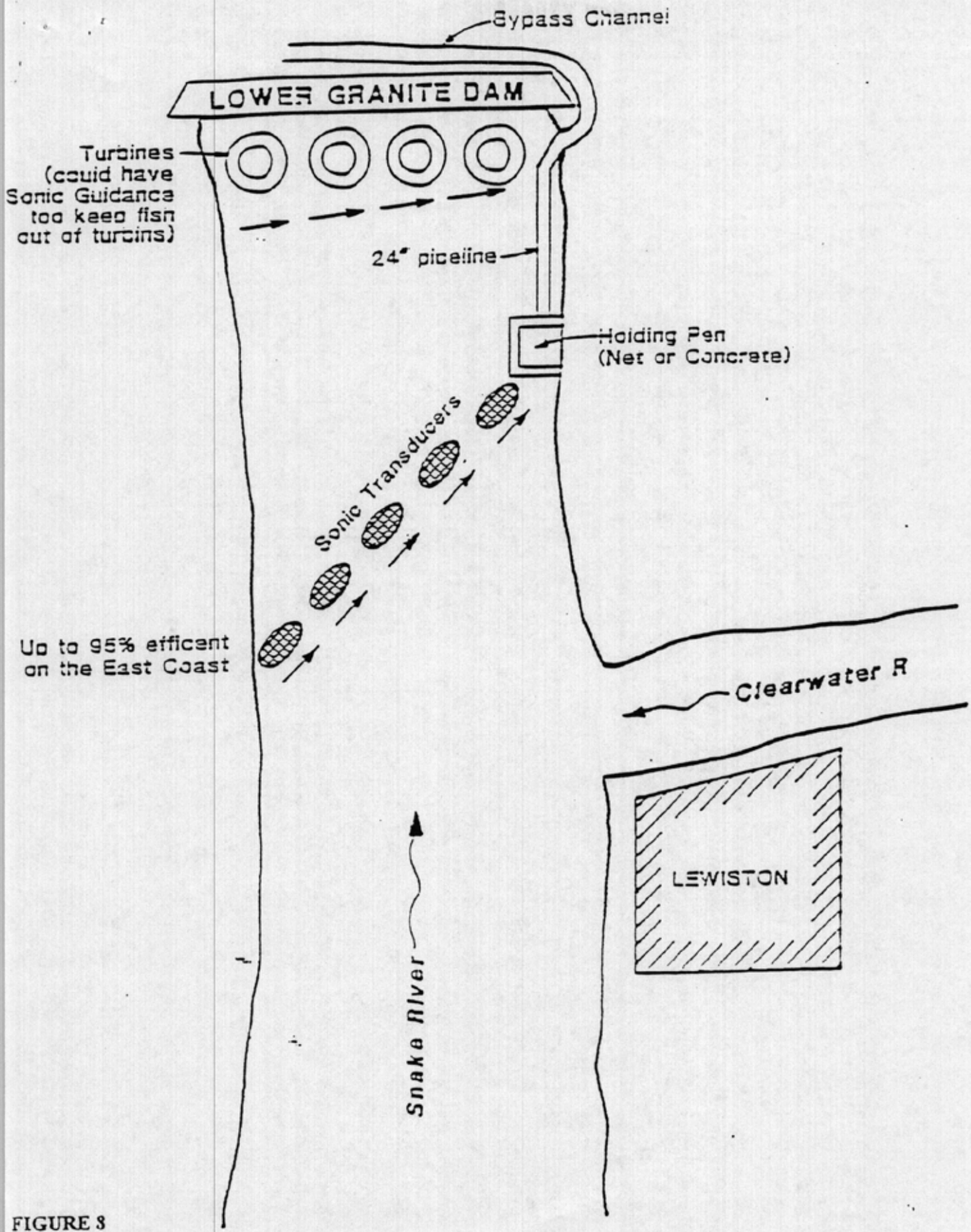

Bypass Channel
LOWER GRANITE DAM
Turbines
(could have
Sonic Guidance
too keep fish
out of turbins)
24" pipeline
Holding Pen
(Net or Concrete)
Sonic Transducers
Up to 95% efficent
on the East Coast
Clearwater R
LEWISTON
Snake River

FIGURE 3

IDAHO STATESMAN
OCTOBER 16, 1995

Extinction is no solution

Gov. Phil Batt said during the recent Republican-run water hearing that Idaho can put forth a better salmon recovery plan than the federal government. All right, Phil — what is it?

U.S. Sen. Larry Craig, who only recently withdrew support for an under-the-table ploy to cap Bonneville Power Administration spending on salmon restoration, calls himself a proponent of recovery but opposes any plan involving Idaho water. So does Sen. Dirk Kempthorne.

OK, guys, where's your plan, the one that would quit pitting farmers against fishermen, restore the resource and keep the feds in Washington?

Only U.S. Rep. Helen Chenoweth, whose rhetoric could ultimately make her the Johnnie Cochran of the Northwest, actually proposes a plan: "If the science don't sync, we must extinct."

Opposition without proposition is not leadership, and extinction as solution is the sort of madness that begs federal intervention. Bumper stickers all over this state propose a better option: "Can Helen, not salmon."

Fix the dams, guys.

Howard Shippey, Meridian

EXHIBIT 6

IDAHO FISH & GAME
600 South Walnut / Box 25
Boise, Idaho 83707-0025

Cecil D. Andrus / Governor
Jerry M. Conley / Director

September 6, 1994

Mr. John R. Woodworth
825 E State Street
Boise, ID 83712

Dear Dick:

The Idaho Fish and Game Commission has given your Boyian Pipeline concept considerable review and discussed its potential merits. As such we endorse your idea as a worthy research project and support your pursuit of funding through the project review and funding process established through the Columbia Basin Fish and Wildlife Program. As you know, this is the appropriate process for new activities within the Columbia Basin. Either the Northwest Power Planning Council or Columbia Basin Fish and Wildlife Authority staff can assist you in that regard. 8

I understand that the Fisheries Bureau has offered to utilize both the Salmon River irrigation screening project and Dworshak Dam kokanee entrainment project to help with initial sonic guidance testing aspects of your proposal. You certainly can count on our support in that regard.

Thank you, Dick, for your continued interest in the future of Idaho's salmon resource.

Sincerely,

Richard Hansen
Chairman
Idaho Fish and Game Commission

cc: Bob Saxvik, NPPC
Jack Donaldson, CSF/NA

EXHIBIT 11

University of Idaho
Aquaculture Research Institute
Moscow, Idaho 83844-2250
Phone: 208-885-5830
FAX: 208-885-5968

June 27, 1995

Mr. John R. Woodworth
825 E. State Street
Boise, ID 83712

Dear Mr. Woodworth:

I appreciated the opportunity to hear more about the Boylan Fish Pipeline to transport salmonid smolts down the Snake and Columbia rivers, when you presented the concept at the Columbia River Salmonid Rehabilitation Symposium held a few weeks ago. In the University of Idaho proposal to develop a system of conduits (open and closed) and channels for rearing and transit of chinook salmon and steelhead down the river system, I feel that the Boylan pipeline could certainly satisfy the transit needs of smolts between constructed rearing habitats, and, as you suggested for hatchery steelhead, it could serve as the entire transportation mode.

9

Although, habitat is critical for fall chinook migrants, as well as spring/summer chinook and steelhead moving downstream prior to smoltification, uninterrupted and natural transit speed during smoltification is critical. I certainly support the concept. Any testing that is necessary should be started immediately.

Sincerely,

Ernest L. Brannon
Director

Dr. William S. Platts
1603 Sunrise Rim
Boise, Idaho 83705
(208) 342-2505

Mr. Dick Woodworth
Fish Passage , Inc
825 State Street
Boise, Idaho 83712

Dear Dick:

10 At your request I reviewed the two documents relating to salmon-steelhead passage around dams. The pipe line and sonic guidance approach appears to have promise. In today's confusion on how to pass salmon and steelhead smolts through the lower Snake and Columbia Rivers, no one has the answers. We have spent about 50 years trying all kinds of alternatives and many billions of dollars to pass fish without success. For this reason I believe the pipe line and sonic guidance approach should be tested at the proto-type level. It appears in your documents that this testing could be done for just a small fraction of many passage approaches already tried. The many multi-millions of dollars spent putting logs and rocks into salmon-steelhead streams was entirely wasted. It would have been much better to put a small fraction of these monies into testing something that may work or lead into laying a base for something that may work in the future.

Best of luck with your efforts.

Sincerely,

William S. Platts

William S. Platts

Washington State University
Tri-Cities

100 Sprout Road
Richland, WA 99352
509-375-9200
FAX 509-375-5337

June 27, 1995

Mr. John R. Woodworth
825 East State
Boise, ID 83712

RE: Boylan Pipeline Concept

Dear Mr. Woodworth:

I was pleased that you were able to participate in the dam by-pass session in our recent salmon symposium. I found your proposed Boylan Pipe Concept quite intriguing.

Hydroelectric dams, despite their obvious detriments to fish passage, seem here to stay. While considerable efforts have been expended on methods to ameliorate fish passage, no method used to date, including barging and spilling, is without hazard to fish survival.

11

Your Boylan Pipeline concept is an innovative way to overcome problems associated with other methods. Your proposal to perform a demonstration test on a full scale model is both prudent technically and timely.

Please let me know if I can help in any way to advance your pipeline concept.

Sincerely,

William C. Kinsel
Associate Professor
Civil and Mechanical Engineering

WCK/ggk c:\kinsel11.doc

THOMAS L. WELSH
FISHERY CONSULTANT
419 E. HIGHLAND VIEW DR. . BOISE, IDAHO 83702 . 208-343-9752

Mr. John R. Woodworth
825 East State Street
Boise, Idaho 83712
June 15, 1995

Dear Dick:

As you know, I have studied the Boylan Pipeline Concept as a means of safely transporting juvenile salmonids through reservoir complexes during their seaward migration. My only criticism of the original plans I reviewed a couple of years ago was the lack of an efficient collection system to get the smolts into the pipeline. The remainder of the concept appeared logical and feasible.

Last week I attended the Columbia River Anadromous Salmonid Rehabilitation and Passage Symposium at Richland, Washington where you presented your latest modifications and improvements in the concept. There, you covered the sonic guidance work that has been done successfully with certain fish species on our east coast. Apparently, those working on sonic guidance need additional funding to find the proper frequency for guiding salmonids.

12 In my opinion, work on sonic guidance of salmonids should take place concurrently with testing of the Boylan Pipeline Concept. The two concepts are so dependent on one another that the pipeline cannot succeed without a benign method of concentrating smolts at the entrance to the pipeline. If we are unable to guide smolts by sound, we may need to consider other alternatives. One that comes to mind is collection (already in place) and then transporting them in the pipeline from below Granite Dam to below Bonneville Dam. That plan still has the problem of reservoir mortality in Lower Granite Reservoir. Perhaps spring drawdown of the upper reservoir (to some level where the collectors would still be operational) would speed up smolt migration and reduce reservoir mortality.

I see an unwillingness by National Marine Fisheries Service to consider any program except collection and barging of smolts. I have worked with anadromous fish for 36 year and have been told for nearly 20 years that barging will work, but it has not worked. It may have bought us a little time but it is not a long-term solution to preserving anadromous fish above the Federal Columbia River Power System dams on the lower Snake River. While there are still a few salmon left, let us begin as quickly as possible to test new concepts to save these wonderful fish.

Good luck in your endeavors and thank you for your long and thoughtful efforts to preserve our salmon and steelhead.

Best regards,

TOM

Thomas L. Welsh, Ph.D.

Dr. Phyllis H. Cahn
Long Island University, C.W. Post Campus
Department of Biology
Northern Blvd.
Brookville, NY 11548

July 11, 1995

Mr. Delmar Boylan
Box 572
Bruneau, Idaho 83604

Dear Mr. Boylan:

This letter is in support of your pipeline salmon transport concept, as we discussed in several telephone conversations during this past year. The Snake River salmon is threatened by possible changes in the Endangered Species Act, and in probable changes in acceptable water quality levels. It is very important to try to determine the possibility of using a down-river smolt pipeline system to protect these valuable young fish on their way to the sea.

13 As a research scientist who specializes in fish behavior and physiology, I envisage such a system as feasible. As long as the appropriate water velocity, water chemistry and perhaps some needed visual cues are taken into consideration in planning the device used, there is a strong probability that stress can be minimized. I have had considerable experience along these lines in the 30 years that I have been working on keeping young fish in captivity in a healthy and viable state. Therefore I can visualize the value and extensive use that can be made if such a workable system is designed, and tested, and found to be satisfactory. It will be technology that is transferable to many other anadromous species in North America and to other parts of the world.

Good luck in your efforts to obtain federal funding for this work. Call on me if I may be of assistance.

Sincerely,

Phyllis H. Cahn, Ph.D.
Professor of Biology & Environmental Studies

June 8. 1995

Mr. Delmar Boylan
Box 572
Bruneau. Idaho 83604

Dear Mr. Boylan:

This letter is in support of your pipeline salmon transport concept. I admire your tenacity and am pleased you have not given up. I encourage you to continue in your quest to obtain public and governmental support for a project to determine feasibility of such a system.

My opinion is that a down-river smolt pipeline project warrants public financing, at least to the extent of biological and engineering studies. I envision some manner of controlled pilot testing would be a component of the studies. My views are framed primarily from the biological perspect and not from the engineering side, because I can offer no expertise in the latter.

14 In the salmonid aquaculture industry we have learned that fish of moderate size - and most certainly smolt sized salmon and steelhead - can be efficiently pumped into and moved in pipelines. Since migrating smolts are biologically dependent upon water velocity, by employing controlled and prescribed water velocity, a pipeline presents an opportunity to design precisely desirable conditions for very rapid and safe migration through and around reservoirs and dam structures. Thus, potential exists for both shortening migration time (often cited as a factor in survival) and lowering stress and direct mortality associated with hydroelectric turbines, spillways, and barging of smolts.

There is obviously much to be learned; but I see no constraint on the biological side to preclude the feasiblity of pipeline transport. Since all other options currently under consideration have either enormous financial constraints or biological limitations. I believe it would be prudent to allocate sufficient federal support to determine feasibility.

I am personally interested in solutions such as the pipeline project from the perspective of a taxpayer. However. I also have an abiding interest in the preservation of our anadromous fish stocks. The pipeline concept appears to be one of few creative measures that could potentially enhance fish survival without severely impacting hydropower, river freighting, upstream water users. and perhaps other native species and habitat. Good luck and please keep me informed of your progress.

Sincerely, J. David Erickson

J. David Erickson
Certified Fisheries Biologist. American Fisheries Society
East River Road. Bunl. Idaho 83316

FISH PASSAGE, INC.
825 E. STATE
BOISE, IDAHO 83712
(208) 342-1623

May 10, 1994

Guest Opinion
The Idaho Statesman

We appreciate the article on the "Boylan Fish Pipeline" you published in the May 4th issue of the Statesman. We would like to expound on that article and inform the public of the advantages to the pipeline and to explain the testing procedures.

We are proposing that the "Boylan Fish Pipeline" could virtually solve the critical issue of downstream fish passage for salmon smolt. We have been formulating our plan for over four years and during that time have consulted with numerous parties including fish biologists, Idaho Department of Fish & Game, private fish companies, Morrison Knudson and many others. We know of no reason why the pipeline won't work and in fact we are very confident that it will work.

15

The first step in implementing our plan is to perform a test. The normal scientific approach to testing something of this nature is to perform a lab test. We have a joint proposal from Oregon State University and the University of Idaho for preliminary lab testing. Their proposal calls for $350,000 for a two year study. The problem with this approach is that it is too slow. We can not afford the luxury of a two year study when the salmon runs are declining so rapidly.

We instead favor a much faster approach. We propose a simultaneous lab test and a test of the pipeline in river with full scale equipment. The field test would include a circular 24" plastic pipeline approximately two miles in length with a pump to move the water at the targeted speed of approximately two miles per hour. The system would be set up with viewing windows and rest pens so that scientists could see how the smolt react and examine them for general conditions. The smolts could be run distances up to 500 miles, the approximate distance from Lewiston to the ocean. This

test would simulate actual conditions and would settle any unanswered questions regarding the pipeline. The cost of these tests is estimated to be $5 million.

One question that has repeatedly been asked is "how can the smolts be collected for placement into the pipeline"? We are certain this problem is solved by the use of sonic guidance. This technique has been used successfully on the East coast and the Great Lakes for several years to keep fish out of turbines and to herd them for other reasons. The above mentioned test would include a demonstration of sonic transducers to herd downstream migrating smolts into a holding pen for placement into the pipeline.

15 cont. If the test is successful the pipeline could be constructed in about twelve months. Here are some advantages to the Boylan Pipeline:

1. Does not take any water away from users such as farming.
2. Power generation is unaffected.
3. No effect on the barge industry.
4. Once the pipeline is in operation there would be no predation on smolts.
5. The cost of the pipeline would be less than 10% of most other proposals.
6. River recreation and business would not be disrupted.
7. Smolt travel could be regulated from 5 to 12 days or longer depending on what the field test shows to be the optimum speed.
8. Salmon runs could be restored to rivers that once had successful runs prior to the Hells Canyon dams i.e. Boise, Payette, Owyhee, Malheur Rivers etc.

We cannot afford not to test a system that offers all of these advantages and costs as little as 10 percent of other plans and has no adverse consequences to other users of the river. There is little to lose and much to be gained but time is running out.

John R. Woodworth

John R. Woodworth

FISH PASSAGE, INC.
825 E. STATE
BOISE, IDAHO 83712
(208) 342-1623

May 10, 1994

Guest Opinion
The Idaho Statesman

We appreciate the article on the "Boylan Fish Pipeline" you published in the May 4th issue of the Statesman. We would like to expound on that article and inform the public of the advantages to the pipeline and to explain the testing procedures.

We are proposing that the "Boylan Fish Pipeline" could virtually solve the critical issue of downstream fish passage for salmon smolt. We have been formulating our plan for over four years and during that time have consulted with numerous parties including fish biologists, Idaho Department of Fish & Game, private fish companies, Morrison Knudson and many others. We know of no reason why the pipeline won't work and in fact we are very confident that it will work.

The first step in implementing our plan is to perform a test. The normal scientific approach to testing something of this nature is to perform a lab test. We have a joint proposal from Oregon State University and the University of Idaho for preliminary lab testing. Their proposal calls for $350,000 for a two year study. The problem with this approach is that it is too slow. We can not afford the luxury of a two year study when the salmon runs are declining so rapidly.

We instead favor a much faster approach. We propose a simultaneous lab test and a test of the pipeline in river with full scale equipment. The field test would include a circular 24" plastic pipeline approximately two miles in length with a pump to move the water at the targeted speed of approximately two miles per hour. The system would be set up with viewing windows and rest pens so that scientists could see how the smolt react and examine them for general conditions. The smolts could be run distances up to 500 miles, the approximate distance from Lewiston to the ocean. This

test would simulate actual conditions and would settle any unanswered questions regarding the pipeline. The cost of these tests is estimated to be $5 million.

One question that has repeatedly been asked is "how can the smolts be collected for placement into the pipeline"? We are certain this problem is solved by the use of sonic guidance. This technique has been used successfully on the East coast and the Great Lakes for several years to keep fish out of turbines and to herd them for other reasons. The above mentioned test would include a demonstration of sonic transducers to herd downstream migrating smolts into a holding pen for placement into the pipeline.

If the test is successful the pipeline could be constructed in about twelve months. Here are some advantages to the Boylan Pipeline:

1. Does not take any water away from users such as farming.
2. Power generation is unaffected.
3. No effect on the barge industry.
4. Once the pipeline is in operation there would be no predation on smolts.
5. The cost of the pipeline would be less than 10% of most other proposals.
6. River recreation and business would not be disrupted.
7. Smolt travel could be regulated from 5 to 12 days or longer depending on what the field test shows to be the optimum speed.
8. Salmon runs could be restored to rivers that once had successful runs prior to the Hells Canyon dams i.e. Boise, Payette, Owyhee, Malheur Rivers etc.

We cannot afford not to test a system that offers all of these advantages and costs as little as 10 percent of other plans and has no adverse consequences to other users of the river. There is little to lose and much to be gained but time is running out.

John R. Woodworth

John R. Woodworth

IDAHO FISH & GAME
600 South Walnut
P.O. Box 25
Boise, Idaho 83707-0025

January 27, 2000

Dirk Kempthorne / Governor
Jerry Mallet / Interim Director

Mr. John Woodworth
825 E. State Street
Boise, ID 83712

Dear Mr. Woodworth:

The Idaho Fish and Game Commission (Commission) has previously given your Boylan Pipeline concept considerable review and discussed its potential merits with fisheries staff. While the Commission has developed a policy on Salmon Recovery, it will continue to provide its cooperation on your current research proposal, which is before the Northwest Power Planning Council for funding.

16

The Fisheries Bureau has offered to help in you with utilization of the Salmon River irrigation-screening project, C.J. Strike Reservoir, or at one of the state operated hatcheries as appropriate sites for this research. Fisheries will also provide the appropriate necessary salmonids for a viable test, once you secure a suitable site and have approval from Idaho Power Company, or other entities. Your pursuit of funding through Columbia Basin Fish and Wildlife Authority planning processes is the appropriate review of new research activities

Thank you for your continued interest in salmon recovery.

Sincerely,

John Burns
Chairman
Idaho Fish and Game Commission

Bonneville Power Administration
Fish and Wildlife Program FY2000 Proposal Form

First, read the instructions document

Please carefully read the instructions document that was sent with this proposal template. All field- and content-related help is in that document, plus instructions on which version to use, and how and when to return the completed proposal to BPA. If you are missing the instructions, please visit www.efw.bpa.gov/Environment/EW/Proposals/AIWP/2000/ or call Connie Little at 503-230-4296.

Notes for Word 97 version

- Some help text is included as "hidden" comments on the data form, which are displayed by resting the mouse cursor over any yellow text (usually the section headings or field names).
- You can now ***insert*** rows in tables, instead of just adding them to the end. Press Alt-R in any table and you'll be asked whether to insert a row at the current position or add one to the end of the table. The two budget tables only allow rows to be added at the end.

Steps to complete the form

1. First, read the instructions document.
2. Second, save this form as something other than BLANK97.DOC. Use the BPA project number if available (i.e. 8906200.DOC), or for new projects, use a descriptive filename such as: NMFSGAS.DOC.
3. Your cursor is already in the first field, Title of Project, so start typing.
   NOTE: When you exit the Project Title or Project Number fields, your screen may display a "Header" box briefly. The form is updating its footer, and will continue normally.
4. Fill in all fields (gray boxes) pressing Tab to advance from one field to the next. Then fill in narrative input areas, pressing down arrow to advance.
5. Print the completed document.
6. Save the document to diskette and mail both paper and diskette to:

   Bonneville Power Administration - EW
   ATTN: Connie Little
   FY2000 Proposals
   P.O. Box 3621
   Portland OR 97208-3621

PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Anadromous Salmonid Transit System

BPA project number:
Contract renewal date (mm/yyyy): ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Morrison-Knudsen Corp

Business acronym (if appropriate) MK

Proposal contact person or principal investigator:

Name	Gary West
Mailing Address	One Morrison-Knudsen Plaza, P.O. Box 73
City, ST Zip	Boise, ID 83729
Phone	(208) 386-5695
Fax	(208) 386-6669
Email address	gary_west@mk.com

17

NPPC Program Measure Number(s) which this project addresses
Section 5 Juvenile Salmon Migration, Specifically 5.0B and 5.0E

FWS/NMFS Biological Opinion Number(s) which this project addresses
Not Applicable

Other planning document references
Not Applicable

Short description
MK and co-investigators are proposing a conceptual plan to bypass emigrating salmonids around Snake River dams which includes EPC of the bypass system of conduits and channels, tests on fingerlings/smolt response, and suggested routes for the system.

Target species
Chinook and sockeye salmon, and steelhead trout. Testing will be performed using anadromous smolts provided by the Idaho Fish & Game Department

Section 2. Sorting and evaluation

Subbasin
Snake River

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☒ Anadromous fish ☐ Resident fish ☐ Wildlife	☐ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☐ Watershed councils/model watersheds ☐ Information dissemination ☐ Operation & maintenance ☐ New construction ☒ Research & monitoring ☐ Implementation & management ☐ Wildlife habitat acquisitions

17 cont.

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description
(umbrella)	None

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
0		

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
	None	

17 cont.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Developing Conceptual Plan & Economic Assessment	a	Thorough review of literature related to this project.
		b	Develop cost analysis of the project.
		c	Prepare reconnaissance report to the NPPC.
2	Assessing Biological Requirements	a	Assess migratory and residence habitat needs of target species.
		b	Assess migratory behavioral needs.
3	Engineering Design of Migratory Conduit	a	Collect engineering data.
		b	Develop conduit design, drawings and specifications.
		c	Develop conduit accessory support systems.
		d	Prepare design specification for an engineered stream.
4	Testing Biological Performance of Migrants	a	Procure and construct working model of conduit and engineered stream.
		b	Performance testing of fingerlings and smolts.
5	Documenting Test Methods and Results	a	Report Preparation & Presentation

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1999	2/2000			9.19%
2	11/1999	3/2000			10.08%
3	12/1999	2/2000			19.43%
4	3/2000	5/2000			33.75%
5	6/2000	9/2000			27.55%
				Total	100.00%

Schedule constraints

Funding is primary constraint

Completion date

The MK & Co-PIs Team estimates that FY 2000 is the last year requiring funding for the Phase I scope of this work.

Section 5. Budget

FY99 project budget (BPA obligated):

FY2000 budget by line item

17 cont.

Item	Note	% of total	FY2000
Personnel	5946 man-hours @ $36. per hour	%31	213,400
Fringe benefits	35% of Personnel Cost	%11	74,690
Supplies, materials, non-expendable property	Working Model @ Hagerman	%19	134,633
Operations & maintenance	included above	%0	
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		%0	
NEPA costs		%0	
Construction-related support	included above	%0	
PIT tags	# of tags: 1000	%0	1,000
Travel	5% of Personnel Cost	%1	10,000
Indirect costs	65% of Personnel Cost	%20	138,710
Subcontractor	Biological Consultants	%13	87,913
Other	CADD & ODC	%5	38,177
	TOTAL BPA FY2000 BUDGET REQUEST		$698,523

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
Idaho Fish & Game	Hagerman Facility & Service	%3	27,500
Fish Passage, Inc	Consulting Service	%2	20,000
Dr. Brannon	Consulting Service	%4	30,000
Jon Mason	Consulting Service	%2	15,000
MK Company	Engr & Mgmt Service	%6	50,000
	Total project cost (including BPA portion)		$841,023

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$0	$0	$0	$0

Section 6. References

Watershed?	Reference
☐	Brannon, E.L. 1995. Chinook Salmon and Steelhead Smolt Migration. SOAC report to Bureau of Reclamation, Yakima, WA. pp 23.
☐	Daüble, D.D. 1998. Habitat Requirements of Columbia River Salmonids: What's Missing? pages 109-113; E. Brannon and W. Kinsel editors. Proceedings of Columbia River Anadromous Rehabilitation and Passage Symposium.
☐	US Army Corps of Engineers Reconnaissance Report. 1994. Columbia River Salmon Mitigation Analysis System Configuration Study, Phase I. Seattle District. pp 68.
☐	

PART II - NARRATIVE

Section 7. Abstract

17 cont.

Recovery of Snake River anadromous salmon and steelhead runs is a major objective of NMFS's Recovery Plan and the Northwest Power Planning Council's regional multispecies framework. Successful recovery of these important runs must include adequate passage of downstream migrating smolts. Alternatives to facilitate emigration through the lower Snake River include barge and truck transportation of smolts, altering the flow regime to increase reservoir velocities, partial drawdown of reservoirs to reduce travel time, and breaching of the dams. We believe the fifth alternative, submitted previously in various forms, regarding a by-pass conduit and/or channel around the dams needs to be given serious reconsideration. Morrison-Knudsen and the co-investigators (MK & Co-PIs) are proposing a study related to a by-pass concept as it applies to the four lower Snake River dams. The MK & Co-PIs proposal has two primary goals. One is to develop the conceptual plan for a smolt transit system, the other is to plan the route on which the by-pass system would be deployed. The design of the by-pass system of conduits and channel and basic tests on fingerlings and smolts response to transit conditions in the by-pass system, are included as the specific proposal.

Section 8. Project description

a. Technical and/or scientific background

Anadromous salmonid species in the Columbia River system have not responded well to development that has altered the migratory corridor of the Columbia and Snake river systems. Delays, predation, problems associated with nitrogen supersaturation and

difficulties while passing the hydroelectric dams and reservoirs, have caused major losses of migrating salmonids that have reduced the production of both wild and hatchery fish in the system. Present smolt transportation involving trucking and barging of smolts has not demonstrated substantial improvements in survival and creates other problems, such as homing impairment, and a commitment to a perpetual transportation program as long as the hydro system lasts. Flushing flows or partial drawdown of the reservoirs offers only partial solutions with no corroborating evidence to substantiate the expected benefit, and will result in the reduction of river uses for power, transportation and irrigation.

17 cont.

The most recent alternative being considered to recover salmon and steelhead populations in the river system is the breaching of dams. The particular dams considered at the present time include the four on the lower Snake River. Dam breaching, of course, results in the permanent reduction of those facilities from the river. Such a measure as dam breaching concludes that societal benefits in the Pacific Northwest resulting from the economic development of the river are to be subjugated for the societal benefits of the recovered salmonid runs expected to occur thereafter.

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We propose another alternative, in which the present river operation will not be altered, but that smolt migration through the system will be both enhanced and replicate historical migratory conditions in rate and timing through the system. It is best for all interests associated with the Columbia River system to seek a "common ground" and resolve their differences or the Columbia Basin will lose both its salmon resources and economic opportunity for the future. The present status of the salmon and steelhead runs in the Columbia underscores the need to give a priority to the biological health of the salmonid resources. There is a "common ground" that will allow the restoration of the salmon and steelhead in the Columbia River system, and still permit the economic benefits that such a river can provide for the Pacific Northwest. We propose an alternative that will provide benefits to the migratory anadromous salmonids without sacrificing the economic status of the river.

In the broader picture, the concept of an emigrant transit system is a combination of migratory habitat and conduit transportation propositions that have been made previously, and were reported in the 1995 Columbia River Anadromous Salmonid Rehabilitation and Passage Symposium held in 1995 at Richland, WA. The anadromous migrant transit system proposed is a combination of engineered migratory habitat and a closed conduit that will allow the transportation of migratory salmonids in a system conducive to both the slower movement of migrating fingerling fall chinook as well as the rapid transit of spring chinook and steelhead smolts. It is a system that provides secure volitionary migration adjacent to or inside the present corridor, without any reduction of river development or potential. The proposed system is meant to address the migratory needs of those fish in the lower Snake River. The by-pass stream and conduit system will transport smolts and fingerlings from Lower Granite past Ice Harbor, at a speed comparable to their historic transport rate, away from the hazards and problems associated with the present migratory corridor.

The concept of migratory habitat underscores the fact that migration also must occur in the appropriate environment. These species, and the stocks making up their Columbia River population structure, have evolved under the historic natural flow regime of the river system. The altered flow dynamics, new abundance of competitor/predator species, excessive and unnatural levels of dissolved nitrogen, unnatural physical barriers, and the extreme temporal distortion in marine entry are challenges that are difficult or even impossible for salmonids to adapt. It is imperative to recognize that salmonid migration can not effectively occur independent of the migratory pathway, residence provisions, and transit time, to include the slow fingerling-type downstream movement and the rapid transit of yearling smolts.

18,19 cont.

We are proposing only the conceptual plan and details of the salmonid emigration transit system, which we identify as Phase I of the broader plan. The proposed phase I plan of action will include a preliminary economic assessment of the rearing and migratory habitat channel, development of the biological and engineering design requirements for the system, and basic comparative evaluation of the conduit/channel versus river transport. If these analyses and design specifications warrant further development, the next phases would include completed design and construction of the trial system between Lower Granite Dam and Little Goose Dam (Phase II). If that proves feasible, we would then propose completion of the system to Ice Harbor, with the appropriate design and construction completed as part of the final (Phase III) plan of action. However, these phases are stand alone projects and would be justified in separate proposals. The present proposal in only the Phase I study.

b. Rationale and significance to Regional Programs

The proposal describes the conceptual plan for an independent salmonid emigrant transit system from Lower Granite Pool to below Ice Harbor Dam. The assessment includes initial biological and engineering evaluations that would be required for such a system, if there is ultimate acceptance and installation of the transit system.

With the development of the Snake River for economic benefits, habitat and the migratory corridor were drastically altered, with the result that anadromous salmonid species in the system were seriously depleted. Moreover, the prospect for recovery does not appear to be an option unless the migratory passage problem is addressed. We believe barging and trucking of smolts have not demonstrated adequate promise to justify dependence on those systems. Flushing flows and partial drawdown proposals have limited demonstrable evidence that suggests such changes will provide better survival, and they reduce the present use of the river for power production, transportation, and recreation during those periods of partial drawdown. Finally, dam breaching is being offered as another option, but at considerable cost to the economic status of the present system.

The proposed bypass channel and conduit system would provide marked advantages over the present conditions, and prospect of conditions in the long-term future. These advantages are:

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- The transit system would promote the historic balance of anadromous salmonids that existed in the lower Snake.
- Natural migratory behavior and volitional rate of transit would be provided that is consistent with the historic patterns of migration in the system.
- The mortality associated with spillway and turbine passage would be reduced.
- Major losses from predation between dams would be substantially reduced.
- Problems associated with nitrogen supersaturation would be avoided.
- Storage for flushing flows and partial reservoir drawdown would be eliminated.
- River operations for shipping, irrigation, and hydropower would not be impacted.

We believe the system that approaches the problem from a biologically sound perspective, and addresses the economic concerns with minimum impact is the best "common ground" resolution to the present crisis in the Columbia River Basin.

c. Relationships to other projects

The current options of barging and trucking of smolts have not demonstrated adequate promise to justify dependence of those systems. Flushing flows and partial drawdown proposals have limited demonstrable evidence that suggests such changes will provide better survival, and they reduce the present use of the river as a functional working river during those periods of flow alteration. Finally, dam breaching is being offered as another option, but at considerable cost to the economic status of the present system.

It is obvious that the options being considered have serious consequences to the present system without prospect for total resolution of the problem presently facing anadromous Snake River salmonids. Reduction of salmonid habitat in the Columbia and disruption of the natural migratory pathway has encouraged escalation of competing species through altered river dynamics with major cost to salmonid resources. We believe a solution rests with the transit system we are proposing.

d. Project history (for ongoing projects)

Not Applicable

e. Proposal objectives

22,23

The Phase I Conceptual Design and Assessment, to be completed in twelve (12) months, will include the following five (5) Objectives:

(1) **Developing the Conceptual Plan and Economic Assessment**: The Team will collect and organize pertinent data for the preliminary development of a

conceptual plan of the proposed emigrant transit system in Little Goose reservoir, based on the U.S. Army Corps of Engineers reconnaissance completed in 1994 (Columbia River Salmon Mitigation Analysis System Configuration Study). The performance and progress of this work will be reviewed by MK & Co-PIs.

(2) **Assessing Biological Requirements**: The Team will conduct biological and engineering research in preparation for the design, construction, and operation of the working model test facility. The testing program criteria and requirements will be defined by the fishery biologists which will provide the basis for the design of the working model test facility.

(3) **Engineering Design of Migratory Conduit**: The Team will prepare equipment and material procurement specifications and construction drawings. The design team will consult on a regular basis with fishery biologists and representatives of the Idaho Fish and Game Department. A Test Facility Work Plan will be prepared which will describe the design basis for the facility, construction requirements, and test operations/maintenance requirements.

22,23 cont.

(4) **Testing Biological Performance of Migrants**: The team will complete the procurement and construction of the working model test facility. The work includes mobilization of the construction team at the Hagerman Fish Hatchery site, assembly of the test facility, operations support during testing, and dismantling the installation at the conclusion of testing.

(5) **Documenting Test Methods and Results**: The Team will prepare a technical report containing a record of the project.

Phase II (pending successful Phase I) would be prototype trials using conduit and engineered channel between Lower Granite and Little Goose if Phase I justifies continuation. This section will provide comparisons of survival, imprinting, passage time, design and operation considerations. Basic trials with the prototype would include survival evaluation of smolt performance through the channel compared with in-river migratory success.

Phase III (pending successful Phase II) would be the integration of the full length habitat channel design, plan for construction, and construction of the migrant transit system from Little Goose to Ice Harbor Dam.

f. Methods

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The approach to satisfy the five objectives will include specific tasks associated with each objective, and the methods used to accomplish work associated with each listed task.

In Objective 1, the development of a conceptual plan and economic assessment, there are three tasks.

Task a. Make a thorough review of relevant experiences associated with the project. Methods will include a review of the literature on fish passage, guidance, and diversions around dams, as it applies to the transit system. (References – The fisheries Engineering Research Program reports of the US Army Corps of Engineers beginning in 1956 and other relevant research data to the present).

Task b. Develop basic cost analysis of the project. Methods will assess materials, earthen or lined open channels, grade, configuration, structures, excavations, reinforcements, pressure levels, pumps, aeration, systems, temperature controls, security, and operational requirements (Reference – US Army Corps of Engineers Reconnaissance report in 1994 – Columbia River Salmon Mitigation Analysis System Configuration Study, Phase I).

Task c. Prepare a reconnaissance report to the NPPC. The method will be based on results of Objective 1 studies, and the US Army Corps of Engineers Reconnaissance report in 1994 (Reference – Columbia River Salmon Mitigation Analysis System Configuration Study, Phase I).

In Objective 2, assessing the biological requirements of emigrating salmonids, there are two tasks.

24,25 cont.

Task a. Assess migratory and residence habitat needs of target species. Method will include criteria based on habitat definitions around depth, velocity, cover, temperature preferences, and feeding requirements (References – Bjornn and Reiser 1991, Chapman and Bjornn 1969, Chapman et al. 1994, Dauble 1998, Don Chapman Consultants Inc. 1989).

Task b. Assess migratory behavioral needs. Methods will include criteria associated with imprinting, temperature preferences, and migratory stimuli (Reference – Brannon, 1995, Brannon and Quinn 1990).

In objective 3, the engineering design of migratory conduit specifications and materials, there are four tasks.

Task a. Conduct preliminary engineering research to obtain information for use in the design of the test facility, including pump and pipe materials types, sizes and pricing options; existing power and water supply locations; access routes and work areas. A preliminary site plan will be prepared as a working document for use by the project team during the research and planning stage of the project.

Task b. Develop conduit design, drawings and specifications. Methods will include development of cross-sectional area, materials, fixtures, structures, and linkages associated with the enclosed conduit element.

Task c. Develop conduit accessory support systems. Methods will include the anchoring system design, flow/velocity control measures and pump, water

exchange mechanisms, temperature control devices, security, and monitoring systems.

Task d. Prepare design specifications of an engineered stream. Methods will include determination of cross-sectional area, slope and configuration, habitat materials based on Objective 2 results, control structures and enumeration capability.

In Objective 4, on testing biological performance of migrants in a model closed conduit and open channel, there are two tasks.

24,25 cont.

Task a. Procurement and construction of a conduit test model and engineered stream model. Methods will include the development of the model system for testing on the IDF&G Hagerman hatchery site. Specifications for the model will be based on Objective 3 studies, and will be constructed in an oval loop to simulate a continuous conduit. An engineered stream section will be designed separate from, but complementary to the conduit for simulating the habitat parameter specifications under Objective 3.

Task b. Performance testing of fingerlings and smolts. Methods will include assessment of migrant behavior in the conduit to include, rheotactic performance, speed of movement, readiness to feed, and physical well being after traversing various lengths of migratory reaches. Physical well being will involve distribution behavior after entering the engineered stream, search for cover, readiness to feed, readiness to continue migratory behavior, and mortality.

In Objective 5, the test results, conclusions and recommendations will be published.

Task a. This task includes documentation of all test methods and findings resulting from the tests performed in the fish transit conduit facility. A technical report will be prepared which will contain a record of the project and, assuming the outcome is positive, will include a proposal for the preparation of a Phase II Development Plan. This plan will consist of a conceptual design for the prototype fish transit system proposed for installation in Little Goose Reservoir, together with a proposed scope of work, a development schedule and budget for the design of this facility.

g. Facilities and equipment

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There are several requirements that such a fish transit system must have, but in essence the features must be conducive to smolt migration. Water used in the conduit and engineered channel would have to represent the composition of sources in the adjacent river to assure that imprinting for the adult return migration in the mainstream isn't disrupted.

The assessment of the concept in a model system will be undertaken at the IDF&G Hagerman Hatchery where sufficient space, water, and equipment are available for study. IDF&G personnel, graduate students, and the Co-PIs will participate in the testing protocol, and will be supported by the University of Idaho Fish Culture Experiment Station at Hagerman.

26,27 cont.

The working model will be constructed at the Hagerman site by MK engineers. The model will be constructed in a manner to allow simulation of the pressures, velocities, conduit size, transit times, and engineered habitat to assess the efficiency of the system and its effect on fish condition.

Research stocks of migrants will be provided to the study by IDF&G. Test fish will include spring chinook or steelhead as the species that rapidly migrates through the Snake River corridor, and fall chinook as the species that undertakes a slower feeding migration downstream.

h. Budget

(Replace this text with your response in paragraph form)

Section 9. Key personnel

Gary W. West, Principal Investigator, is a Project Manager for Morrison Knudsen Corporation. Mr. West will be assigned full time during the execution of this project, and his duties include coordinating design criteria of individual components with overall working model concept.

28

Ernest Brannon, PhD, Fishery Consultant, is a Professor of Fisheries Resources and Animal Science, and the Director of the Aquaculture Research Institute at the University of Idaho, Moscow. Dr. Brannon will design experiments to measure stress in smolts and fingerlings, and supervise a graduate student assigned to carry out the experiments.

Terry Holubetz, Fishery Consultant, is an independent consultant who worked in production and migration studies of juvenile salmonids with Idaho Department of Fish & Game. Mr. Holubetz will work with MK to verify the design of the monitoring and testing equipment.

William Kinsel, PhD, Fluids Mechanics Consultant, is a Professor of Mechanical Engineering at Washington State University, Richland. Dr. Kinsel will verify the hydraulic design of the combined open channel/closed conduit working model.

John Richard "Dick" Woodworth, Project Consultant, is a principal in Fish Passage, Inc. Mr. Woodworth will be available to provide historical perspective to the project.

Jon Mason, P.E., Process Consultant, is a Professor of Construction Management at Boise State University, Boise. Mr. Mason will develop scale-up factors for the working model.

Jim Winner, Project Biologist, is a Project Biologist for Morrison Knudsen Corporation. Mr. Winner will assist with biological assessments, design criteria, and operation of the working model.

28 cont.

Section 10. Information/technology transfer

A report on the conceptual foundation of the transit system and results of the tests will be submitted to all fisheries management entities in the Columbia River Basin. Extension information will be developed on the project and entered on the Internet. Also, demonstrations of the working model at Hagerman will be scheduled for interested parties and the NPPC to observe the system dynamics with migrating fish.

Congratulations!