PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Passage Improvement Evaluation

BPA project number: 8506200
Contract renewal date (mm/yyyy): 10/1999 ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Pacific Northwest National Laboratory

Business acronym (if appropriate) PNNL

Proposal contact person or principal investigator:

Name	Duane A. Neitzel
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NPPC Program Measure Number(s) which this project addresses
Council Measure 7.11 (NPPC 1994) which follows from previous Council Measures [Section 800 (NPPC 1987) and Section 900 (NPPC 1984)

FWS/NMFS Biological Opinion Number(s) which this project addresses
None

Other planning document references
The following people are the technical representatives at the Federal and State Agencies with whom our project planning takes place. They can be reached at the following offices and extensions:
Walt Larrick, U.S. Bureau of Reclamation, 509/575-5848 ex209;
Steve Rainey, National Marine Fisheries Service 503/230-5418;
Bryon Nordlund, National Marine Fisheries Service 503/230-5418;
John Easterbrook, Washington State Department of Fish and Wildlife 509/575-2733
Chuck Keller. U.S. Bureau of Reclamation, 208/756-6850

Short description
Evaluate the biologic and hydrologic effectiveness of juvenile fish passage facilities constructed to correct structural problems at irrigation diversion dams, canals and ditches that interfere with the passage of anadromous fish

Target species
Juvenenile salmonids

Section 2. Sorting and evaluation

Subbasin
Yakima subbasin in the Lower Mid-Columbia subregion

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

Section 3. Relationships to other Bonneville projects

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

Project #	Project title/description

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1998	Completed on-site evaluations of Phase II screens in the Yakima Basin (report in progress)	Yes
1998	Completed laboratory studies testing salmonid response to infrasound and strobe lights (report in progress)	Yes
1997	Completed on-site evaluations of Phase II screens in the Yakima Basin (Blanton, Neitzel, and Abernethy, in press).	Yes
1997	Completed laboratory studies testing salmonid response to infrasound (Mueller RP, DA Neitzel, WV Mavros and TJ Carlson. 1998. Evaluation of low and high frequency sound for enhancing fish screening facilities to protect outmigrating salmonids	Yes

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	On-Site Evaluations Phase II Screens	a	Provide fisheries and hydrological evaluations of new screens as they are installed. The criteria used to measure this goal are the screen criteria developed by the National Marine Fisheries Service.
		b	Provide on site monitoring of operating screens. Monitoring criteria are: operating as designed, seals installed and maintained to prevent fish from passing through screens, and approach and sweep flows to NMFS criteria.
2		a	Support cooperating agencies to evaluate new or revised screen designs as they are developed and address site-specific concerns at Phase I or Phase II sites. Provide a laboratory facility for testing proposed changes to facility

			components.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1999	12/2000		Project completion report	100.00%
				Total	100.00%

Schedule constraints
The evaluation schedule is constrained by the irrigation season and spring outmigration.

Completion date
12/2003

Section 5. Budget

FY99 project budget (BPA obligated): $100,000

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	based on FY1999 estimate	%29	29,300
Fringe benefits	based on FY1999 estimate	%19	18,700
Supplies, materials, non-expendable property	based on FY1999 estimate	%22	21,600
Operations & maintenance		%0	
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		%0	
NEPA costs		%0	
Construction-related support		%0	
PIT tags	# of tags:	%0	
Travel	based on FY1999 estimate	%6	5,500
Indirect costs	based on FY1999 estimate	%25	24,900
Subcontractor		%0	
Other		%0	

TOTAL BPA FY2000 BUDGET REQUEST	$100,000

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
		%0	
		%0	
		%0	
		%0	
Total project cost (including BPA portion)			$100,000

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$100,000	$100,000	$100,000	

Section 6. References

Watershed?	Reference
☐	Abernethy, C.S., D.A. Neitzel, and W.V. Mavros. 1996. Movement and Injury Rates for Three Life Stages of Spring Chinook Salmon Oncorhychus tshawytscha: A Comparison of Submerged Orifices and an Overflow Weir for Fish Bypass in a Modular Rotary Drum Fis
☐	Abernethy, C. S., D. A. Neitzel, and E. W. Lusty. 1990. Velocity Measurements at Three Fish Screening Facilities in the Yakima River Basin. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richland, Washington.
☐	Abernethy, C. S., D. A. Neitzel, and E. W. Lusty. 1989. Velocity Measurements at Six Fish Screening Facilities in the Yakima River Basin. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richland, Washington.
☐	Blanton, SL, D.A. Neitzel, and C.S. Abernethy. 1998. Washington Phase II Fish Diversion Screen Evaluations in the Yakima River Basin, 1997. Prepared by the Pacific Northwest National Laboratory, Richland, Washington, for the Division of Fish and Wildli
☐	Mueller, R.P.,D.A. Neitzel, T.J. Carlson, and W.V. Mavros. 1998. Evaluation of Infrasound for Enhancing the Capacity of Fish Screening Facilities to Protect Outmigrating Salmonids. Prepared for the Bonneville Power Administration by the Pacific Nor
☐	Mueller, R.P., C.S. Abernethy, and D.A. Neitzel. 1995. A Fisheries Evaluation of the Dryden Fish Screening Facility. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richland, Washington.

☐	Neitzel, D.A., S.L. Blanton, C.S. Abernethy, and D.S. Daly. 1996. Movement of Fall Chinook Salmon Fry Oncorhynchus tshawytscha: A Comparison of Approach Angles for Fish Bypass in a Modular Rotary Drum Fish Screen. Prepared by the Pacific Northwest Nat
☐	Neitzel, D. A., C. S. Abernethy, and E. W. Lusty. 1990a. A Fisheries Evaluation of the Wapato, Sunnyside, and Toppenish Creek Canal Fish Screening Facilities, Spring 1988. Prepared for the Bonneville Power Administration by the Pacific Northwest Labora
☐	Neitzel, D. A., C. S. Abernethy, and E. W. Lusty. 1990b. A Fisheries Evaluation of the Westside Ditch and Wapato Canal Fish Screening Facilities, Spring 1989. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richlan
☐	Neitzel, D. A., C. S. Abernethy, and G. A. Martenson. 1990c. A Fisheries Evaluation of the Westside Ditch and Town Canal Fish Screening Facilities, Spring 1990. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richl
☐	Neitzel, D. A., C. S. Abernethy, E. W. Lusty, and S. J. Wampler. 1988. A Fisheries Evaluation of the Richland and Wapato Canal Fish Screening Facility, Spring 1987. Prepared for the Bonneville Power Administration by the Pacific Northwest Laborato
☐	Neitzel, D. A., C. S. Abernethy, and E. W. Lusty. 1986. A Fisheries Evaluation of the Richland and Toppenish/Satus Canal Fish Screening Facility, Spring 1986. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richlan
☐	Neitzel, D. A., C. S. Abernethy, E. W. Lusty, and L. A. Prohammer. 1985. A Fisheries Evaluation of the Sunnyside Canal Fish Screening Facility, Spring 1985. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richland,
☐	Northwest Power Planning Council (NPPC). 1984. Columbia River Basin Fish and Wildlife Program. Northwest Power Planning Council, Portland, Oregon.
☐	Northwest Power Planning Council (NPPC). 1987. Columbia River Basin Fish and Wildlife Program. Northwest Power Planning Council, Portland, Oregon.
☐	Northwest Power Planning Council (NPPC). 1994. Columbia River Basin Fish and Wildlife Program. Northwest Power Planning Council, Portland, Oregon.

PART II - NARRATIVE

Section 7. Abstract

The Council's Program includes actions to correct structural problems at irrigation diversion dams, canals and ditches that interfere with the passage of anadromous fish.

This project's objective is to provide an evaluation of the fish passage facilities at these diversions. The evaluations are guided by provisions of Council Measure 7.11 (NPPC 1994) which follows from previous Council Measures [Section 800 (NPPC 1987) and Section 900 (NPPC 1984)]. Using video cameras and multidirectional flow meters, we will monitor screen facilities to determine if the sites are equipped to provide safe fish passage and if they are operated within design limits. Using fyke nets placed in the canals we will determine if the sites are maintained in a "fish-tight" condition. During the irrigation season (March-October), we expect to monitor fish behavior and document sedimentation, debris buildup, and flow-patterns at all Phase II screens and any other screens requested by the BPA or other agencies. Information collected will be presented to BPA as technical reports. Additionally, results will be sent to the other agencies involved with the screening facility. Reports will be placed at http://www.bpa.gov/ and http://www.pnl.gov/ecology/library/Screen/Screen.html. Problems associated with operations and maintenance will also be reported immediately to the agencies responsible for daily operation of a screening facility.

Section 8. Project description

a. Technical and/or scientific background

This project was established to provide an evaluation of fish screening facilities being constructed and operated in the Yakima River Basin, Washington. The evaluations are guided by provisions of Council Measure 7.11 (NPPC 1994) which follows from previous Council Measures [Section 800 (NPPC 1987) and Section 900 (NPPC 1984)]. The evaluations are conducted to ensure screening facilities "correct structural problems at irrigation diversion dams, canals and ditches that interfere with the passage of anadromous fish" [Council Measure 7.11 (NPPC 1994)]. These are off-site enhancement projects to mitigate the impacts of hydropower elsewhere in the basin.

Evaluation of 7 Phase I sites in the Yakima Basin from 1985 through 1990 relied heavily on the use of release-and-recapture tests with hatchery fish to monitor major fisheries concerns such as the potential for injury, migration delay, and screen integrity. Measurements of approach and sweep velocity in front of the screens and flow through the fish bypass system were completed at 8 sites to determine if screening facilities satisfied design criteria established to ensure safe fish passage conditions. The methods and results of Phase I evaluations are presented in BPA annual reports (Abernethy et al. 1989, 1990; Neitzel et al. 1985, 1986, 1988, 1990 a,b,c).

Due to the large number of Phase II screening facilities, the expense of conducting release-and-recapture tests with fish, and other constraints, such as gaining approval to acquire and release fish stocks for research, we developed new methods and strategies to evaluate Phase II fish screens. Using the new methods and technologies, we determined if screening facilities protect fish by determining if the sites were; 1) properly equipped to provide safe fish passage; 2) operated within their design limits; and 3) properly maintained in a "fish-tight" condition.

Using these 3 benchmarks, we streamlined the evaluation process and documented the performance of 20 Phase II fish screening facilities in Washington (Table 1) and

dozens more in Idaho during 1994, 1997, and 1998 (Blanton and Neitzel 1998). We also were able to identify fish species and monitor fish behavior, document sedimentation and debris buildup, and document aberrant flow patterns in the screen forebay by observing particle drift and eddies. These techniques provide the groundwork for monitoring and documenting screening facility performance in order to "certify" or "audit" fish screen facilities.

The approach to evaluating Phase II screens includes two types of tasks. The first is in-field, on-site evaluation of operating screens. Second, is the testing of specific operational or design criteria at the Phase II screen operating at the PNNL laboratory in Richland, Washington.

SITE NUMBER	LOCATION	SCREENS IN OPERATION	PNNL EVALUATION (# of site visits)	CRITERIA	SCHEDULED FOR EVALUATION
54	Bachelor/Hatton Screens	YES	1994 (1), 1997 (5), 1998 (2)	YES	1999
66	Bull Diversion Screens	YES (1997)	1997 (3), 1998 (3)	YES	1999
64	Clark Screens	YES (1997)	1997 (4), 1998 (3)	YES	1999
52	Congdon Screens	YES	1997 (4), 1998 (3)	YES	1999
68	Ellensburg Mill Screens	YES (1997)	1997 (3), 1998 (3)	YES	1999
58	Fruitvale Screens	YES	1997 (4), 1998 (3)	YES	1999
43	Gleed Ditch Screens	YES	1994 (2), 1997 (3), 1998 (3)	YES	1999
53	Kelley/Lowry Screens	YES	1994 (4), 1997 (4), 1998 (3)	YES	1999
41	Kiona Screens	NO	1993 (1)	YES	Removed in 1996
67	Lindsey Screens	YES (1997)	1997 (3), 1998 (3)	YES	1999
46	Lower WIP Screen/Ladder	YES	1997 (4), 1998 (1)	YES	1999
42	Naches/Cowiche Screens	YES	1994 (2), 1997 (4), 1998 (3)	YES	1999
56	Naches/Selah Screens	YES	1997 (4), 1998 (3)	YES	1999
44	New Cascade Screens	YES	1997 (3), 1998 (3)	YES	1999
48	Snipes/Allen Screens	YES	1997 (4), 1998 (2)	YES	1999
49	Taylor Screens	YES	1997 (3), 1998 (3)	YES	1999
47	Toppenish Pump Screen	YES (1997)	1997 (5), 1998 (1)	YES	1999
59	Union Gap Screens	YES (1997)	1997 (3), 1998 (3)	YES	1999
65	WIP Upper Screens	YES (1997)	1997 (4), 1998 (3)	YES	1999
57	Yakima-Tieton	YES (1997)	1997 (3), 1998 (3)	YES	1999

	Screens				

Task I-a, Field Evaluations - During 2000, we will continue examination of fish screening facilities in the Yakima Basin and evaluate their operation using the 3-step approach. We will determine if sites are properly equipped to provide safe, efficient fish bypass by reviewing design drawings, operating procedures, and components installed and in use at the facilities. We will monitor approach and sweep velocities in front of the screens and in the fish bypass to determine if the facilities meet fish passage criteria. Screen integrity will be monitored by completing "real-time" inspections of sites using underwater video technology.

Task I-b, Technical assistance task - We propose to establish a technical assistance task to support the cooperating agencies to evaluate screen designs as they are developed and to address site-specific concerns at Phase I or Phase II sites as they are identified. Many questions concerning screen design can be addressed by using the modular fish screen already installed at the PNNL laboratory. An example of a design criteria that can be evaluated is the angles vs. parallel screen or orifice size for the fish return. Both have been successfully tested at the PNNL facility (Neitzel et. al 1996, Abernethy et. al 1996).

Many problems identified during and after our Phase I evaluations in the Yakima Basin may still be unresolved. We propose to revisit up to 6 Phase I sites to monitor potential fisheries problems (such as flow balance, conditions in the bypass separation chamber, screen integrity, and operations) using the new tools and technology developed to monitor Phase II screens.

b. Rationale and significance to Regional Programs

Rationale: Unscreened and inadequately screened irrigation diversions, or poorly maintained screen facilities result in the loss of many juvenile salmon and steelhead that have already survived the rigors of natural rearing. Screening irrigation diversions has a high probability of reducing salmon and steelhead mortality if the screens are designed, installed, operated and maintained properly.

Project 8506200 has provided the region with the evaluations of installed screening facilities to ensure that the facilities are accomplishing the objectives for which they were designed and built. Monitoring of the screening facilities' compliance with the design and maintenance criteria is key to measure 7.11B of meeting its objective of protecting juvenile salmon and steelhead during their migration to the ocean.

Furthering the Goals of the FWP: During the last 50 years, state and federal entities initiated water diversion screening programs and passage improvements throughout the Columbia River Basin. Installation of new screens and improvement of old screens was initiated in the Yakima Basin during 1985. Project 8506200 relates to screen improvement projects throughout the basin. These include: 7.10A.3 (Fisheries Managers maintenance of a prioritized list of tributary screening and passage facilities), 7.10A.4 (National Marine Fisheries Service, Working Oversight Committee, Appropriate Technical Work Groups and Bonneville identification of resources needed to accomplish

screening and passage and monitoring and evaluation plans), 7.10A.5 (Bureau of Land Management, Idaho and Oregon/Washington Offices; U.S. Forest Service Regions 1,4,6; and Bureau of Reclamation, Pacific Northwest Region requirements that existing and new water use authorizations have functional fish screens and other passage facilities), 7.10A.6 (Corps of Engineers inspection of underwater diversions), 7.10A.7 (Idaho, Oregon, Washington requirements that installation, operation, and maintenance of fish screens are in compliance with state laws), 7.10.D (Bonneville's evaluation of Dryden Dam screens), and 7.11 (Improvement of irrigation diversions in the Yakima River basin).

Novel Ideas: The evaluation of fish screening facilities has evolved since PNNL began working with BPA during 1985. Together we have identified many of the problems that reduce the potential effectiveness of the screening facilities and have been able to work with the WDFW and NMFS to change designs, operations, and maintenance of the screens. Today, the potential to further improve and maintain the fish screening facilities has changed. Screen technology has progressed to the point that screens can be placed in very small diversions (less than 1 cfs total flow). This has resulted in the desire to protect fish during the very earliest period of their life history.

The use of the PNNL screen facility is important to provide a setting for the testing of improvements/modifications to fish screens. As pointed out earlier, mark and recapture techniques that have proved so useful in the past screen evaluations are difficult to employ. The potential for introducing non-indigenous stocks into streams near test site is not acceptable. This is especially true where there are Threatened or Endangered species in the watershed. Additionally, the protection of very small fish (less than 30 mm) requires a very controlled environment because it is difficult to recapture and account for test fish and marking small fish it also difficult.

PNNL has two screening facilities at its Richland laboratory; a 4 ft wide forebay with a 4-ft wide, 2-ft diameter drum screen. The drum can be tested using 1/8-in. or 3/16-in. mesh perforated plate. The PNNL laboratory also has a screen facility with a 6 ft wide forebay. The bay can be set up to provide flows that are perpendicular to the drum screen or that approach the screen at a forty-five degree angle.

c. Relationships to other projects

The completion of this work will assist the USFWS/BRD in interpreting their data and developing recovery goals for fall chinook salmon in the Snake River (Project 9102900). The WDFW stranding project (Project 9701400) and this project have been able to share resources including staff and computer equipment.

Additionally, project staff regularly work with the Washington State Department of Fish and Wildlife, the Idaho Fish and Game, the U.S. Bureau of Reclamation, and the National Marine Fisheries Service. Project work also requires coordination with the irrigation districts of the Yakima Basin and the Yakama Indian Nation. The table below lists some of the pertinent staff in these agencies with whom we have cooperated.

Pertinent Staff	Affiliation

Washington Department of Fish and Wildlife	Ken Bates, Staff Engineer, Olympia, Washington
	John Easterbrooks, Biologist, Screens Shop, Yakima, Washington
Idaho Department of Fish and Game	Gary Power, Regional Supervisor, Salmon Region, Salmon, Idaho
	Pat Marcuson, Program Coordinator, Anadromous Fish Screening Program, Salmon, Idaho
	Lynn Stratton, Construction Supervisor, Anadromous Fish Screening Program, Salmon, Idaho
	Matt Hightree, Project Engineer, Anadromous Fish Screening Program, Salmon, Idaho
	Mike Mitchell, Project Engineer, Anadromous Fish Screening Program, Boise, Idaho
U.S. Bureau of Reclamation	Walt Larrick, Biologist, Yakima Office
	Chuck Keller, Biologist, Salmon, Idaho branch office
National Marine Fisheries Service	Steve Raney, Hydraulic Engineer, Portland, Oregon
	Bob Pearce, Hydraulic Engineer, Portland, Oregon
	Bryan Nordlund, Hydraulic Engineer, Portland, Oregon

Finally, Project 8506200 is related to screen improvement projects throughout the basin. These include: 7.10A.3 (Fisheries Managers maintenance of a prioritized list of tributary screening and passage facilities), 7.10A.4 (National Marine Fisheries Service, Working Oversight Committee, Appropriate Technical Work Groups and Bonneville identification of resources needed to accomplish screening and passage and monitoring and evaluation plans), 7.10A.5 (Bureau of Land Management, Idaho and Oregon/Washington Offices; U.S. Forest Service Regions 1,4,6; and Bureau of Reclamation, Pacific Northwest Region requirements that existing and new water use authorizations have functional fish screens and other passage facilities), 7.10A.6 (Corps of Engineers inspection of underwater diversions), 7.10A.7 (Idaho, Oregon, Washington requirements that installation, operation, and maintenance of fish screens are in compliance with state laws), 7.10.D (Bonneville's evaluation of Dryden Dam screens), and 7.11 (Improvement of irrigation diversions in the Yakima River basin).

d. Project history (for ongoing projects)

Project 8506200 began in 1985 with a fisheries evaluation of the Sunnyside Canal Fish Screening Facility. Since 1985, project staff have completed fisheries evaluations at the following Phase I facilities:

- Richland Canal Fish Screening Facility
- Toppenish/Satus Canal Fish Screening Facility
- Wapato Canal Fish Screening Facility
- Toppenish Creek Canal Fish Screening Facility
- Westside Ditch Fish Screening Facility
- Town Canal Fish Screening Facility.

Water velocity evaluations were completed at the

- Columbia Canal Fish Screening Facility,
- Roza Canal Fish Screening Facility,
- Easton Canal Fish Screening Facility, and
- Chandler Canal Fish Screening Facility.

Project staff evaluated the potential for migration delay and increased loss to predation at Wapato and **Sunnyside Canal Fish Screening Facilities** during 1991 operations. They evaluated the **Dryden Fish Screening Facility** during 1994. In all, twelve Phase I sites have been evaluated.

In addition, components of modular fish screens were evaluated in the laboratory at Richland during 1994 and 1995. Angled screen criteria were also tested. Results indicate that significant monetary savings can be affected by using non-angled 6-ft screens at many sites.

During 1997 and 1998, all the active Phase II screens (a total of 19 sites) were evaluated during the spring, summer and fall. This entailed making about three visits to site to monitor changes in water flow patterns and maintenance practices through the course of the irrigation season.

Additionally, we began studies in 1996 to verify that infrasound can be used to modify the behavior of Pacific salmon of the species, age group, and physiological state of interest. The work was conducted with zero age chinook salmon and rainbow trout. We determined that zero age chinook salmon and rainbow trout do respond to infrasound. Studies were continued in 1997 and 1998 to: 1) distinguishing between a “startle” response and responses based on other mechanisms that are longer lasting, such as appears to the case in the Norwegian studies, and 2) determine the ability of some of the younger age groups (fish less than 35 mm in length) to avoid sound fields under conditions that tax their swimming ability or other physiological or morphological characteristics. An evaluation of juvenile salmonid response to strobe lights was also conucted in 1998.

In all, a total of 13 technical reports have been written regarding screen design, operation, and maintenance evaluations, and infrasound and strobe light testing. Two more are in progress. Also, at least 15 presentations have been given around the world at national and international professional society conferences and at regional screen and fishery workshops. These are cited in Section 10 below. In addition, every technical

report we have produced from 1985 through the present has been posted to the internet so that anyone with internet access can view the reports on-line or download the files to disk. In addition to the reports, links to state agencies and other regional organizations that have a part in fisheries management are included. Maps showing the locations of each screen site we have evaluated, along with color photos and detailed information about their design can also be found on our website located at http://www.pnl.gov/ecology/library/Screen/Screen.html.

e. Proposal objectives

There were two specific measurable objectives for Project 8506200:

1. (a)Provide fisheries and hydrological evaluations of new screens as they are installed. The criteria used to measure this goal are the screen criteria developed by the National Marine Fisheries Service.

   (b)Provide on site monitoring of operating screens. Monitoring criteria are: operating as designed, seals installed and maintained to prevent fish from passing through screens, and approach and sweep flows to NMFS criteria.

2. Support cooperating agencies to evaluate new or revised screen designs as they are developed and address site-specific concerns at Phase I or Phase II sites. Provide a laboratory facility for testing proposed changes to facility components.

The testable hypothesis for Project 8506200 is fish screening facilities can be designed, constructed, operated and maintained to protect fish that are diverted into irrigation canals.

Underlying Assumptions

The underlying assumptions for testing this hypothesis are:

1. Fish are not killed or injured as they are diverted from the irrigation canal back to the river.
2. Fish can not pass downstream of the facility into the irrigation canal.
3. Migrating fish are not delayed in or by the fish screening facility.
4. Fish are not subjected to increased predation by the presence or operation of the screening facility.
5. Fish are protected during all possible screen operating scenarios, including periods between scheduled maintenance.

Information collected during field and laboratory studies in 2000 will be presented to BPA as technical reports. The reports will include site descriptions, the methods used to make our evaluations, the results and a discussion of our evaluations, and recommendations on how to improve monitoring methods, operating procedures, screen operations, and facility maintenance to address any identified problems. In addition, results of technical assistance efforts will be sent to BPA as letter reports, with copies going to the other agencies involved with the screening facility. Reports will be placed at http://www.bpa.gov/ and http://www.pnl.gov/ecology/library/Screen/Screen.html.

Problems associated with operations and maintenance will also be reported verbally to the agencies responsible for daily operation of a screening facility.

f. Methods

Methods, Task 1-a. The approach to evaluating Phase II screens include two types of tasks. The first is in-field, on-site evaluation of operating screens. Second, is the testing of specific operational or design criteria at the Phase II screens operating at the PNNL laboratory in Richland, Washington.

Task I-A, Field Evaluations - During 2000, we will examine up to 20 Phase II fish screening facilities in the Yakima Basin and evaluate their operation using the 3-step approach detailed in our report, "Washington Phase II Fish Diversion Screen Evaluations in the Yakima River Basin, 1997" (Blanton, et.al. 1998). Sites will include those evaluated previously (to determine if concerns identified earlier are resolved or if any problem patterns exist) as well as any recently constructed or modified sites. As in our 1997 investigations, we will visit each site several times to monitor changes in seasonal water flows and canal diversions, and consistency in operation and maintenance practices over the course of the irrigation season. We will determine if sites are properly equipped to provide safe, efficient fish bypass by reviewing design drawings, operating procedures, and components installed and in use at the facility. We will monitor approach and sweep velocities using a bi-directional flow meter in front of the screens and in the fish bypass to determine if the facilities meet fish passage criteria. Screen integrity will be monitored by completing "real-time" inspections of sites using underwater video technology. Our evaluations are designed to compare current site conditions to Federal screening guidelines developed by the National Marine Fisheries Service (NMFS) and to State fish screening criteria and to highlight areas where these guidelines are not being met.

Task I-B, Technical assistance task - We propose to establish a technical assistance task to support the cooperating agencies to evaluate screen designs as they are developed and to address site-specific concerns at Phase I or Phase II sites as they are identified. Many questions concerning screen design can be addressed by using the modular fish screen already installed at the PNNL laboratory. An example of a design criteria that can be evaluated is the angles vs. parallel screen or orifice size for the fish return. Both have been successfully tested at the PNNL facility (Neitzel et. al 1996, Abernethy et. al 1996).

Critical Assumptions

Some uncertainties underlie the assumptions for testing the hypothesis that fish screening facilities can be designed, constructed, operated and maintained to protect fish that are diverted into irrigation canals. The critical uncertainties are:

1. Can fish be killed or injured as they are diverted from the irrigation canal back to the river?
2. Can fish pass downstream of the facility into the irrigation canal?
3. Are migrating fish delayed in or by the fish screening facility?

4. Are fish subjected to increased predation by the presence or operation of the screening facility?
5. Are fish protected during all possible screen operating scenarios, including periods between scheduled maintenance?

Factors That May Limit Success: The risks associated with project 8506200 are inherit in the underlying assumptions:

1. Fish are not killed or injured as they are diverted from the irrigation canal back to the river.
2. Fish can not pass downstream of the facility into the irrigation canal
3. Migrating fish are not delayed in or by the fish screening facility.
4. Fish are not subjected to increased predation by the presence or operation of the screening facility.
5. Fish are protected during all possible screen operating scenarios, including periods between scheduled maintenance.

If any of these assumptions about the screens that are being designed, constructed, operated, and maintained in the Columbia River basin are false, salmon and steelhead will not be protected. Project 8506200 objectives are to determine that fish are being protected at irrigation diversions. Through our evaluation process, we will be able to identify screens that are not perfoming to criteria standards and demonstrate of document what the particular problems are (i.e., gaps between screens and seals, flows capable of impinging small fish, obstructions in bypass pipes). Timely review of the data collected and communication about concerns at particular facilities with the agencies responsible for managing the sytems will benefit the fish migrating through the system.

g. Facilities and equipment

PNNL Facilities. Laboratory studies will be conducted at the PNNL laboratory in Richland, Washington. The wet lab at PNNL has been in operation since 1971. A rainbow trout brood stock has been continuously maintained at the lab to provide fish for experimental use. Besides rainbow trout, we are currently holding fall chinook salmon and have access to spring chinook salmon. We have facilities for holding and testing all life stage (egg through adults). We have successfully held and cultured other aquatic species including, cutthroat trout, brook trout, coho salmon, steelhead, whitefish, American shad, and various warm water fish and invertebrates at the laboratory.

The wet lab (1600 ft^2) has photoperiod control and is supplied with multiple water sources. Two adjoining labs are also supplied with water. Three other labs are used for special studies, analytical work, and chemical storage. The wet lab and one other lab have hepa-filtered hoods for handling chemicals. All labs are supplied with compressed air and ground fault interrupted electrical outlets.

All critical water pressures and temperatures are continuously recorded and monitored by an automated annunciator system. Abnormal events trigger an alarm that

notifies facility operators of problems. In the event of a complete failure of either the well water or river water system, an automated crossover valve opens to supply the working water supply to the entire system.

Water Supplies

River Water. The wet lab is supplied with raw Columbia River water (1000 gpm capacity). Our supply system is part of a larger system that supplies water to a large industrial complex. In addition to redundant pump supplies for the main system, we have our own generator-powered emergency backup pump that can supply water to the lab in the event of primary pump failure. River water can be strained (100 micron self-cleaning filter) to remove large particulate matter. Water temperature varies from 1 to 21° C seasonally.

Well Water. Well water (600 gpm capacity) is pumped from an unconfined aquifer. The water is 17° C throughout the year. Water quality conditions are constant throughout the year. Oxygen level is near saturation without aeration.

Conditioning Equipment

Strainer. A self-cleaning 100µ strainer removes large particulate matter from the river water supply. Strained river water can then be chilled, heated, aerated, or delivered to the wet lab at ambient temperature. In the even of strainer failure, an automated valve opens to bypass the strainer.

Aerator. One water source, either well water or river water, can be aerated. Since river water is usually saturated, we use our aerator with well water. The aerator is capable of handling at least 500 gpm.

Chillers. The chilled water system is a recycling loop with two chillers. Makeup water is added on demand based on water usage. The chillers are capable of chilling about 50 gpm of water about 5° C. A third chiller used for emergency backup can supply about 15 gpm of water chilled about 5° C. The system is capable of providing temperature control to ± 1°C.

Heat Exchangers. The heated water system has two steam heat exchangers in a recycling loop with makeup water added on demand based on water usage. The system is capable of heating about 100 gpm of water to 40° C. A 40 KW electric boiler serves as emergency backup. The system is capable of providing temperature control to ± 1°C.

Indoor Facilities

Wet Lab. The existing fish culture facilities in the wet lab are summarized in the following table:

Facility	Description	#	Total Capacity
Egg incubators	Vertical flow-through	8	125,000
Fry troughs	10 ft long x 1 ft wide x 6 in deep	8	80,000
Fingerling tanks	4 ft in diameter	5	75,000

Egg Incubators. Eggs are hatched in vertical flow incubator trays (Heath incubators). Four incubators are set up, and two other systems are available. About 125,000 salmon eggs can be incubated at a time.

Fry Troughs. Eight fry troughs (10 ft long by 1 ft wide by 8 in deep) , each capable of holding about 10,000 fry, are housed in the lab. Troughs can be divided to hold several fish groups.

Fingerling Tanks. Fingerlings are reared in fiberglass circular tanks, each capable of holding about 15,000 small fingerlings. More tanks can be added in the lab as needed. When the rearing capacity of these tanks is reached, the fish are moved outdoors.

Special Test Equipment at the PNNL Laboratory

Laser Doppler Velocimeter. Measurements of turbulent fluid properties with fish present require the use of a noninvasive velocity measurement instrument. A laser Doppler velocimeter (LDV) system can be used to measure mean velocities and turbulence quantities such as shear without having to be placed inside the experimental facility. A LDV system that samples 2 velocity components is needed to measure the turbulent shear. PNNL has a fiber-optic based LDV system and has considerable experience using this system to make turbulence measurements in a variety of experimental settings.

Outdoor Facilities

The outdoor tank yard consists of several concrete ponds and a drain system where portable troughs and circular tanks are installed as needed. The outside tank yard covers about 4,000 ft^2. The following table describes our current holding facilities:

Facility	Description	#	Smolt Capacity
Fingerling tanks	4 ft in diameter	4	6,000
Juvenile tanks	6 ft in diameter	4	16,000
Juvenile raceways	Concrete, 10 ft x 4 ft x 3 ft deep	6	30,000
Yearling raceway	Concrete, 40 ft x 4 ft x 3 ft deep	1	50,000
Brood ponds	Concrete, 20 ft dia x 2 ft deep	2	50,000

Effluent Facilities

River Discharge. Wet lab effluent is discharged directly to the Columbia River. The discharge is controlled under a NPDES permit. Under the permit, we are required to monitor suspended and settleable solids, pH, and total discharge volume.

Process Sewer. The process sewer is used to dispose of effluent from bioassays and other tainted water, and as a method of quarantining fish stocks from the Columbia River. The quantity of water we may discharge to the process is limited.

h. Budget

The total cost to complete this work in FY2000 is estimated to be approximately $100,000. Approximately 48% of this amount is for personnel and fringe benefits. Contained within these two categories are direct labor and direct overheads including program development and management (business development, planning and monitoring), PNNL procurement and subcontract support, general and administrative expenses (e.g., accounting, legal, contracting, and personnel departments), and service assessment fees (costs paid to the Department of Energy for plant-wide support services such as patrol, fire, library, mail and roads). Twenty-two percent of the total is for supplies and materials. These include nets and frames designed to fit canal dimensions, digital image processing software, video tapes, sampling equipment and other miscellaneous expenses. Approximately 5% of the budget is for travel to and from the work sites in the Yakima River Basin as well as travel to various locations to present research findings at regional meetings. The percentage of the budget allocated to indirect costs is approximately 25%. Indirect costs include primarily organizational overheads which include costs for management, supervision, and administration of technical departments as well as costs for buildings and utilities, maintenance and operation of research equipment.

The amount proposed for FY2000 is similar to the amount proposed for FY1999 and FY2000 in the FY1999 proposal.

Section 9. Key personnel

Key Staff: Duane Neitzel, Project Manager 0.26 FTE
Scott Abernethy, Senior Fisheries Specialist 0.30 FTE
Sue Blanton, Fisheries Specialist 0.22 FTE
Bob Mueller, Fisheries Specialist 0.10 FTE

RESUMES
DUANE A. NEITZEL: Staff Scientist

EDUCATION: B.A., Zoology, University of Washington, 1968
M.S., Biology, Washington State University, 1982

EXPERIENCE: Mr. Neitzel is a staff scientist with the Aquatic Ecology Group of Battelle, Pacific Northwest Laboratories. He joined Battelle in 1972. His research efforts have focused on the assessment of impacts to aquatic ecosystems from the development and production of energy, and the management of hazardous wastes. Mr. Neitzel has reported his work in over 100 journal articles, symposium proceedings, and technical reports. Additionally, he has managed or facilitated environmental research workshops related to hazardous-waste site management, fisheries research, arid ecosystems, and marine pollution research. Some of his major assignments are summarized below:

Mr. Neitzel manages an evaluation of fish screening facilities that are being constructed in the Yakima River basin, Washington and Lemhi River basin, Idaho. The facilities are being built in irrigation canals and are designed to divert fish in the irrigation canals back to the Yakima River. The evaluation is being conducted for the Bonneville Power Administration as part of their

salmonid enhancement efforts in the Columbia River basin. Mr. Neitzel participated in a 5-year study of entrainment and impingement at two water intakes on the Columbia River. Studies included estimates of impacts to phytoplankton, zooplankton, and fish. These studies were used to support the Washington Public Power Supply System's National Pollutant Discharge Elimination System permit application. The fish studies concluded with an assessment of engineering and operational changes that eliminated significant entrainment and impingement mortalities for fish populations. In 1981, Mr. Neitzel prepared a report for the U.S. Fish and Wildlife Service that outlines procedures for providing biological input to the design, location, and modification of water intake structures. This project concluded with a guidance manual for implementation of the procedures. Mr. Neitzel has presented the results of this regionally, nationally, and internationally, including the American Fisheries Society, an international meeting of fisheries engineers in Japan, and to the U.S. Congressional Office of Technical Assessment.

SELECTED PUBLICATIONS

Abernethy, C.S., D.A. Neitzel, and W.V. Mavros. 1996. Movement and Injury Rates for Three Life Stages of Spring Chinook Salmon Oncorhychus tshawytscha: A Comparison of Submerged Orifices and an Overflow Weir for Fish Bypass in a Modular Rotary Drum Fish Screen. Prepared by the Pacific Northwest National Laboratory, Richland, Washington for the Bonneville Power Administration, Portland, Oregon.

Blanton, S.L, D.A. Neitzel, and C.S. Abernethy. 1998. Washington Phase II Fish Diversion Screen Evaluations in the Yakima River Basin, 1997. Prepared by the Pacific Northwest National Laboratory, Richland, Washington, for the Division of Fish and Wildlife, Bonneville Power Administration, Portland, Oregon.

Mueller, R.P., C.S. Abernethy, and D.A. Neitzel. 1994. A Fisheries Evaluation of the Dryden Fish Screen Facility. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richland, Washington.

Neitzel, D.A., S.L. Blanton, C.S. Abernethy, and D.S. Daly. 1996. Movement of Fall Chinook Salmon Fry *Oncorhynchus tshawytscha*: A Comparison of Approach Angles for Fish Bypass in a Modular Rotary Drum Fish Screen. Prepared by the Pacific Northwest National Laboratory, Richland, Washington for the Bonneville Power Administration, Portland, Oregon.

Neitzel, D. A., C. S. Abernethy, and E. W. Lusty. 1990a. A Fisheries Evaluation of the Wapato, Sunnyside, and Toppenish Creek Canal Fish Screening Facilities, Spring 1988. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richland, Washington.

C. SCOTT ABERNETHY: Senior Science and Engineering Associate

EDUCATION: B.S., Fisheries Management, University of Washington, 1969

EXPERIENCE: Mr. C. Scott Abernethy is a Senior Science and Engineering Associate at the Pacific Northwest National Laboratory (PNNL). His primary area of expertise is fisheries biology with emphasis on salmon and trout culture. In 26 years at PNNL, Mr. Abernethy has participated in field projects, many of which are related to the impacts of water use in the Columbia Basin on salmon and other native fish populations. Mr. Abernethy has also been a major contributor in studies to evaluate the effectiveness of fish screening facilities in irrigation diversions in the Yakima Basin, Washington and the Lemhi Basin, Idaho.

Mr. Abernethy's broad research experiences have exposed him to many technological tools used in the fisheries field. He is experienced in fish transport, use of anesthetics, and fish marking techniques, including the use of PIT tags. He has used underwater video technology to survey and map bottom substrate and to locate salmon redds in the tailraces of dams on the Snake River. He also has used underwater video to observe fish behavior and monitor the integrity of fish screens in irrigation canals. Mr. Abernethy is also proficient in entering and processing data for computer analysis.

SELECTED PUBLICATIONS

Abernethy, C.S., D.A. Neitzel, and W.V. Mavros. 1996. Movement and Injury Rates for Three Life Stages of Spring Chinook Salmon O*ncorhynchus tshawytscha*: A Comparison of Submerged Orifices and an Overflow Weir for Fish Bypass in a Modular Rotary Drum Fish Screen. Prepared for the Bonneville Power Administration by Pacific Northwest National Laboratory, Richland, Washington.

Dauble, D.D., R.L. Johnson, R.P. Mueller, C.S. Abernethy, B.J. Evans, and D.R. Geist. 1994. Identification of Fall Chinook Salmon Spawning Sites near Lower Snake River Hydroelectric Projects. Prepared for U.S. Army Corps of Engineers, Walla Walla District. Walla Walla, Washington.

Mueller, R.P., C.S. Abernethy, and D.A. Neitzel. 1995. A Fisheries Evaluation of the Dryden Fish Screening Facility. Prepared for the Bonneville Power Administration by Pacific Northwest Laboratory, Richland, Washington.

Neitzel, D.A., S.L. Blanton, C. S. Abernethy, and D.S. Daly. 1996. Movement of Fall Chinook Salmon Fry, *Oncorhynchus tshawytscha*: A Comparison of Approach Angles for Fish Bypass in a Modular Rotary Drum Fish Screen. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richland, Washington.

SUSAN L. BLANTON: Science and Engineering Associate II

EDUCATION: B.S., Zoology, Miami University, 1992

EXPERIENCE: Ms. Blanton is currently a Science and Engineering Associate II in the Ecology Group within the Environmental Technology Division. She joined the Pacific Northwest National Laboratory in 1994. Her research has focused on diverse salmonid issues in the Columbia and Snake River Basins. She has evaluated fish screening facilities in the Yakima River Basin, supported hydroacoustic fish passage research efforts at Snake and Columbia River hydroelectric projects, studied the effects of gas bubbles in salmonids, contributed to preparation of environmental impact statements, and conducted teacher workshops on numerous aspects of aquatic ecology. Selected experiences are given below.

Fish Screen Facility Studies - Ms. Blanton has evaluated fish screening facilities in the Yakima River Basin, Washington. The facilities are built in irrigation canals and are designed to divert fish in the irrigation canals back to the Yakima River. Evaluations are done to ensure that the screens are properly maintained and that operating criteria set by the National Marine Fisheries Service for the protection of juvenile salmonids are met. These studies are conducted for the Bonneville Power Administration as part of their salmonid enhancement efforts in the Columbia River Basin.

SELECTED PUBLICATIONS

Blanton, S.L., D.A. Neitzel, and C.S. Abernethy. 1998. Washington Phase II Fish Diversion Screen Evaluations in the Yakima River Basin, 1997. Prepared by the Pacific Northwest National Laboratory, Richland, Washington, for the Division of Fish and Wildlife, Bonneville Power Administration, Portland, Oregon.

Neitzel, D.A., S.L. Blanton, C. S. Abernethy, and D.S. Daly. 1996. Movement of Fall Chinook Salmon Fry, *Oncorhynchus tshawytscha*: A Comparison of Approach Angles for Fish Bypass in a Modular Rotary Drum Fish Screen. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richland, Washington.

Geist, D.R., C.S. Abernethy, and S.L. Blanton. 1997. The Use of Electromyogram Telemetry to Estimate Energy Expenditure of Adult Fall Chinook Salmon. Pacific Northwest National Laboratory, Richland, Washington.

Neitzel, D., T.J. Carlson, R. Mueller, W. Mavros, and S. Blanton. 1997. Avoidance Response of Juvenile Hatchery and Wild Chinook Salmon and Rainbow Trout. Prepared for the Bonneville Power Administration by the Pacific Northwest National Laboratory, Richland, Washington.

Poston, T.M., R.A. Pappas, S.L. Blanton, A.A. Diaz, and K.J. Lessor. 1997. Using Ultrasound to Detect Gas Bubbles in Rainbow Trout (Oncorhynchus mykiss). PNNL-15545, Pacific Northwest National Laboratory, Richland, Washington.

ROBERT P. MUELLER: Science and Engineering Associate III

EDUCATION: B.S., St. Cloud State University, Fisheries - Aquatic Biology, 1987

EXPERIENCE: Robert Mueller has been a staff member at PNNL since January 1992. He is currently a Science and Engineering Associate III in the Ecology Group within the Water and Land Resources Department. His research efforts have focused on GIS, GPS directed video surveys of adult salmon spawning habitat, juvenile salmon protection at screening facilities, behavior barriers, and aquatic bioassessments. He is responsible for designing, testing, and monitoring field experiments to support research being conducted at PNNL. His research interests includes; fish passage investigations, water quality assessments, video applications directed at researching current fisheries issues. Selected experience includes the following:

Yakima River Fisheries Project - Applied digital imaging and infrared lighting to enhance the U.S. Bureau of Reclamation and the Yakima Indian Nation to acquire high quality images of adult salmonid passage at fish counting sites in the Yakima Basin. Worked with engineers to modify and improve passage conditions and incorporate underwater lighting. The enhanced system uses high definition cameras, imaging software, infrared lighting, to archive fish runs and collect biological data. The data is used to predict future fish runs, evaluate passage and stock origin, and to assess meristic parameters. The system produces a complete image oriented database which is archived and available to fisheries resources managers and other interested parties.

Yakima River Basin Fish Screening Evaluations – Principal investigator in the evaluation of juvenile Salmonid passage at fish screening diversion facilities. Studies include passage rate, descaling tests, Underwater video surveys, velocity measurements, and fish impingment and screen intergrity tests. Conducted feasibility tests using infrasound as a behavior barrier using pre-smolt salmonids.

Oregon Department of Fish and Wildlife - From 1990 to 1991, Mr. Mueller worked as a technician in 1990 and was promoted to a fisheries biologist in 1991. Research projects included collecting biological data on predators of juvenile salmonids in the lower Columbia River. Data collected was used to determine species populations, fish age structure, fecundity, and sampling gear effectiveness. Mr. Mueller also directed the activities of employees to evaluate two fish screening diversion facilities on the Umatilla River. He was involved all components of the evaluations including the development of a sampling plan, design and testing of fish holding facilities, trap design and construction, fish marking, data summary, and report writing.

SELECTED PUBLICATIONS

Dauble, D.D., R.L. Johnson, R.P. Mueller, W.V. Mavros, and C.S. Abernethy. 1995-1996. Surveys of Fall Chinook Spawning Areas Downstream of Lower Snake River Hydroelectric Projects, 1995-1996 Season. Prepared for U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington.

Dauble, D.D., R.L. Johnson, R.P. Mueller, and D.R. Geist. 1995. Identification of Fall Chinook Spawning Sites Near Lower Snake River Hydroelectric Projects. Prepared for U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington.

Mueller, R.P., D.A. Neitzel, W.V. Mavros, and T.J. Carlson. 1998. Evaluation of Low and High Frequency Sound for Enhancing Fish Screening Facilities to Protect Outmigrating Salmonids. Prepared for the Bonneville Power Administration by the Pacific Northwest National Laboratory, Richland, Washington.

Mueller, R.P., C.S. Abernethy, and D.A. Neitzel. 1995. A Fisheries Evaluation of the Dryden Fish Screening Facility. Prepared for the Bonneville Power Administration by the Pacific Northwest Laboratory, Richland, Washington.

Section 10. Information/technology transfer

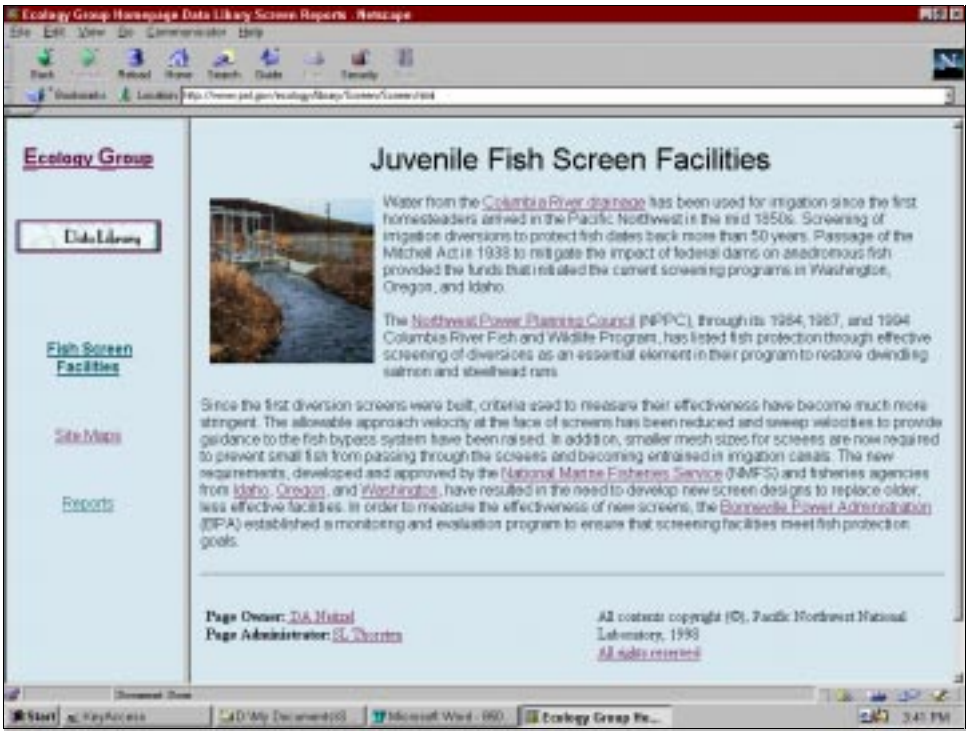
We have worked hard to get the results of our past studies to the people who use them to make decisions regarding fish passage. A large body of information relating to the impact of hydraulic facilities on anadromous fish migration exists in the form of written technical reports. As an example, we refer to Abernethy et al. 1989, 1990; Neitzel et al. 1985, 1986, 1988, 1990 a,b,c; (all cited in Section 8) which describe screen evaluations from fish screening facilities in the Yakima River basin. These reports often contained tables of measured data, either hand-written or typed. During 1996, we digitized our past BPA reports and developed an electronic database with a hypertext interface that provides easy access of these older reports through the internet. To date, all 13 of these reports have been placed on websites at the Pacific Northwest National Laboratory (PNNL) and several are available through BPA's web site. The addresses for these sites as of December 1998 are:

PNNL - http://www.pnl.gov/ecology/library/Screen/Screen.html

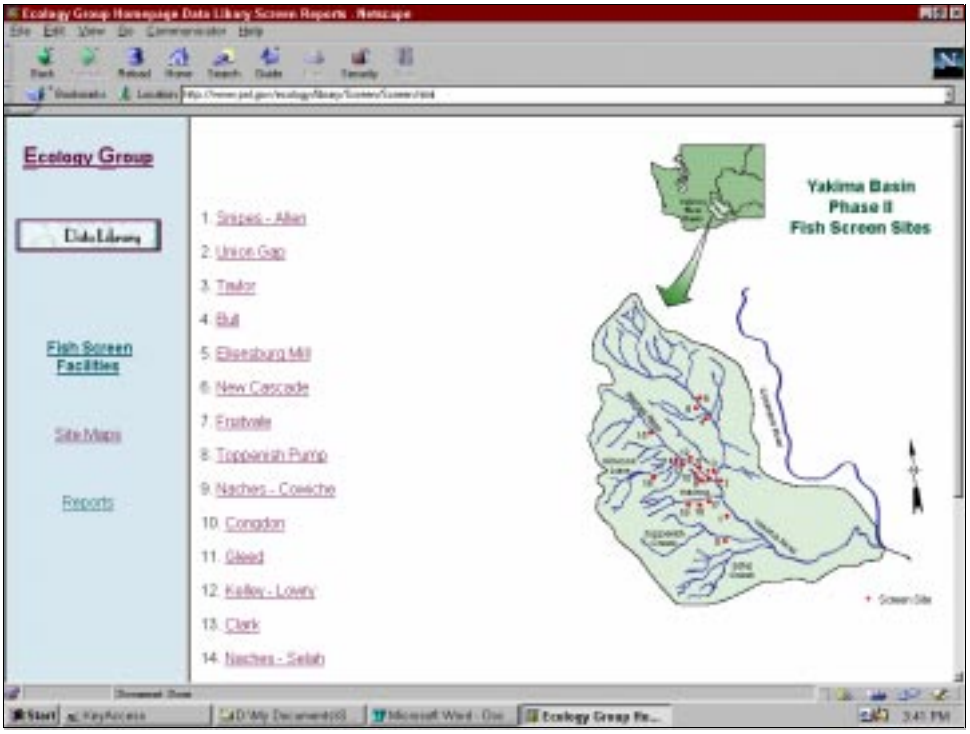
BPA - http://www.efw.bpa.gov/Environment/EW/EWP/DOCS/REPORTS/HABITAT/withpdf.htm).

In the future, new reports will be sent to BPA for hard copy distribution and will also be placed PNNL's web site.

Besides posting reports, the PNNL website also contains hypertext links to important federal, state, and other regional agencies involved in fish passage and protection. We include maps indicating the locations of each screen site we evaluate as well as color photos and detailed descriptions of each screening facility. Five selected screen images from the website are shown below:

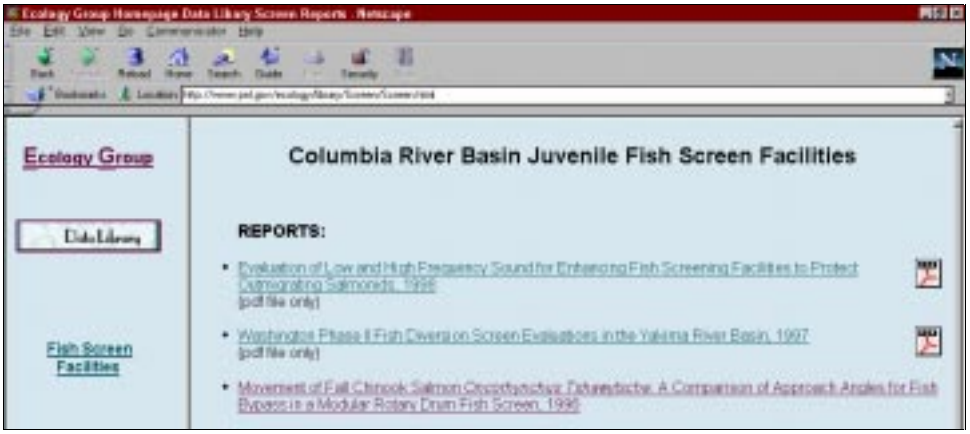


The Fish Screen Home Page Containing Links to Other Agencies

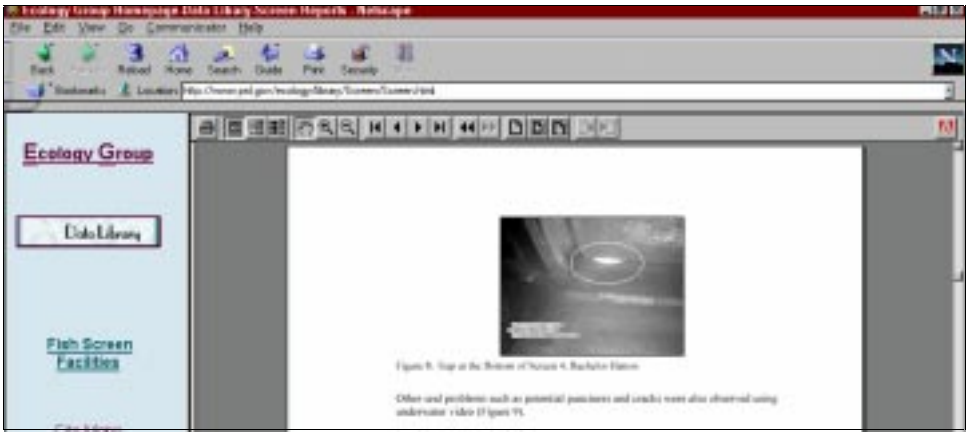


Hypertext Map Showing Locations of Phase II Screen Sites in the Yakima Basin

Photo and Description of a Phase II Screenin Facility



The Beginning of Our List of Reports



Page from a Report Showing Underwater Video Footage of a Gap between a Bottom Seal and Drum Screen

New information will also be discussed directly with potentially affected agencies so the information can be used immediately.

Finally, PNNL staff attend annual professional society meetings (i.e., American Fisheries Society,) and regional workshop forums where results of our studies are presented. This is consistent with the approach we have used on this project in the past. A number of presentations (some cited below) have already been given and this practice will continue as an effective way of communicating with researchers around the country who are interested in fish passage issues.

1998

Blanton, S.L. 1998. "Fish Screens On-Line." Presented at the 8th Annual Fish Screen Operation and Maintenance Workshop, Hood River, Oregon.

Mueller, R.P. 1998. "Update on Behavioral Studies of Fish Response to Strobe Lights." Presented at the 7th Annual Fish Screen Operation and Maintenance Workshop , Hood River, Oregon.

1997

Blanton, S.L. 1997. "Phase II Screen Evaluations in the Yakima Basin 1997." Presented at the 6th Annual Fish Screen Operation and Maintenance Workshop, Salmon, Idaho.

Mueller, R.P. 1997. "Evaluation of Infrasound as a Potential Behavioral Enhancement of Fish Screens." Presented at the 6th Annual Fish Screen Operation and Maintenance Workshop, Salmon, Idaho.

Neitzel, D.A., R.P. Mueller, and T.J. Carlson. 1997. "Evaluating Infrasound for Use at Fish Screening Facilities". Presented at the Annual Meeting of the American Fisheries Society, August 24-28, 1997, Monterey, California.

1996

Abernethy, C.S. 1996. "Factors Affecting Salmonid Fry Impingement and Rollover on Drum Screens." Presented at the 5th Annual Fish Screen Operation and Maintenance Workshop , Yakima, Washington.

Blanton, S.L. 1996. "Evaluation of WDFW Six-foot Modular Screen Orientation (Angled vs. Perpendicular) and Fish Bypass Efficiency." Presented at the 5th Annual Fish Screen Operation and Maintenance Workshop , Yakima, Washington.

Carlson, T.J. 1996. "Use of Sound for Fish Protection at Water Diversions." Presented at the 5th Annual Fish Screen Operation and Maintenance Workshop , Yakima, Washington.

Previous Years

Hoffmann, A. C.S. Abernethy, and D.A. Neitzel. 1994. "Survival Estimates for Spring and Fall Chinook Salmon, and Coho Salmon Smolts in the Yakima River." Presented at the 1994 American Fisheries Society Annual Meeting, Halifax, Nova Scotia.

Neitzel, D.A., D.A. New, C.S. Abernethy, and C. Keller. 1994. "Monitoring and Evaluation of the Fish Screening Facilities in the Lemhi River Basin of Idaho, United States." Presented at the 1994 American Fisheries Society Annual Meeting, Halifax, Nova Scotia.

Abernethy, C. S., and D. A. Neitzel. 1991. "A Summary of Fisheries Evaluations of Rotary Drum Fish Screening Facilities in the Yakima Basin, 1985 1990." Presented at the Pacific Fishery Biologists 53rd Annual Meeting, Sun River, Oregon.

Neitzel, D. A., C. S. Abernethy, and E. W. Lusty. 1991. "Evaluation of Rotating Drum Screen Facilities in the Yakima River Basin, South-Central Washington State." Fisheries Bioengineering Symposium, American Fisheries Society Symposium 10:325-334.

Neitzel, D. A., T. J. Clune, and C. S. Scott. 1990. "Evaluation of Rotary Drum Screens Used to Protect Juvenile Salmonids in the Yakima River Basin, Washington, USA." Presented on October 18-22, 1990, Gifu, Japan.

Neitzel, D. A. 1989. "Assessment of Irrigation Screen Facilities Effects on Juvenile Salmonids in the Yakima River, Washington." Presented at the Annual Meeting of the American Fisheries Society, September 4-8, 1989, Anchorage, Alaska.

Neitzel, D. A., C. S. Abernethy, and E. W. Lusty. 1988. "Evaluation of Fish Screening Facilities in the Yakima Basin, Washington." Program for Fisheries Bioengineering Symposium, American Fisheries Society: Bioengineering Section, October 24-27, 1988.

Congratulations!