EST. 1891
MARYSVILLE
WASHINGTON

CITY COUNCIL REGULAR MEETING
TUESDAY, MAY 27, 2025 – 7:00 PM
501 DELTA AVENUE
MARYSVILLE, WA 98270

AGENDA

To listen to the meeting without providing public comment:
Join Zoom Meeting
https://us06web.zoom.us/j/86246307568
Or
Dial toll-free US: 888 475 4499
Meeting ID: 862 4630 7568

Call to Order

Invocation

Pledge of Allegiance

Roll Call

Approval of the Agenda

Presentations

Public Comment

Approval of Minutes *(Written Comment Only Accepted from Audience)*

1. April 28, 2025, City Council Meeting Minutes
   CC 04282025.docx

Consent

2. May 7, 2025, Claims in the Amount of $815,385.35 Paid by EFT Transactions and Check Numbers 177527 through 177658 with Check Numbers 165418, 166499, 168075, 169569, 169776, 170122 and 177326 Voided
   050725.rtf

3. May 9, 2025 Payroll in the Amount of $2,107,215.47 Paid by EFT Transactions and Check Numbers 35668 through 35695

4. May 14, 2025, Claims in the Amount of $756,023.53 Paid by EFT Transactions and Check Numbers 177659 through 177827 with Check Numbers 170355 and 177552 Voided
051425.rtf

Review Bids

Public Hearings

New Business

5. Subaward Between the Tulalip Tribes of Washington and the City of Marysville to Implement Portions of the Tulalip Fish Passage Collaborative I Project. *Resubmittal of Subaward with all referenced exhibits.
Recommended Motion: I move to authorize the Mayor to sign and execute the Subaward with the Tulalip Tribes of Washington.
Final Subaward with Exhibit A, B, C.pdf

6. Revised Local Agency Agreement and Prospectus with WSDOT for the 67 th Ave NE (Grove St to 88th St NE) project
Recommended Motion: I move to ratify the Mayor's execution of the revised Local Agency Agreement and Prospectus with WSDOT for the 67th Ave NE (Grove ST to 88th St NE) project.
Revised LAA & Prospectus 67th Ave NE to 88th St NE--City Executed.pdf

7. Interlocal Agreement between City of Marysville and Snohomish County to Provide Information Technology Services
Recommended Motion: I move to authorize the Mayor to sign and execute the interlocal agreement with Snohomish County for IT Services.
Marysville ILA 2025 with WO_final AATF.pdf
Snohomish County_City of Marysville_25-26 GL, Ex, Cyber, Stop_5-21-2025.pdf

Legal

Mayor's Business

Staff Business

Call on Councilmembers and Committee Reports

Adjournment/Recess

Executive Session
A. Litigation
B. Personnel
C. Real Estate

Reconvene

Adjournment

<u>Special Accommodations:</u> The City of Marysville strives to provide accessible meetings for people with disabilities. Please contact the City Clerk's office at (360) 363-8000 or 1-800-833-6384 (Voice Relay), 1-800-833-6388 (TDD Relay) two business days prior to the meeting date if any special accommodations are needed for this meeting.

AGENDA ITEM NO. 1.

Agenda Bill

CITY COUNCIL AGENDA ITEM REPORT

DATE:	May 27, 2025
SUBMITTED BY:	Chari Taber, City Clerk
ITEM TYPE:	Minutes
AGENDA SECTION:	Approval of Minutes
SUBJECT:	April 28, 2025, City Council Meeting Minutes
SUGGESTED ACTION:	
SUMMARY:	

ATTACHMENTS:
CC 04282025.docx

City Council

501 Delta Ave
Marysville, WA 98270

Regular Meeting Minutes April 28, 2025

Call to Order

Mayor Nehring called the meeting to order at 7:00 p.m.

Invocation

The invocation was given by Chaplain Dan Hazen from Allen Creek Community Church.

Pledge of Allegiance

Mayor Nehring led the Pledge of Allegiance.

Roll Call

Present:

Mayor: Jon Nehring

Council; Councilmember Condyles, Councilmember James, Councilmember King, Council President Stevens, Councilmember Richards, Councilmember Muller, Councilmember Norton

Staff: Deputy City Attorney Burton Eggertsen, Finance Director Jennifer Ferrer-Santa Ines, City Administrator Jennifer Stapleton, Parks & Rec Director Tara Mizell, Communications Manager Connie Mennie, Interim Community Development Director Jeff Wilson, Communications Specialist Bridgette Larsen, IT Director Stephen Doherty, Systems and Database Analyst Will Kaiser, Asst. Chief Jim Lawless, Human Resources Director Megan Hodgson, Engineering Services Director Jeff Laycock

Approval of the Agenda

Motion to approve the agenda moved by Councilmember James seconded by Councilmember Richards.
AYES: ALL

Presentations

A. Swearing-in of Corporal Aly Mustain

Aly Mustain Oath of Office.docx

Asst. Chief Lawless introduced Corporal Aly Mustain. Mayor Nehring performed the Oath of Office.

B. Proclamation Declaring May 4-10, 2025, Professional Municipal Clerks Week in Marysville

PROCLAMATION Municipal Clerks Week 2025.pdf

Mayor Nehring read the proclamation into the record.

Public Comment

None

Approval of Minutes

1. April 7, 2025, City Council Work Session Minutes

CC 04072025.docx

Motion to approve the April 7, 2025, City Council Work Session Minutes moved by Councilmember Richards seconded by Council President Stevens.
AYES: ALL

2. Approval of April 14, 2025, City Council Meeting Minutes

CC 04142025.docx

Under Call on Councilmembers "Quack Car Wash" should be corrected to "Quick Quack Car Wash".

Motion to approve the April 14, 2025, City Council Meeting Minutes with the correction of Quack to Quick Quack under Call on Councilmembers moved by Councilmember James seconded by Councilmember King.
AYES: ALL

Consent

3. April 9, 2025, Claims in the Amount of $4,749,744.76 Paid by EFT Transactions and Check Numbers 176940 through 177123

040925.rtf

4. April 10, 2025, Payroll in the Amount of $2,065,348.67 Paid by EFT Transactions and Check Numbers 35630 through 35644

5. April 16, 2025, Claims in the Amount of $1,302,749.27 Paid by EFT Transactions and Check Numbers 177124 through 177265 with Check Number 176309 Voided

041625.rtf

Motion to approve the Consent Agenda items 3, 4, and 5 moved by Councilmember Condyles seconded by Councilmember Muller.
AYES: ALL

Review Bids

6. Contract Award - 2025 Pavement Preservation Project

T2501_Vicinity Map.pdf

TS2501 2025 PPP Bid Tab.pdf

T2501_Draft Contract_Reece.pdf

Director Laycock reviewed this item. Councilmember King asked about the price of asphalt. Director Laycock said they got a really good price from Reece.

Motion to authorize the Mayor to sign and execute the 2025 Pavement Preservation Project contract with Reece Construction Company in the amount of $2,318,639.95 and approve a management reserve of $231,864.00 for a total allocation of $2,550,503.95 moved by Councilmember Richards seconded by Councilmember Muller.
AYES: ALL

Public Hearings

7. An Ordinance Adopting the 2025-2029 Community Development Block Grant Consolidation Plan

Executive Summary.pdf

ORD-CDBG 2025-2029 ConPlan.docx

Interim Community Development Director Jeff Wilson reviewed this item.

The public hearing was opened at 7:16 p.m. and comments were solicited. Seeing none, the hearing was closed at 7:16 p.m.

Motion to adopt Ordinance No. 3349 moved by Councilmember King seconded by Councilmember Condyles.
AYES: ALL

New Business

8. A Resolution Amending the City's Personnel Rules

Resolution_-_Amending_Personnel_Rules.pdf

Policy 5.1 - Workweek and Timesheets.pdf

Policy 5.5 - Alternative Work Schedule.pdf

Policy 5.6 - Remote Work.pdf

Mayor Nehring introduced this item related to working from home and alternative work schedules. Director Hodgson made a presentation on Personnel Policies related to Workweek and Timesheets; Alternative Work Schedules; and the Remote Work Policy. Clarification questions followed about leadership approval, consistency with other jurisdictions, and the revised meal period.

Motion to adopt Resolution No. 2567 moved by Councilmember Norton seconded by Councilmember Condyles.
AYES: ALL

9. Contract with CML Security, LLC for Four Jail Housing Pod Mezzanine Mesh Jump Barriers

CML Security - Jump Barrier.pdf

Marysville Mezzanine Mesh Jump Barrier Sole Source Letter.pdf

Sole Source Justification.pdf

Asst. Chief Lawless reviewed this agreement for the installation of barrier additions to four jail housing pods. Questions followed related to impacts to jail operations during the installation, the material to be used, and background checks on contractors.

Motion to authorize the Mayor to sign and execute the agreement with CML Security for mezzanine barrier additions to the four housing pods in the Marysville Jail in the amount

of $465,986.00 moved by Council President Stevens seconded by Councilmember James.
AYES: ALL

10. Local Agency Agreement and State Funds Project Prospectus with WSDOT for the Cascade Elementary – 100th St NE (52nd Dr NE to 55th Ave NE) Safe Routes to School Project

R2104_140-087_LPSFA.pdf

R2104-140-052 Prospectus.pdf

Director Laycock reviewed this item related to a portion of construction for the Safe Routes to School project at Cascade Elementary.

Motion to authorize the Mayor to sign and execute the Local Agency Agreement and State Funds Project Prospectus to obligate funds for the construction phase for the Cascade Elementary – 100th St NE SRTS project moved by Councilmember Muller seconded by Councilmember Norton.
AYES: ALL

11. Project Acceptance - SR 531/172nd St NE Shoulder Improvements

Notice of Physical Completion.pdf

Director Laycock explained this is to start the 60-day lien filing period for project closeout for a shoulder project at SR 531 and 172nd Street NE

Motion to authorize the Mayor to accept the SR 531/172nd St NE Shoulder Improvements project, starting the 60-day lien filing period for the project closeout moved by Councilmember Condyles seconded by Councilmember Richards.
AYES: ALL

12. Project Acceptance - 2024 Pavement Preservation Project

Notice of Physical Completion.pdf

Director Laycock reviewed this request to accept the project closeout for the 2024 Pavement Preservation Project.

Motion to authorize the Mayor to accept the 2024 Pavement Preservation Project, starting the 60-day lien filing period for the project closeout moved by Councilmember Norton seconded by Council President Stevens.
AYES: ALL

13. Project Acceptance - Sunnyside Blvd and 52nd St NE Intersection Improvement Project

Physical Completion Letter_2025-03-20.pdf

Director Laycock reviewed the request to accept project closeout for the Sunnyside Blvd and 52nd St NE Intersection Improvement project.

Councilmember King referred to the delay on materials and asked if they would have a similar situation on 53rd Avenue. Director Laycock indicated that they would, but they are hoping to get it all done by the end of August.

Councilmember Muller commented that they did a great job managing that project. Councilmember King concurred.

Motion to authorize the Mayor accept the Sunnyside Blvd and 52nd Street NE Intersection Improvement project, starting the 60-day lien filing period for the project closeout moved by Councilmember King seconded by Councilmember James.
AYES: ALL

14. 2024 Transportation Benefit District (TBD) Annual Report

2024 TBD Annual Report Letter Final.pdf

TBD_Snapshot.pdf

Director Laycock presented the TBD Annual Report.

Councilmember Condyles asked about the election costs. Director Ferrer-Santa Ines explained it refers to the cost to put the item on the ballot.

Councilmember Norton asked if there are any plans for using the funds for any other transportation improvements besides overlay projects. Director Laycock indicated they could look into this for future budget projections.

Councilmember Richards asked if some of the TBD money could be used for quiet zones. Director Laycock thought that was a possibility.

Councilmember Condyles asked if the current Pavement Preservation level is currently stretching staff to capacity. He has to balance it out with other obligations each year.

Motion to approve the 2024 Transportation Benefit District (TBD) Annual Report moved by Councilmember Condyles seconded by Councilmember Richards.
AYES: ALL

15. RCO Grant - Deed of Right for 4922 61st St NE - Ebey Waterfront Trail Acquisition, RRG Trails #20-1721

Deed of Right - Ebey Waterfront Trail Property.pdf

RCO Grant Agreement.pdf

Deputy City Attorney Eggertsen reviewed this item related to a grant from the RCO for the acquisition of properties to support the Ebey Waterfront Trail.

Motion to authorize the Mayor to sign and execute the Deed of Right to Use Land for Public Outdoor Recreation Purposes for the Ebey Waterfront Trail Property moved by Councilmember James seconded by Councilmember Norton.
AYES: ALL

Legal

Mayor's Business

Mayor Nehring:

- He said he is looking forward to the annual business summit at the Opera House tomorrow.
- The fishing derby is happening this Saturday.
- They had a great Economic Alliance Snohomish County event last week.

Staff Business

Director Mizell:

- The Eagle Wings will be the new tenant at Jennings Park.
- The inclusive play training will be happening next month at Council Chambers.
- The fishing derby this weekend will be great.

Deputy City Attorney Eggertsen stated the need for an executive session for one item related to acquisition of real estate for five minutes with a request for action.

Call on Councilmembers and Committee Reports

Councilmember Condyles:

- He reported on the Finance Committee and Snohomish County Tomorrow meetings.
- He attended an adopt-a-stream Earth Day celebration last week and a cleanup at Twin Lakes.
- He reported on an informative presentation by Lorraine Ralston from America 250.
- He thanked staff and Council for the condolences and the flowers.

Councilmember James:

- He is looking forward to the business summit.
- Congratulations to Corporal Mustain.
- He reported on the Snohomish County Cities meeting.

- He attended a really good "Elton John" show at the Opera House.
- He attended the Easter Eggstravaganza which was very well attended.
- He also attended the EASC event.

Councilmember King:
- Congrats to Corporal Mustain.
- He also enjoyed the Easter Eggstravaganza.
- The spring cleanup was a great event.
- The Strawberry Festival float will be going to Wenatchee this weekend.

Council President Stevens highlighted the number of grants that Public Works used to accomplish many of the completed projects that were approved tonight.

Councilmember Richards reported on the Public Works meeting.

Councilmember Muller:
- He attended Clean Sweep; they did a great job.
- Sidewalks are looking good.
- The exit from I-5 looks like it is done. He is looking forward to it opening.
- He will be out of town for next week's meeting but will be attending on Zoom.

Councilmember Norton:
- She reported on the April 15 Public Safety Committee meeting.
- She also enjoyed the EASC event.
- She also is looking forward to the business summit tomorrow.

Adjournment/Recess

Council recessed at 8:08 p.m. for seven minutes before reconvening at 8:15 p.m. in the Executive Session.

Executive Session

Council entered Executive Session for five minutes at 8:15 p.m. to discuss one item, related to the acquisition of real estate with action expected.

A. Litigation
B. Personnel
C. Real Estate—one item, RCW 42.30.110(1)(b)

Reconvene

The regular meeting reconvened at 8:20 p.m.

Motion to authorize the Mayor to sign the settlement agreement with James and Linda Cavanaugh in the amount of $205,800 plus miscellaneous improvements as described

in the agreement moved by Councilmember Richards seconded by Councilmember Muller.
AYES: ALL

Adjournment

Motion to adjourn the meeting at 8:21 p.m. moved by Councilmember Muller seconded by Council President Stevens.
AYES: ALL

Approved this _______ day of ___________________, 2025

AGENDA ITEM NO. 2.

EST. 1891 MARYSVILLE WASHINGTON

Agenda Bill

CITY COUNCIL AGENDA ITEM REPORT

DATE:	May 27, 2025
SUBMITTED BY:	Shauna Crane, Finance
ITEM TYPE:	Claims
AGENDA SECTION:	**Consent**
SUBJECT:	May 7, 2025, Claims in the Amount of $815,385.35 Paid by EFT Transactions and Check Numbers 177527 through 177658 with Check Numbers 165418, 166499, 168075, 169569, 169776, 170122 and 177326 Voided
SUGGESTED ACTION:	
SUMMARY:	

ATTACHMENTS:
050725.rtf

CITY OF MARYSVILLE
INVOICE LIST

FOR INVOICES FROM 5/7/2025 TO 5/7/2025

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177527	LICENSING, DEPT OF	STATE GUN DEALER LICENSE	INTERGOVERNMENTAL	125.00
177528	LICENSING, DEPT OF	FIREARMS SECTION	INTERGOVERNMENTAL	714.00
177529	FIRST AMERICAN TITLE	RECORD POSSESSION/ AGREEMENT	GMA - STREET	206,115.50
177530	LICENSING, DEPT OF	DRIVING ABSTRACT - ANGULO	PERSONNEL ADMINISTRATION	15.00
	LICENSING, DEPT OF	DRIVING ABSTRACT - FRANKLIN	PERSONNEL ADMINISTRATION	15.00
	LICENSING, DEPT OF	DRIVING ABSTRACT - MORALES	PERSONNEL ADMINISTRATION	15.00
	LICENSING, DEPT OF	DRIVING ABSTRACT - THOMAS	PERSONNEL ADMINISTRATION	15.00
177531	BOYD, RAE	NURSES ASSESSMENT/BLOOD DRAWS	DETENTION & CORRECTION	1,650.00
	BOYD, RAE	NURSES CONTRACT	DETENTION & CORRECTION	45,150.00
177532	DUNFORD, TARA	2024 ACFR REVIEW	FINANCE-GENL	2,340.00
177533	911 SUPPLY INC.	CUSTODY UNIFORMS	DETENTION & CORRECTION	660.85
177534	AGUIRRE, ANDREW	UB REFUND	WATER/SEWER OPERATION	31.98
177535	ALEXANDER PRINTING	BUSINESS CARDS	EXECUTIVE ADMIN	102.83
	ALEXANDER PRINTING	LAMINATED WARNING CARDS	METER READING	261.12
	ALEXANDER PRINTING	EVIDENCE RECEIPT PRINTING	POLICE PATROL	643.60
177536	ANDERTON, WESLEY MIC	UB REFUND	WATER/SEWER OPERATION	204.10
177537	ASSN OF WA CITIES	SAFETY ALLIANCE/CONSORTIUM SERVICE	PERSONNEL ADMINISTRATION	4,370.00
	ASSN OF WA CITIES		PERSONNEL ADMINISTRATION	77,888.77
177538	BELLINGHAM ALIVE MAG	ADVERTISING	RECREATION SERVICES	500.00
177539	BILLING DOCUMENT SPE	BILL PRINTING SERVICE	UTILITY BILLING	2,578.00
	BILLING DOCUMENT SPE		UTILITY BILLING	2,905.84
177540	BIO CLEAN, INC.	CAR DECONTAMINATION	POLICE PATROL	492.30
177541	BIOTECH SCREENING	JAIL SUPPLIES	DETENTION & CORRECTION	922.38
177542	BLAKE, BRANDON	AXON INVESTIGATE	POLICE INVESTIGATION	293.00
	BLAKE, BRANDON	IACIS FORENSICS CONFERENCE	POLICE INVESTIGATION	520.00
177543	BROCK, TINA	WAPRO TRAINING	CITY CLERK	23.97
177544	BROOKS, JEFF	REIMBURSEMENT	UTIL ADMIN	106.00
	BROOKS, JEFF		UTIL ADMIN	196.89
177545	BRUCE, KENT D	LIGHT BAR ASSEMBLY - P221	EQUIPMENT RENTAL	515.93
177546	BURTIS, MICHAEL	EXPENSE REIMBURSEMENT	DETENTION & CORRECTION	72.53
177547	CML SECURITY, LLC	CAMERA REPAIR/MAINTENANCE	POLICE PATROL	328.20
177548	CMR2 LLC	REFRIGERATOR DROP OFF	ROADSIDE VEGETATION	75.00
177549	COMCAST	ACCT #8498310021752089	COMPUTER SERVICES	598.64
177550	COMMERCIAL FIRE	CITY HALL FIRE TESTING	NON-DEPARTMENTAL	2,073.90
177551	CORE & MAIN LP	WATER METER REGISTERS	METER READING	5,007.18
	CORE & MAIN LP	FIRE HYDRANT, LUGGED RESTR PACK	HYDRANTS	5,150.40
177552	CRUTCHER, NIKOLE	TRAINING	OFFICE OPERATIONS	219.00
177553	DETROIT INDUSTRIAL T	SAW BLADES	WATER/SEWER OPERATION	-103.86
	DETROIT INDUSTRIAL T		WATER SERVICES	1,208.80
177554	DIAMOND, BLAIR	LICENSING RENEWAL	GENERAL	136.00
177555	DICKS TOWING	TOWING 25-22248	POLICE PATROL	77.54
	DICKS TOWING	TOWING 25-21009	POLICE PATROL	155.08
177556	DORSCHER, EMILY	REIMBURSEMENT - TRAINING	POLICE INVESTIGATION	481.80
177557	DRIVE PAYMENTS, LLC	PAYMENT PROCESSING	UTILITY BILLING	933.45
177558	DUNLAP INDUSTRIAL	SECURITY BIT TIP SET	TRANSPORTATION	30.44
177559	E&E LUMBER	PADLOCK	NON-DEPARTMENTAL	11.78
	E&E LUMBER	REBAR CAP	SIDEWALK MAINTENANCE	18.22
	E&E LUMBER	WATERMAIN THRUST BLOCKS	WATER DIST MAINS	19.25
	E&E LUMBER	ADAPTERS, CLAMP	WATER SERVICES	24.31
	E&E LUMBER	SAW BLADES	WATER DIST MAINS	42.93
	E&E LUMBER	WIRE/CRIMPED/ANGLE GRIND BRUSHES	SIDEWALK MAINTENANCE	47.40
	E&E LUMBER	POWER BITS, FIP CAP	FACILITY MAINTENANCE	49.45

FOR INVOICES FROM 5/7/2025 TO 5/7/2025

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177559	E&E LUMBER	PICKUP STICKS	ROADSIDE VEGETATION	57.87
	E&E LUMBER	HAMMER, FASTENERS	SIDEWALK MAINTENANCE	71.65
	E&E LUMBER	WATERMAIN THRUST BLOCKS	WATER DIST MAINS	313.32
	E&E LUMBER	GRAFFITI PAINT/SUPPLIES	ROADSIDE VEGETATION	361.09
177560	EAST JORDAN IRON WORK	VALVE COVERS	WATER DIST MAINS	254.03
	EAST JORDAN IRON WORK	WATER VALVE BOX	WATER DIST MAINS	1,355.86
177561	EGGERTSEN, BURTON	REIMBURSEMENT OF COURT RECORDS	COMMUNITY	68.16
177562	EMPLOYMENT SECURITY	Q1 EMPLOYMENT SECURITY INTEREST	EMPLOYEE BENEFIT	29,411.08
177563	ENTERPRISE RENTAL	CAR RENTALS	POLICE PATROL	319.03
177564	ESPINOZA, MARION	UB REFUND	WATER/SEWER OPERATION	147.12
177565	EVANS, WILLIAM & JAC	UB REFUND	GARBAGE	158.66
177566	EVERETT, CITY OF	ANIMALS TO SHELTER	POLICE COMMUNITY	6,480.00
177567	EVIDENT, INC.	EVIDENCE SUPPLIES	GENERAL FUND	-16.25
	EVIDENT, INC.		GENERAL FUND	-8.08
	EVIDENT, INC.		POLICE PATROL	94.08
	EVIDENT, INC.		POLICE PATROL	189.14
177568	EWING IRRIGATION	GENERAL USE PESTICIDE	ROADSIDE VEGETATION	2,484.87
177569	FAMILY PET MEDICAL	VET VISIT	K9 PROGRAM	116.96
	FAMILY PET MEDICAL		K9 PROGRAM	1,595.31
177570	FARLEY, CHRISTOPHER	FUGITIVE TRANSPORT OPERATION	POLICE INVESTIGATION	129.00
177571	FELDMAN & LEE P.S.	PUBLIC DEFENSE - APRIL 2025	PUBLIC DEFENSE	17,955.00
	FELDMAN & LEE P.S.		PUBLIC DEFENSE	45,045.00
177572	FERGUSON ENTERPRISES	SEAL KIT	WATER DIST MAINS	142.09
177573	FERRARO, TABITHA	REIMBURSEMENT - UNIFORM	SOLID WASTE OPERATIONS	42.63
177574	FIDELITY NATIONAL	PARTIAL RECONVEYANCE FEE	GMA - STREET	496.35
177575	FOOT WORKS	INSTRUCTOR PAYMENT	RECREATION SERVICES	480.00
177576	FORSLOF, WALLACE	FUGITIVE TRANSPORT OPERATION	POLICE INVESTIGATION	129.00
177577	GILDEN, ROBERT	UB REFUND: 9516 57TH DR NE	WATER/SEWER OPERATION	278.45
177578	GRAINGER	BRAILLE FACILITY SIGN	PARK & RECREATION FAC	17.62
	GRAINGER	REFLECTIVE FIRE ALARM SIGN	NON-DEPARTMENTAL	43.28
	GRAINGER	SPRING HINGE	UTIL ADMIN	72.88
	GRAINGER	LEAK DIVERTER	SMALL ENGINE SHOP	298.65
177579	GRANITE CONST	SEED LIMIT SIGNS	TRANSPORTATION	1,263.85
177580	GRAY AND OSBORNE	STORM/SURFACE WATER COMP PLAN	SURFACE WATER CAPITAL	36,489.07
177581	GRIFFEN LAW OFFICE	PUBLIC DEFENSE/CONFLICT COUNCIL	PUBLIC DEFENSE	450.00
	GRIFFEN LAW OFFICE		PUBLIC DEFENSE	450.00
	GRIFFEN LAW OFFICE		PUBLIC DEFENSE	450.00
	GRIFFEN LAW OFFICE		PUBLIC DEFENSE	450.00
	GRIFFEN LAW OFFICE		PUBLIC DEFENSE	450.00
	GRIFFEN LAW OFFICE		PUBLIC DEFENSE	450.00
	GRIFFEN LAW OFFICE		PUBLIC DEFENSE	450.00
	GRIFFEN LAW OFFICE		PUBLIC DEFENSE	450.00
177582	HD FOWLER COMPANY	PLUNGER, REPAIR KIT, SAMPLE STATION	WATER DIST MAINS	3,087.53
177583	HERC RENTALS INC	AIR COMPRESSOR RENTAL	WATER DIST MAINS	826.45
177584	HOME DEPOT PRO	FILTER FOR VAC	CUSTODIAL SERVICES	19.66
	HOME DEPOT PRO	TOILET SEAT COVERS	CUSTODIAL SERVICES	86.84
	HOME DEPOT PRO	CLEANER	CUSTODIAL SERVICES	88.22
	HOME DEPOT PRO	GLASS CLEANER	CUSTODIAL SERVICES	98.56
	HOME DEPOT PRO	DOLLY SWIVEL WHEELS	CUSTODIAL SERVICES	104.54
	HOME DEPOT PRO	PLUNGERS	CUSTODIAL SERVICES	127.45
	HOME DEPOT PRO	RESTROOM MATS	CUSTODIAL SERVICES	213.05
	HOME DEPOT PRO	PAPER TOWELS	CUSTODIAL SERVICES	257.37

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177584	HOME DEPOT PRO	PICK UP TOOLS	CUSTODIAL SERVICES	273.06
	HOME DEPOT PRO	PAPER TOWELS	CUSTODIAL SERVICES	278.90
	HOME DEPOT PRO		CUSTODIAL SERVICES	278.90
	HOME DEPOT PRO	BROOMS/DUST PANS	CUSTODIAL SERVICES	287.59
	HOME DEPOT PRO	TRASH BAGS	CUSTODIAL SERVICES	296.15
	HOME DEPOT PRO	WIRE SHELVING	CUSTODIAL SERVICES	356.10
	HOME DEPOT PRO	TOILET PAPER	CUSTODIAL SERVICES	371.65
	HOME DEPOT PRO	HAND SOAP/CLEANER	CUSTODIAL SERVICES	541.26
	HOME DEPOT PRO	TOILET PAPER/SCRUB BRUSHES	CUSTODIAL SERVICES	565.03
	HOME DEPOT PRO	PAPER TOWELS/TRASH BAGS	CUSTODIAL SERVICES	926.30
177585	HORNUNG, CHRIS	REIMBURSEMENT - MILEAGE/HOTEL	PROBATION	581.41
177586	HUTCHISON LAW, LLC	CONFLICT COUNSEL	PUBLIC DEFENSE	450.00
	HUTCHISON LAW, LLC		PUBLIC DEFENSE	450.00
	HUTCHISON LAW, LLC		PUBLIC DEFENSE	450.00
177587	INTERSTATE BATTERY	BATTERY CORE CREDIT	EQUIPMENT RENTAL	-20.00
	INTERSTATE BATTERY	BATTERIES	ER&R	229.37
	INTERSTATE BATTERY		ER&R	379.97
177588	J & B TOOLS, LLC.	DRIVER BITS, JOINT PLIERS	EQUIPMENT RENTAL	246.57
177589	JACOBSON, ELLIOT	MOUNTING TV SUPPLIES	COMPUTER SERVICES	26.14
177590	JULZ ANIMAL HOUZ	K9 SUPPLIES	K9 PROGRAM	28.73
177591	KBHPNW LLC	UB REFUND	WATER/SEWER OPERATION	31.20
177592	KENWORTH NORTHWEST	CRANK CASE FILTER - J046	EQUIPMENT RENTAL	115.88
177593	KINNEY, HEATHER	REIMBURSEMENT - MEAL CLASS	TRAINING	24.58
177594	KITSAP TRACTOR	TIRE/WHEEL ASSEMBLY - W019	EQUIPMENT RENTAL	788.11
177595	KUYATEH, SAIKOU	UB REFUND	WATER/SEWER OPERATION	192.03
177596	LASTING IMPRESSIONS	SOCCER LEAGUE T-SHIRTS	RECREATION SERVICES	5,671.73
177597	LAYTON TREE CONSULT	TREE ASSESSMENTS	ROADSIDE VEGETATION	282.55
177598	LEE, DARRYL	REIMBURSEMENT - MILEAGE	DETENTION & CORRECTION	77.00
177599	LES SCHWAB TIRE CTR	TIRES	ER&R	260.61
	LES SCHWAB TIRE CTR		ER&R	2,345.51
177600	LGI HOMES WASHINGTON	UB REFUND	WATER/SEWER OPERATION	25.00
177601	LGI HOMES WASHINGTON		WATER/SEWER OPERATION	5.98
	LGI HOMES WASHINGTON		WATER/SEWER OPERATION	282.40
177602	LGI HOMES WASHINGTON		WATER/SEWER OPERATION	50.00
177603	LOOMIS	ARMORED CAR SERVICE	UTILITY BILLING	158.63
	LOOMIS		MUNICIPAL COURTS	158.63
	LOOMIS		POLICE ADMINISTRATION	158.64
	LOOMIS		COMMUNITY	158.64
	LOOMIS		GOLF ADMINISTRATION	346.40
177604	MALLORY SAFETY & SUP	SWAT HELMET ACCESSORIES	POLICE PATROL	312.43
	MALLORY SAFETY & SUP	SWAT HELMET	POLICE PATROL	1,713.75
177605	MARYSVILLE AWARDS	ALUMINUM PLAQUE	PARK & RECREATION FAC	224.26
	MARYSVILLE AWARDS	AWARDS	POLICE ADMINISTRATION	778.36
177606	MILLER, DEANNA	PERDIEM - TRAINING	OFFICE OPERATIONS	219.00
177607	MILLER, TARYN M	UB REFUND	GARBAGE	464.59
177608	MISTAL-MANER, MEGAN	REIMBURSEMENT - SUPPLIES	DETENTION & CORRECTION	19.62
177609	NAPA AUTO PARTS	FUEL FILTER - J046	EQUIPMENT RENTAL	17.72
	NAPA AUTO PARTS	GAS CAP - J038	EQUIPMENT RENTAL	19.06
	NAPA AUTO PARTS	AIR FILTER - H011	EQUIPMENT RENTAL	20.29
	NAPA AUTO PARTS	FUEL CONDITIONER	WATER SERVICES	125.93
	NAPA AUTO PARTS	BATTERY - P899	EQUIPMENT RENTAL	160.97
177610	NATIONAL BARRICADE	PEDESTRIAN SIGNS	TRANSPORTATION	119.46

FOR INVOICES FROM 5/7/2025 TO 5/7/2025

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177610	NATIONAL BARRICADE	DETOUR SIGNS	TRAFFIC CONTROL DEVICES	660.06
	NATIONAL BARRICADE	SIGNS	TRANSPORTATION	2,789.14
177611	NELSON-REISNER	ENGINE/TRANSMISSION/HYDRAULIC OIL	ER&R	2,680.16
177612	NEWREZ LLC	APPRAISAL SERVICE	GMA - STREET	1,350.30
177613	NGUYEN, HUONG	UB REFUND	WATER/SEWER OPERATION	379.50
177614	NW EMERGENCY	INMATE MEDICAL CARE	DETENTION & CORRECTION	1,370.00
177615	OCCUPATIONAL HEALTH	CDL EXAM - GANT	UTIL ADMIN	136.00
177616	OLSON, MELISSA	REFUND - SOCCER	PARKS-RECREATION	110.00
177617	OREILLY AUTO PARTS	O-RING KIT - J055	EQUIPMENT RENTAL	11.86
	OREILLY AUTO PARTS	BULB - H011	EQUIPMENT RENTAL	14.97
177618	OWEN EQUIPMENT	PARTS - 799 S	EQUIPMENT RENTAL	920.66
	OWEN EQUIPMENT	DEBRIS HOSE	WATER SERVICES	3,995.28
177619	PACIFIC PLUMBING	MECHANIC SHOP HOSE BIB	EQUIPMENT RENTAL	878.66
177620	PALITZ, JUSTIN	REIMBURSEMENT - MEAL	UTIL ADMIN	20.00
177621	PALMER, BRANDON	WASPC CONFERENCE	DETENTION & CORRECTION	215.00
177622	PEACE OF MIND	CITY COUNCIL MEETING	CITY CLERK	171.00
177623	PETERSON, COLBY	CLAIMS FOR DAMAGES	RISK MANAGEMENT	3,382.10
177624	PITCH PERFECT ACADEMY	INSTRUCTOR PAYMENT	RECREATION SERVICES	3,617.40
177625	PLATT ELECTRIC	ZOOM FISH TAPE	TRANSPORTATION	200.46
177626	PROVIDENCE EVERETT M	INMATE MEDICAL CARE	DETENTION & CORRECTION	921.12
177627	PUBLIC SAFETY TESTIN	SERGEANT ASSESSMENT CENTER	POLICE ADMINISTRATION	8,806.56
177628	PUD	ACCT #205283641	STREET LIGHTING	10.46
	PUD	ACCT #205026479	STREET LIGHTING	14.39
	PUD		STREET LIGHTING	22.53
	PUD	ACCT #204584361	STREET LIGHTING	22.66
	PUD		STREET LIGHTING	30.05
	PUD	ACCT #204933311	PUMPING PLANT	46.49
	PUD	ACCT #202177861	PUMPING PLANT	48.66
	PUD	ACCT #200998532	PARK & RECREATION FAC	49.19
	PUD	ACCT #201380995	PUMPING PLANT	57.23
	PUD	ACCT #202791166	PUMPING PLANT	57.74
	PUD	ACCT #224162602	PARK & RECREATION FAC	60.00
	PUD	ACCT #223286667	METER READING	62.98
	PUD	ACCT #202220760	GOLF ADMINISTRATION	63.05
	PUD	ACCT #221303498	STREET LIGHTING	67.44
	PUD	ACCT #220153100	TRANSPORTATION	80.29
	PUD	ACCT #200869303	TRANSPORTATION	85.34
	PUD	ACCT #202183679	TRANSPORTATION	87.75
	PUD	ACCT #220339238	TRAFFIC CONTROL DEVICES	88.86
	PUD	ACCT #200800704	STREET LIGHTING	89.82
	PUD	ACCT #204879134	TRAFFIC CONTROL DEVICES	96.82
	PUD	ACCT #202368197	PUMPING PLANT	158.58
	PUD	ACCT #202576112	STREET LIGHTING	158.87
	PUD	ACCT #200084150	TRANSPORTATION	170.76
	PUD	ACCT #222592917	PARK & RECREATION FAC	204.06
	PUD	ACCT #203344585	STREET LIGHTING	252.66
	PUD	ACCT #200164598	SOURCE OF SUPPLY	414.35
	PUD	ACCT #201639630	GOLF ADMINISTRATION	797.33
	PUD	ACCT #201147253	PUMPING PLANT	1,032.89
	PUD	ACCT #200303477	WATER FILTRATION PLANT	1,429.80
	PUD	ACCT #202604203	STREET LIGHTING	2,185.24
	PUD	ACCT #202576112	STREET LIGHTING	3,018.69

FOR INVOICES FROM 5/7/2025 TO 5/7/2025

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177628	PUD	ACCT #202604203	STREET LIGHTING	3,277.87
	PUD	ACCT #201577921	PUMPING PLANT	5,585.79
	PUD	ACCT #202882098	STREET LIGHTING	13,280.82
	PUD		STREET LIGHTING	16,232.13
177629	RIPPO, TOBIN	UB REFUND	WATER/SEWER OPERATION	445.00
177630	ROSE, JASON	REIMBURSEMENT - MEAL	SOLID WASTE OPERATIONS	80.00
177631	SAMMUT, GRACE	UB REFUND	GARBAGE	22.04
177632	SENIOR HEALTH INS	LEOFF PREMIUM	POLICE ADMINISTRATION	6,736.15
177633	SHAKE, KATHY	UB REFUND	WATER/SEWER OPERATION	24.46
177634	SIX ROBBLEES INC	CREDIT FOR INV 14P46890	EQUIPMENT RENTAL	-158.17
	SIX ROBBLEES INC	CREDIT FOR INV14P46870	EQUIPMENT RENTAL	-130.54
	SIX ROBBLEES INC	WHEEL BALANCING	EQUIPMENT RENTAL	127.07
	SIX ROBBLEES INC	WHEELS - P129/P130	EQUIPMENT RENTAL	130.54
	SIX ROBBLEES INC		EQUIPMENT RENTAL	158.17
	SIX ROBBLEES INC	WHEEL BALANCING	EQUIPMENT RENTAL	594.45
	SIX ROBBLEES INC	WHEELS - P129/P130	EQUIPMENT RENTAL	1,044.29
177635	SKAGIT RADIOLOGY INC	INMATE MEDICAL CARE	DETENTION & CORRECTION	55.00
177636	SMOKEY POINT CONCRETE	CONCRETE DELIVERY	SIDEWALK MAINTENANCE	2,465.88
177637	SNO CO TREASURER	CRIME VICTIM/WITNESS FUNDS	CRIME VICTIM	1,213.21
177638	SNOHOMISH CO 911	DISPATCH	COMMUNICATION CENTER	103,932.42
177639	SOUND SAFETY	UNIFORM - NELSON	FACILITY MAINTENANCE	109.28
177640	STANG, JONNY	STATUTORY EVALUATION SETTLEMENT	GMA - STREET	750.00
177641	STATE PATROL	FINGERPRINT ID SERVICE	INTERGOVERNMENTAL	312.00
177642	SUPERIOR RESTROOMS	PORTABLE RESTROOM CLEANING	WATER DIST MAINS	71.11
	SUPERIOR RESTROOMS	PORTABLE RESTROOM	WATER DIST MAINS	71.11
	SUPERIOR RESTROOMS	PORTABLE RESTROOM CLEANING	ROADSIDE VEGETATION	142.22
	SUPERIOR RESTROOMS		ROADSIDE VEGETATION	142.22
	SUPERIOR RESTROOMS	PORTABLE RESTROOM RENTAL	PARK & RECREATION FAC	480.00
177643	TRANSUNION RISK & AL	INVESTIGATIVE TOOL	POLICE INVESTIGATION	490.18
177644	TSUI, CHI SHING	UB REFUND	WATER/SEWER OPERATION	143.95
177645	ULINE	EVIDENCE SUPPLIES	POLICE PATROL	424.65
	ULINE	JAIL SUPPLIES	DETENTION & CORRECTION	1,771.88
177646	VANDERWALKER,M	REIMBURSEMENT - TRAVEL	POLICE ADMINISTRATION	61.46
177647	VERIZON	AMR LINES	METER READING	462.37
177648	VESTIS GROUP INC.	UNIFORM CLEANING/SHOP RENTALS	EQUIPMENT RENTAL	38.60
	VESTIS GROUP INC.		EQUIPMENT RENTAL	58.79
177649	VESTIS GROUP INC.	CUSTODIAL CLEANING /MCC RENTALS	CUSTODIAL SERVICES	35.88
	VESTIS GROUP INC.		CUSTODIAL SERVICES	148.65
177650	VESTIS GROUP INC.	LINEN SERVICE	OPERA HOUSE	385.66
177651	WA STATE TREASURER	PUBLIC SAFETY/BLDG REVENUE	INTERGOVERNMENTAL	536.00
	WA STATE TREASURER		GENERAL FUND	68,302.27
177652	WATCH SYSTEMS	RSO MAILING	POLICE INVESTIGATION	113.41
177653	WILSON, JEFF	REIMBURSEMENT TRAVEL	COMMUNITY	1,368.88
177654	YUMUL, ROMA C	UB REFUND	WATER/SEWER OPERATION	221.09
177655	ZIPLY FIBER	ACCT #3606534028	CITY HALL	186.39
177656	ZIPLY FIBER	ACCT #3606577075	POLICE PATROL	75.44
177657	ZIPLY FIBER	ACCT #3606577108	STREET LIGHTING	75.23
177658	ZIPLY FIBER	ACCT #3606583358	POLICE PATROL	75.23

CITY OF MARYSVILLE
INVOICE LIST

FOR INVOICES FROM 5/7/2025 TO 5/7/2025

CHK #	VENDOR	ITEM DESCRIPTION		ACCOUNT DESCRIPTION	ITEM AMOUNT
			WARRANT TOTAL:		818,967.77
	ELLIOT JACOBSON	CHECK OST/DAMAGED	165418	VOID	$26.14
	TINA BROCK	CHECK OST/DAMAGED	166499	VOID	$23.97
	BURTON EGGERTSEN	CHECK OST/DAMAGED	168075	VOID	$68.16
	BLAIR DIAMOND	CHECK OST/DAMAGED	169569	VOID	$136.00
	MEGAN MISTAL-MANER	CHECK OST/DAMAGED	169776	VOID	$19.62
	MICHAEL BURTIS	CHECK OST/DAMAGED	170122	VOID	$72.53
	CODEX CORPORATION	CHECK OST/DAMAGED	177326	VOID	$3236.00

REASON FOR VOIDS:

WARRANT TOTAL: **$815,385.35**

INITIATOR ERROR

CHECK LOST/DAMAGED

UNCLAIMED PROPERTY

AGENDA ITEM NO. 3.

EST. 1891
MARYSVILLE
WASHINGTON

Agenda Bill

CITY COUNCIL AGENDA ITEM REPORT

DATE: May 27, 2025

SUBMITTED BY: Shannon Early, Finance

ITEM TYPE: Payroll

AGENDA SECTION: **Consent**

SUBJECT: May 9, 2025 Payroll in the Amount of $2,107,215.47 Paid by EFT Transactions and Check Numbers 35668 through 35695

SUGGESTED ACTION:

SUMMARY:

ATTACHMENTS:

AGENDA ITEM NO. 4.

EST. 1891
MARYSVILLE
WASHINGTON

Agenda Bill

CITY COUNCIL AGENDA ITEM REPORT

DATE: May 27, 2025

SUBMITTED BY: Shauna Crane, Finance

ITEM TYPE: Claims

AGENDA SECTION: **Consent**

SUBJECT: May 14, 2025, Claims in the Amount of $756,023.53 Paid by EFT Transactions and Check Numbers 177659 through 177827 with Check Numbers 170355 and 177552 Voided

SUGGESTED ACTION:

SUMMARY:

ATTACHMENTS:
051425.rtf

CITY OF MARYSVILLE
INVOICE LIST
FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
	PCARD ONE TIME PAY	COMPUTER SOFTWARE STORES	UTIL ADMIN	-431.20
	PCARD ONE TIME PAY	GOLF COURSE BATHROOM PARTS	GOLF ADMINISTRATION	-267.40
	PCARD ONE TIME PAY	MESH HOUSE HEATER- RETURN	NON-DEPARTMENTAL	-160.38
	PCARD ONE TIME PAY	AMAZON	RECREATION SERVICES	-116.94
	PCARD ONE TIME PAY	CITY LOGO GARMENTS CREDIT	MUNICIPAL COURTS	-101.52
	PCARD ONE TIME PAY	AMAZON	RECREATION SERVICES	-77.96
	PCARD ONE TIME PAY		RECREATION SERVICES	-64.82
	PCARD ONE TIME PAY		RECREATION SERVICES	-58.47
	PCARD ONE TIME PAY	CORK BOARD RETURN	CITY CLERK	-43.75
	PCARD ONE TIME PAY	AMAZON	RECREATION SERVICES	-38.98
	PCARD ONE TIME PAY		RECREATION SERVICES	-38.98
	PCARD ONE TIME PAY		RECREATION SERVICES	-32.21
	PCARD ONE TIME PAY	OFFICE SUPPLIES REFUND	UTIL ADMIN	-19.64
	PCARD ONE TIME PAY	AMAZON	RECREATION SERVICES	-19.49
	PCARD ONE TIME PAY		RECREATION SERVICES	-19.49
	PCARD ONE TIME PAY		RECREATION SERVICES	-12.72
	PCARD ONE TIME PAY		RECREATION SERVICES	-8.02
	PCARD ONE TIME PAY	DRIVING RECORD	PERSONNEL ADMINISTRATION	0.24
	PCARD ONE TIME PAY	AMAZON	COMPUTER SERVICES	1.37
	PCARD ONE TIME PAY	MAJOR CRIMES	POLICE INVESTIGATION	2.81
	PCARD ONE TIME PAY	EVENT SUPPLIES	OPERA HOUSE	3.11
	PCARD ONE TIME PAY	STATE AVE SIDEWALKS	SIDEWALK MAINTENANCE	3.82
	PCARD ONE TIME PAY	EVENT CREAMER	OPERA HOUSE	4.15
	PCARD ONE TIME PAY	VIDEO - HOP/AMAZON	RECREATION SERVICES	4.15
	PCARD ONE TIME PAY	SENIOR COFFEE SUPPLIES	RECREATION SERVICES	5.58
	PCARD ONE TIME PAY	ADVERTISING	COMMUNITY	5.94
	PCARD ONE TIME PAY	COURT COSTS	COMMUNITY SERVICES UNIT	6.94
	PCARD ONE TIME PAY	CHARGER EVIDENCE	POLICE PATROL	6.98
	PCARD ONE TIME PAY	SENIOR COFFEE/VILLAGE MARKET	RECREATION SERVICES	7.98
	PCARD ONE TIME PAY	MOP SINK HOSE	MAINT OF GENL PLANT	8.71
	PCARD ONE TIME PAY	SUPPLIES, WELLNESS	POLICE ADMINISTRATION	8.74
	PCARD ONE TIME PAY	GOOD TO GO TRAVEL	POLICE PATROL	9.00
	PCARD ONE TIME PAY	USP SHIPPING	POLICE PATROL	9.05
	PCARD ONE TIME PAY	TRAIL SIGN INSTALLATION	PARK & RECREATION FAC	9.63
	PCARD ONE TIME PAY	WELLNESS MOLLY SUPPLIES	POLICE ADMINISTRATION	9.84
	PCARD ONE TIME PAY	WINDOW SURFACE CORD	GENERAL	9.84
	PCARD ONE TIME PAY	FOOD HANDLERS PERMIT	POLICE ADMINISTRATION	10.00
	PCARD ONE TIME PAY	MAJOR CRIMES	POLICE INVESTIGATION	10.06
	PCARD ONE TIME PAY	DRIVING RECORD	PERSONNEL ADMINISTRATION	10.30
	PCARD ONE TIME PAY	FEED VALVE SUPPLIES	WATER FILTRATION PLANT	10.42
	PCARD ONE TIME PAY	WELLNESS SUPPLIES	POLICE ADMINISTRATION	10.82
	PCARD ONE TIME PAY	GROCERY STORES	PROBATION	11.48
	PCARD ONE TIME PAY	MUSIC UNLIMITED	RECREATION SERVICES	13.12
	PCARD ONE TIME PAY	PLANNER SUPPLIES	EMBEDDED SOCIAL WORKER	13.12
	PCARD ONE TIME PAY	NAMEPLATE HOLDERS	UTIL ADMIN	13.50
	PCARD ONE TIME PAY	SCRUBBING PADS	CUSTODIAL SERVICES	13.76
	PCARD ONE TIME PAY	GOODWIN HYPO REPAIR	SUNNYSIDE FILTRATION PLANT	13.83
	PCARD ONE TIME PAY	CHIEF SUPPLIES	POLICE ADMINISTRATION	13.86
	PCARD ONE TIME PAY	CEMENT/ MATERIALS	PARK & RECREATION FAC	15.00
	PCARD ONE TIME PAY	GOOD TO GO TRAVEL	POLICE PATROL	15.00
	PCARD ONE TIME PAY	OFFICE SUPPLIES, DIVIDERS	POLICE PATROL	15.16
	PCARD ONE TIME PAY	BATTERIES	CUSTODIAL SERVICES	15.72

CITY OF MARYSVILLE
INVOICE LIST

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
0	PCARD ONE TIME PAY	FLAGGING TAPE	RECREATION SERVICES	17.48
	PCARD ONE TIME PAY	SUPPLIES	RECREATION SERVICES	17.74
	PCARD ONE TIME PAY	CSO SUPPLIES	POLICE COMMUNITY SERVICES	17.86
	PCARD ONE TIME PAY	KLEENEX	TRANSPORTATION	19.13
	PCARD ONE TIME PAY	LOGO GARMENTS	MUNICIPAL COURTS	19.23
	PCARD ONE TIME PAY	OFFICE SUPPLIES	UTIL ADMIN	19.64
	PCARD ONE TIME PAY	TWIN LAKES CONCRETE PAD	GMA-PARKS	19.66
	PCARD ONE TIME PAY	INK PADS	FINANCE-GENL	19.68
	PCARD ONE TIME PAY	SEATTLE TIMES SUBSCRIPTION	EXECUTIVE ADMIN	19.96
	PCARD ONE TIME PAY	OFFICE SUPPLIES	PARK & RECREATION FAC	20.42
	PCARD ONE TIME PAY	TOTE FOR SUPPLIES	POLICE PATROL	20.78
	PCARD ONE TIME PAY	JAIL SUPPLIES CUPS	DETENTION & CORRECTION	21.38
	PCARD ONE TIME PAY	WATER, PAPER PLATES, NAPKINS	PERSONNEL ADMINISTRATION	21.51
	PCARD ONE TIME PAY	TRAINING SUPPLIES	POLICE PATROL	21.72
	PCARD ONE TIME PAY	ADOBE SOFTWARE	POLICE INVESTIGATION	21.87
	PCARD ONE TIME PAY	TRAINING SUPPLIES	POLICE PATROL	21.88
	PCARD ONE TIME PAY	SNACKS - CERT COURSE	EXECUTIVE ADMIN	22.47
	PCARD ONE TIME PAY	COFFEE	RECREATION SERVICES	22.88
	PCARD ONE TIME PAY	FOOD FOR CLIENT	EMBEDDED SOCIAL WORKER	22.96
	PCARD ONE TIME PAY	RESERVOIR TELEMETRY	WATER RESERVOIRS	23.75
	PCARD ONE TIME PAY	CANDY	RECREATION SERVICES	23.96
	PCARD ONE TIME PAY	PACKING TAPE SUPPLIES	POLICE PATROL	24.06
	PCARD ONE TIME PAY	MAJOR CRIMES	POLICE PATROL	24.46
	PCARD ONE TIME PAY	LOGO GARMENTS	MUNICIPAL COURTS	24.49
	PCARD ONE TIME PAY	MARYSVILLE BUSINESS SUMMIT/TULALIP	RECREATION SERVICES	25.00
	PCARD ONE TIME PAY		RECREATION SERVICES	25.00
	PCARD ONE TIME PAY	GROCERY STORES	EXECUTIVE ADMIN	26.73
	PCARD ONE TIME PAY	SPARE KEYS	PARK & RECREATION FAC	27.08
	PCARD ONE TIME PAY	TESTING	POLICE PATROL	27.64
	PCARD ONE TIME PAY	MAG MEETING - STAPLETON	EXECUTIVE ADMIN	28.01
	PCARD ONE TIME PAY	EVIDENCE SUPPLIES	POLICE PATROL	28.94
	PCARD ONE TIME PAY	ADVERTISING	COMMUNITY	29.14
	PCARD ONE TIME PAY	BATTERY	WATER RESERVOIRS	29.42
	PCARD ONE TIME PAY	AED BRACKETS	PERSONNEL ADMINISTRATION	29.50
	PCARD ONE TIME PAY		SUNNYSIDE FILTRATION PLANT	29.50
	PCARD ONE TIME PAY	HOSE FOR PARKS	PARK & RECREATION FAC	29.53
	PCARD ONE TIME PAY	BRIDGE REPAIR	PARK & RECREATION FAC	30.09
	PCARD ONE TIME PAY	SHIPPING BOX	POLICE PATROL	30.24
	PCARD ONE TIME PAY	TOILET PLUNGER/ TARNISH REMOVER	CUSTODIAL SERVICES	30.26
	PCARD ONE TIME PAY	JENNINGS SIGN LANDSCAPES	PARK & RECREATION FAC	31.02
	PCARD ONE TIME PAY	TWIN LAKES TURF REPAIR	GMA-PARKS	31.02
	PCARD ONE TIME PAY	MCC COURT ANT BAIT	MUNICIPAL COURTS	31.07
	PCARD ONE TIME PAY	GRAFFITI MATERIALS	PARK & RECREATION FAC	31.27
	PCARD ONE TIME PAY	FEDEX	GMA - STREET	33.50
	PCARD ONE TIME PAY	LIGHTING CLEAN UP	PARK & RECREATION FAC	33.74
	PCARD ONE TIME PAY	FOOD FOR CLIENT	EMBEDDED SOCIAL WORKER	34.30
	PCARD ONE TIME PAY	RATCHET STRAPS	WATER QUAL TREATMENT	34.89
	PCARD ONE TIME PAY	CORK BOARD	CITY CLERK	35.00
	PCARD ONE TIME PAY	GMTCC BBH REGISTRATION - CMENNIE	EXECUTIVE ADMIN	35.00
	PCARD ONE TIME PAY	BUCKETS FOR PROJECTS	STORM DRAINAGE	35.50
	PCARD ONE TIME PAY	LUNCH FOR SUPERVISORS	UTIL ADMIN	36.82
	PCARD ONE TIME PAY	FIRST AID SUPPLIES	PERSONNEL ADMINISTRATION	37.90

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
0	PCARD ONE TIME PAY	CUBICLE NAME PLATE	COMMUNITY	37.91
	PCARD ONE TIME PAY	SUPPLIES	OPERA HOUSE	39.18
	PCARD ONE TIME PAY	OFFICE SUPPLIES	UTIL ADMIN	39.52
	PCARD ONE TIME PAY	FUEL FOR TRAINING	POLICE PATROL	40.00
	PCARD ONE TIME PAY	OFFICE SUPPLIES	TRANSPORTATION	40.20
	PCARD ONE TIME PAY	DRINKING FOUNTAIN MATERIALS	PARK & RECREATION FAC	40.23
	PCARD ONE TIME PAY	SHIPPING	POLICE PATROL	41.51
	PCARD ONE TIME PAY	TRAFFIC SUPPLIES	POLICE PATROL	41.56
	PCARD ONE TIME PAY	FREIGHT CHARGE	EQUIPMENT RENTAL	42.08
	PCARD ONE TIME PAY	TABLE COVERS, SERVING DISHES	PERSONNEL ADMINISTRATION	42.58
	PCARD ONE TIME PAY	TRAVEL TOLL	POLICE PATROL	43.23
	PCARD ONE TIME PAY	TRAINING SUPPLIES	POLICE PATROL	43.76
	PCARD ONE TIME PAY		POLICE PATROL	43.76
	PCARD ONE TIME PAY		POLICE PATROL	43.76
	PCARD ONE TIME PAY		POLICE PATROL	43.76
	PCARD ONE TIME PAY	SHIPPING SERVICES	POLICE PATROL	44.62
	PCARD ONE TIME PAY	TRAINING SUPPLIES	POLICE PATROL	46.57
	PCARD ONE TIME PAY	TWIN LAKES DEBRIS DUMP	GMA-PARKS	48.00
	PCARD ONE TIME PAY	TWIN LAKES TURF REPAIR	GMA-PARKS	48.01
	PCARD ONE TIME PAY		GMA-PARKS	48.01
	PCARD ONE TIME PAY	TEEN NIGHT SUPPLIES	RECREATION SERVICES	48.16
	PCARD ONE TIME PAY	ARMORY AIR LINE REPAIR	POLICE PATROL	48.56
	PCARD ONE TIME PAY	SHIPPING SERVICES	POLICE PATROL	48.68
	PCARD ONE TIME PAY	PRINTING PAPER	PERSONNEL ADMINISTRATION	49.22
	PCARD ONE TIME PAY	DEBRIS DUMP	PARK & RECREATION FAC	49.40
	PCARD ONE TIME PAY	SOUR PUNCH TWISTS, COOKIE TRAY	RECREATION SERVICES	49.96
	PCARD ONE TIME PAY	ORCA CARD	EMBEDDED SOCIAL WORKER	50.00
	PCARD ONE TIME PAY		EMBEDDED SOCIAL WORKER	50.00
	PCARD ONE TIME PAY		EMBEDDED SOCIAL WORKER	50.00
	PCARD ONE TIME PAY	EASTER SUPPLIES	RECREATION SERVICES	51.17
	PCARD ONE TIME PAY	N ANNEX BID REPAIR	POLICE PATROL	51.26
	PCARD ONE TIME PAY	DUES WSP K9	POLICE PATROL	51.80
	PCARD ONE TIME PAY		POLICE PATROL	51.80
	PCARD ONE TIME PAY	SHIPPING SERVICES	POLICE PATROL	52.50
	PCARD ONE TIME PAY	FOUNDATION DRAIN REPAIR	GOLF ADMINISTRATION	52.63
	PCARD ONE TIME PAY	CLOROX WIPES, PENS, PLASTIC FORK	UTIL ADMIN	52.90
	PCARD ONE TIME PAY	VAN	TRIBAL GAMING-GENL	53.47
	PCARD ONE TIME PAY	EVIDENCE SUPPLIES	POLICE PATROL	53.60
	PCARD ONE TIME PAY	TRAINING - LARSEN	EXECUTIVE ADMIN	53.61
	PCARD ONE TIME PAY	TRAINING SUPPLIES	POLICE PATROL	54.08
	PCARD ONE TIME PAY	SIGNAGE	PERSONNEL ADMINISTRATION	54.45
	PCARD ONE TIME PAY	PAPER ROLL SUPPLIES	POLICE PATROL	56.87
	PCARD ONE TIME PAY	BUS TICKET	EMBEDDED SOCIAL WORKER	56.99
	PCARD ONE TIME PAY	STRAWBERRY GOAL REPAIR	PARK & RECREATION FAC	57.18
	PCARD ONE TIME PAY		PARK & RECREATION FAC	57.18
	PCARD ONE TIME PAY	OFFICE SUPPLIES	PARK & RECREATION FAC	57.95
	PCARD ONE TIME PAY	UNIFORM SHOES	POLICE PATROL	58.46
	PCARD ONE TIME PAY	AED BRACKETS	WASTE WATER TREATMENT	59.00
	PCARD ONE TIME PAY	DOLLY X3	CUSTODIAL SERVICES	59.04
	PCARD ONE TIME PAY	MEETING REGISTRATION	CITY COUNCIL	60.54
	PCARD ONE TIME PAY	MEETING REGISTRATION	CITY COUNCIL	60.54
	PCARD ONE TIME PAY	SEAT UPGRADE	POLICE INVESTIGATION	61.00

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
0	PCARD ONE TIME PAY	SEAT UPGRADE	POLICE INVESTIGATION	61.00
	PCARD ONE TIME PAY	CSO SUPPLIES	POLICE COMMUNITY SERVICES	61.22
	PCARD ONE TIME PAY	REPLACEMENT TIPS	SEWER MAIN COLLECTION	61.63
	PCARD ONE TIME PAY		STORM DRAINAGE	61.64
	PCARD ONE TIME PAY	FREIGHT CHARGE	EQUIPMENT RENTAL	61.65
	PCARD ONE TIME PAY	DEBRIS DUMP	PARK & RECREATION FAC	61.75
	PCARD ONE TIME PAY	JENNINGS SIGN LANDSCAPE	PARK & RECREATION FAC	62.04
	PCARD ONE TIME PAY	JENNINGS SIGN LANDSCAPES	PARK & RECREATION FAC	62.04
	PCARD ONE TIME PAY	GOOD TO GO TRAVEL	POLICE PATROL	63.50
	PCARD ONE TIME PAY	MISC - SAFETY WEEK	COMMUNITY	64.00
	PCARD ONE TIME PAY	EVIDENCE MEMBERSHIP DUES	POLICE PATROL	65.00
	PCARD ONE TIME PAY	WAPRO DUES	OFFICE OPERATIONS	65.00
	PCARD ONE TIME PAY	WAPRO SPRING CONFERENCE - TABER	CITY CLERK	65.00
	PCARD ONE TIME PAY	WAPRO TRAINING	POLICE TRAINING-FIREARMS	65.00
	PCARD ONE TIME PAY	GOLF COURSE LIGHTING	GOLF ADMINISTRATION	65.37
	PCARD ONE TIME PAY	CABLE SUPPLIES	POLICE INVESTIGATION	65.62
	PCARD ONE TIME PAY	ALL HANDS REFRESHMENTS	UTIL ADMIN	65.64
	PCARD ONE TIME PAY	HEALTH SUPPLIES FOR CLIENT	EMBEDDED SOCIAL WORKER	65.91
	PCARD ONE TIME PAY	BAND MEAL/JIMMY JOHN'S	OPERA HOUSE	66.04
	PCARD ONE TIME PAY	RES GROUNDS MAINT.	WATER RESERVOIRS	66.37
	PCARD ONE TIME PAY	SURVEY STAKES	RECREATION SERVICES	66.72
	PCARD ONE TIME PAY	FUEL FOR TRAINING	POLICE PATROL	66.96
	PCARD ONE TIME PAY	SUPPLIES FOR PARKS	RECREATION SERVICES	67.11
	PCARD ONE TIME PAY	OFFICE SUPPLIES	RECREATION SERVICES	67.90
	PCARD ONE TIME PAY	GOOD TO GO TRAVEL	POLICE PATROL	69.00
	PCARD ONE TIME PAY	MOLLY SUPPLIES WELLNESS	POLICE ADMINISTRATION	69.45
	PCARD ONE TIME PAY	TRAINING SUPPLIES	POLICE PATROL	69.55
	PCARD ONE TIME PAY	EVIDENCE GLOVES	POLICE PATROL	69.56
	PCARD ONE TIME PAY	OFFICE SUPPLIES	OFFICE OPERATIONS	69.59
	PCARD ONE TIME PAY	BINDERS	EXECUTIVE ADMIN	69.82
	PCARD ONE TIME PAY	NOTEBOOK PLANNER, CORK BOARD	CITY CLERK	71.09
	PCARD ONE TIME PAY	LUNCH - JEFF WILSON	EXECUTIVE ADMIN	71.63
	PCARD ONE TIME PAY	FUEL FOR TRAINING	POLICE PATROL	72.91
	PCARD ONE TIME PAY	TRAINING SUPPLIES	POLICE PATROL	73.62
	PCARD ONE TIME PAY	PRINTER PAPER	RECREATION SERVICES	73.81
	PCARD ONE TIME PAY	DEBRIS DUMP	PARK & RECREATION FAC	74.10
	PCARD ONE TIME PAY		PARK & RECREATION FAC	74.10
	PCARD ONE TIME PAY	JAIL SUPPLIES CUPS	DETENTION & CORRECTION	74.38
	PCARD ONE TIME PAY	5 ROTARY LUNCHES	COMMUNITY EVENTS	75.00
	PCARD ONE TIME PAY	MEMBERSHIP ORGANIZATIONS	PROBATION	75.00
	PCARD ONE TIME PAY		PROBATION	75.00
	PCARD ONE TIME PAY	LUNCH FOR SUPERVISORS	UTIL ADMIN	76.44
	PCARD ONE TIME PAY	DOOR STOPS WITH HANDLES	CUSTODIAL SERVICES	76.48
	PCARD ONE TIME PAY	MEASURING WHEEL	SOURCE OF SUPPLY	76.49
	PCARD ONE TIME PAY	COMMS VAN	TRIBAL GAMING-GENL	76.56
	PCARD ONE TIME PAY	ADVERTISING	COMMUNITY	76.60
	PCARD ONE TIME PAY	ELECTRONICS STORES	PARK & RECREATION FAC	77.00
	PCARD ONE TIME PAY		GENERAL	77.00
	PCARD ONE TIME PAY		SOLID WASTE OPERATIONS	77.00
	PCARD ONE TIME PAY		EQUIPMENT RENTAL	77.00
	PCARD ONE TIME PAY		FACILITY MAINTENANCE	77.00
	PCARD ONE TIME PAY	COMMS VAN	TRIBAL GAMING-GENL	77.71

CITY OF MARYSVILLE
INVOICE LIST
FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
0	PCARD ONE TIME PAY	COMMS VAN	TRIBAL GAMING-GENL	78.65
	PCARD ONE TIME PAY	WIRELESS HEADSET	RECREATION SERVICES	79.50
	PCARD ONE TIME PAY	TRAINING WEBINAR	PERSONNEL ADMINISTRATION	82.05
	PCARD ONE TIME PAY	SUPPLIES	RECREATION SERVICES	82.46
	PCARD ONE TIME PAY	LANDSCAPE IRRIGATION	PARK & RECREATION FAC	83.03
	PCARD ONE TIME PAY	PLANT SUPPLIES	SOURCE OF SUPPLY	83.59
	PCARD ONE TIME PAY	COMMS VAN	TRIBAL GAMING-GENL	84.07
	PCARD ONE TIME PAY	SERVICE OF PROCESS	GMA - STREET	85.00
	PCARD ONE TIME PAY	SERVICE OF PROCESS	GMA - STREET	85.00
	PCARD ONE TIME PAY	SERVICE OF PROCESS	GMA - STREET	85.00
	PCARD ONE TIME PAY	MAYOR'S COFFEE KLATCH	EXECUTIVE ADMIN	85.17
	PCARD ONE TIME PAY	FOOD FOR SCRABBLE STEPS	PERSONNEL ADMINISTRATION	85.88
	PCARD ONE TIME PAY	LUNCH	PERSONNEL ADMINISTRATION	87.17
	PCARD ONE TIME PAY	NAMEPLATES	UTIL ADMIN	87.24
	PCARD ONE TIME PAY	UNIFORM SHORTS	POLICE PATROL	87.51
	PCARD ONE TIME PAY	UNIFORMS/OFFICE SUPPLIES	COMMUNITY	87.51
	PCARD ONE TIME PAY	BUSINESS SERVICES	GMA - STREET	88.00
	PCARD ONE TIME PAY	ADVERTISING	COMMUNITY	88.02
	PCARD ONE TIME PAY	DOG GROOMING WELLNESS	POLICE ADMINISTRATION	89.70
	PCARD ONE TIME PAY	HITCH FOR V084	SOURCE OF SUPPLY	90.11
	PCARD ONE TIME PAY	CSO SUPPLIES	POLICE COMMUNITY SERVICES	91.00
	PCARD ONE TIME PAY	OPERA HOUSE LIGHTS	PARK & RECREATION FAC	91.85
	PCARD ONE TIME PAY	HEALTH SUPPLIES	EMBEDDED SOCIAL WORKER	92.35
	PCARD ONE TIME PAY	DECANT PALLET EXPORT FEE	STORM DRAINAGE	92.49
	PCARD ONE TIME PAY	UNIFORM - GESSNER	UTIL ADMIN	92.97
	PCARD ONE TIME PAY	MAJOR CRIMES	POLICE INVESTIGATION	93.72
	PCARD ONE TIME PAY	GRANT SUPPLIES	EXECUTIVE ADMIN	93.81
	PCARD ONE TIME PAY	OFFICE SUPPLIES	ENGR-GENL	94.24
	PCARD ONE TIME PAY	GIS CERTIFICATION INSTITUTE	GIS SERVICES IS	95.00
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	95.00
	PCARD ONE TIME PAY	COPY PAPER	PARK & RECREATION FAC	96.26
	PCARD ONE TIME PAY	RATCHET TIE DOWN	PARK & RECREATION FAC	98.44
	PCARD ONE TIME PAY	UNIFORM - BILLIEU	UTIL ADMIN	98.45
	PCARD ONE TIME PAY	ZOOM	COMMUNITY	98.46
	PCARD ONE TIME PAY	SENIOR BROWN BAG LUNCH	RECREATION SERVICES	98.67
	PCARD ONE TIME PAY	DEBRIS DUMP	PARK & RECREATION FAC	98.80
	PCARD ONE TIME PAY		PARK & RECREATION FAC	98.80
	PCARD ONE TIME PAY		PARK & RECREATION FAC	98.80
	PCARD ONE TIME PAY		PARK & RECREATION FAC	98.80
	PCARD ONE TIME PAY	BUS TICKET	EMBEDDED SOCIAL WORKER	99.00
	PCARD ONE TIME PAY	UNIFORM PANTS	POLICE PATROL	99.39
	PCARD ONE TIME PAY		POLICE PATROL	99.39
	PCARD ONE TIME PAY	MUNICIPAL CLERK MEMBERSHIP	CITY CLERK	100.00
	PCARD ONE TIME PAY	AERIFICATION SUPPLIES	PARK & RECREATION FAC	100.63
	PCARD ONE TIME PAY	BUS TICKET	EMBEDDED SOCIAL WORKER	100.99
	PCARD ONE TIME PAY		EMBEDDED SOCIAL WORKER	100.99
	PCARD ONE TIME PAY	BUS TICKET	EMBEDDED SOCIAL WORKER	100.99
	PCARD ONE TIME PAY	SENIOR LUNCH EVENT	RECREATION SERVICES	102.47
	PCARD ONE TIME PAY	UTILITY BLANKET PERMIT	UTIL ADMIN	103.00
	PCARD ONE TIME PAY	WELLNESS/MISC	COMMUNITY	103.37
	PCARD ONE TIME PAY	#J080- LATCH ASSY	EQUIPMENT RENTAL	104.88
	PCARD ONE TIME PAY	PUBLIC WORKS POSTERS	UTIL ADMIN	105.00

CITY OF MARYSVILLE
INVOICE LIST

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
0	PCARD ONE TIME PAY	TWIN LAKES PLUMBING	PARK & RECREATION FAC	108.31
	PCARD ONE TIME PAY	GAS CAN/ BRASS HOSE END	PARK & RECREATION FAC	109.26
	PCARD ONE TIME PAY	STEELE SUPPLIES	K9 PROGRAM	109.40
	PCARD ONE TIME PAY	UNIFORMS/MISC/OFFICE SUPPLIES	COMMUNITY	110.46
	PCARD ONE TIME PAY	GUIDELINES FOR CROSS CONNECTION	WATER CROSS CNTL	111.00
	PCARD ONE TIME PAY	FLOWERS	EXECUTIVE ADMIN	113.15
	PCARD ONE TIME PAY	LUNCH	MUNICIPAL COURTS	113.17
	PCARD ONE TIME PAY	HOTEL	MUNICIPAL COURTS	118.80
	PCARD ONE TIME PAY	OTHER HOTELS	MUNICIPAL COURTS	118.80
	PCARD ONE TIME PAY	SUBSCRIPTION CHARGES/CANVA	RECREATION SERVICES	119.99
	PCARD ONE TIME PAY	WATER TREATMENT WORKSHOP	UTIL ADMIN	120.00
	PCARD ONE TIME PAY	JENNINGS SIGN LANDSCAPE	PARK & RECREATION FAC	123.56
	PCARD ONE TIME PAY	MARYSVILLE BUSINESS SUMMIT	COMMUNITY	125.00
	PCARD ONE TIME PAY	#J080- LATCH ASSY	EQUIPMENT RENTAL	127.20
	PCARD ONE TIME PAY	PAPER	POLICE PATROL	129.61
	PCARD ONE TIME PAY	PARTS FOR WO#18335	STORM DRAINAGE	133.73
	PCARD ONE TIME PAY	OD OFFICE SUPPLIES	UTILITY BILLING	135.79
	PCARD ONE TIME PAY	UNIFORM SHOE	POLICE PATROL	136.75
	PCARD ONE TIME PAY	AUTO RENTAL	POLICE INVESTIGATION	141.95
	PCARD ONE TIME PAY	UNIFORM SHOES	POLICE PATROL	142.21
	PCARD ONE TIME PAY	TRAFFIC SUPPLIES	TRAFFIC UNIT	143.18
	PCARD ONE TIME PAY	OD OFFICE SUPPLIES	UTILITY BILLING	144.85
	PCARD ONE TIME PAY	LODGING DEPOSIT	UTIL ADMIN	145.13
	PCARD ONE TIME PAY	SHIPPING SERVICES	POLICE PATROL	146.72
	PCARD ONE TIME PAY	SAFETY SYMPOSIUM REGISTRATION	PERSONNEL ADMINISTRATION	149.00
	PCARD ONE TIME PAY	SENIOR BROWN BAG LUNCH/HAGGEN	RECREATION SERVICES	149.23
	PCARD ONE TIME PAY	WELLNESS COMMITTEE PRIZES	PERSONNEL ADMINISTRATION	149.78
	PCARD ONE TIME PAY	CANVA MEMBERSHIP	PERSONNEL ADMINISTRATION	149.90
	PCARD ONE TIME PAY	WINTER MAINT. SUPERVISOR TRAINING	TRAINING	150.00
	PCARD ONE TIME PAY	GARAGE OPENER BUTTON	COMPUTER SERVICES	151.50
	PCARD ONE TIME PAY	PARTS	TRANSPORTATION	152.77
	PCARD ONE TIME PAY	HYDRANTS	HYDRANTS	155.00
	PCARD ONE TIME PAY	SUPPLIES	RECREATION SERVICES	159.67
	PCARD ONE TIME PAY	MESH HOUSE BEDROOM HEATER	NON-DEPARTMENTAL	160.38
	PCARD ONE TIME PAY	PRESSURE WASHING EQUIPMENT	PARK & RECREATION FAC	161.64
	PCARD ONE TIME PAY	ELECTRONICS STORES	UTIL ADMIN	161.99
	PCARD ONE TIME PAY	RAIN GARDEN TOOLS	STORM DRAINAGE	162.95
	PCARD ONE TIME PAY	COMMS VAN	TRIBAL GAMING-GENL	163.33
	PCARD ONE TIME PAY	FILTER REJECT PUMP RECOATING	WASTE WATER TREATMENT	164.10
	PCARD ONE TIME PAY	BROWN BAG LUNCH	RECREATION SERVICES	165.29
	PCARD ONE TIME PAY	MEETING REFRESHMENTS	UTIL ADMIN	165.71
	PCARD ONE TIME PAY	ADVERTISING SERVICES/META	RECREATION SERVICES	166.88
	PCARD ONE TIME PAY	ECONOMIC DEVELOPMENT COMMITTEE	PLANNING & COMMUNITY DEV	167.25
	PCARD ONE TIME PAY	STAINLESS STEEL DOLLY	CUSTODIAL SERVICES	167.81
	PCARD ONE TIME PAY	WDM TRAINING MANUALS	UTIL ADMIN	168.40
	PCARD ONE TIME PAY	MOUTHGUARD UNIFORMS	POLICE PATROL	168.41
	PCARD ONE TIME PAY	INSERTA TEE	OVERHEAD	169.54
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	170.00
	PCARD ONE TIME PAY	SHIPPING	COMPUTER SERVICES	172.22
	PCARD ONE TIME PAY	EQUIPMENT	POLICE ADMINISTRATION	172.43
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	173.95
	PCARD ONE TIME PAY	ZOOM SOFTWARE	POLICE INVESTIGATION	174.93

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
0	PCARD ONE TIME PAY	UNIFORM - LINDBERG	CUSTODIAL SERVICES	174.99
	PCARD ONE TIME PAY	EVIDENCE DOLLYS	POLICE PATROL	175.03
	PCARD ONE TIME PAY	SUPPLIES FOR PARKS	OPERA HOUSE	175.60
	PCARD ONE TIME PAY	JENNINGS LANDSCAPE	PARK & RECREATION FAC	177.58
	PCARD ONE TIME PAY	SIGN INSTALLATION	GMA-PARKS	178.77
	PCARD ONE TIME PAY	UNIFORM - LINDBERG	CUSTODIAL SERVICES	180.00
	PCARD ONE TIME PAY	WATER MAIN SHUTDOWN	WATER DIST MAINS	180.30
	PCARD ONE TIME PAY	UNIFORM	POLICE PATROL	185.64
	PCARD ONE TIME PAY	PARKING - TRAINING	POLICE ADMINISTRATION	188.00
	PCARD ONE TIME PAY	COMPUTER AND DATA PROCESS	PROBATION	191.45
	PCARD ONE TIME PAY	MICR/PRINTER CARTRIDGES	FINANCE-GENL	192.91
	PCARD ONE TIME PAY	UNIFORM - BILLIEU	UTIL ADMIN	195.82
	PCARD ONE TIME PAY	GASKET	STORM DRAINAGE	196.26
	PCARD ONE TIME PAY	SUPPLIES - TRAINING	PERSONNEL ADMINISTRATION	197.37
	PCARD ONE TIME PAY	COPY PAPER	FINANCE-GENL	197.91
	PCARD ONE TIME PAY	SPRING CONFERENCE - HANNAHS	TRANSPORTATION	199.00
	PCARD ONE TIME PAY	SAFETY CHAIR	DETENTION & CORRECTION	200.00
	PCARD ONE TIME PAY	BROWN BAG LUNCH	RECREATION SERVICES	201.81
	PCARD ONE TIME PAY	UNIFORM PINS	POLICE PATROL	202.05
	PCARD ONE TIME PAY	FLOOR MATS	CUSTODIAL SERVICES	202.14
	PCARD ONE TIME PAY	GIVE AWAYS PENS	CRIME PREVENTION	205.06
	PCARD ONE TIME PAY	UNIFORM SHOES	POLICE PATROL	205.67
	PCARD ONE TIME PAY	OFFICE SUPPLIES	POLICE PATROL	209.80
	PCARD ONE TIME PAY	TRAVEL FOR TRAINING	POLICE INVESTIGATION	213.99
	PCARD ONE TIME PAY	MONITOR MOUNT SUPPLIES	POLICE PATROL	214.12
	PCARD ONE TIME PAY	PAPER SUPPLIES	POLICE PATROL	216.01
	PCARD ONE TIME PAY	FLEET SOFTWARE	SMALL ENGINE SHOP	217.71
	PCARD ONE TIME PAY	ANNUAL MEMBERSHIP DUES	PERSONNEL ADMINISTRATION	220.00
	PCARD ONE TIME PAY	OFFICE SUPPLIES	POLICE PATROL	220.84
	PCARD ONE TIME PAY	UNIFORMS	POLICE PATROL	223.19
	PCARD ONE TIME PAY	ALASKA AIRLINES	POLICE INVESTIGATION	223.30
	PCARD ONE TIME PAY		POLICE INVESTIGATION	223.30
	PCARD ONE TIME PAY		POLICE INVESTIGATION	223.30
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	225.00
	PCARD ONE TIME PAY		POLICE TRAINING-FIREARMS	225.00
	PCARD ONE TIME PAY		POLICE TRAINING-FIREARMS	225.00
	PCARD ONE TIME PAY		POLICE TRAINING-FIREARMS	225.00
	PCARD ONE TIME PAY		POLICE TRAINING-FIREARMS	225.00
	PCARD ONE TIME PAY		POLICE TRAINING-FIREARMS	225.00
	PCARD ONE TIME PAY	UNIFORM - BILLIEU	UTIL ADMIN	231.69
	PCARD ONE TIME PAY	COPY PAPER	MUNICIPAL COURTS	232.42
	PCARD ONE TIME PAY	UNIFORM - HOLADAY	UTIL ADMIN	235.21
	PCARD ONE TIME PAY	COURT COSTS	COMMUNITY SERVICES UNIT	240.00
	PCARD ONE TIME PAY	SIDEWALK SUPPLIES/TOOLS	SIDEWALK MAINTENANCE	240.46
	PCARD ONE TIME PAY	UNIFORM BOOTS	POLICE PATROL	240.68
	PCARD ONE TIME PAY	UNIFORM SHOES	POLICE PATROL	240.68
	PCARD ONE TIME PAY	OFFICE SUPPLIES	POLICE INVESTIGATION	242.80
	PCARD ONE TIME PAY	TWIN LAKES LIFE JACKET PAD	GMA-PARKS	248.66
	PCARD ONE TIME PAY	UNIFORM - THORNE	TRANSPORTATION	250.00
	PCARD ONE TIME PAY	UNIFORM BOOTS	POLICE PATROL	251.62
	PCARD ONE TIME PAY	ALASKA AIRLINES	POLICE INVESTIGATION	253.31
	PCARD ONE TIME PAY		POLICE INVESTIGATION	253.31

CITY OF MARYSVILLE
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CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
0	PCARD ONE TIME PAY	PROCESS CONDEMNATION - VILLANUEVA	GMA - STREET	254.00
	PCARD ONE TIME PAY	NENA COMPANY ID	COMPUTER SERVICES	255.00
	PCARD ONE TIME PAY	AERIFICATION SUPPLIES	PARK & RECREATION FAC	258.75
	PCARD ONE TIME PAY	COFFEE -TRAINING	PERSONNEL ADMINISTRATION	262.56
	PCARD ONE TIME PAY	PROTECTION PLAN	POLICE PATROL	266.88
	PCARD ONE TIME PAY	LANDSCAPE EQUIPMENT	PARK & RECREATION FAC	271.66
	PCARD ONE TIME PAY	DUO MOBILE	COMPUTER SERVICES	275.00
	PCARD ONE TIME PAY	BANNERS/FEDEX OFFICE	RECREATION SERVICES	278.95
	PCARD ONE TIME PAY	UNIFORMS	POLICE PATROL	282.23
	PCARD ONE TIME PAY		POLICE PATROL	288.72
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	289.00
	PCARD ONE TIME PAY	EYEWASH BOTTLE BRACKETS	PARK & RECREATION FAC	292.81
	PCARD ONE TIME PAY	UNIFORMS/MISC/OFFICE SUPPLIES	COMMUNITY	295.81
	PCARD ONE TIME PAY	LODGING - EXTRADITION	POLICE INVESTIGATION	296.28
	PCARD ONE TIME PAY	ADVERTISING	POLICE ADMINISTRATION	299.00
	PCARD ONE TIME PAY	UNIFORM BOOTS	POLICE PATROL	302.32
	PCARD ONE TIME PAY	OFFICE SUPPLIES	POLICE PATROL	305.03
	PCARD ONE TIME PAY	LODGING - CARY	UTIL ADMIN	310.50
	PCARD ONE TIME PAY	ORCA CARDS REFILLED	EMBEDDED SOCIAL WORKER	318.00
	PCARD ONE TIME PAY	UNIFORM SHOES	POLICE PATROL	318.24
	PCARD ONE TIME PAY	STEEL ROAD PLATE RAMPS	SEWER MAIN COLLECTION	328.18
	PCARD ONE TIME PAY		STORM DRAINAGE	328.19
	PCARD ONE TIME PAY	PROCESS CONDEMNATION - GARTNER	GMA - STREET	329.00
	PCARD ONE TIME PAY	OFFICE SUPPLIES	POLICE PATROL	329.25
	PCARD ONE TIME PAY	AERIFICATION COMEFORD	PARK & RECREATION FAC	330.42
	PCARD ONE TIME PAY	TWIN LAKES ROUTER	COMPUTER SERVICES	339.15
	PCARD ONE TIME PAY	WDM TRAINING - MALLAHAN	UTIL ADMIN	349.99
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	350.00
	PCARD ONE TIME PAY	DT EQUIP	POLICE TRAINING-FIREARMS	361.25
	PCARD ONE TIME PAY	GRIBBLE WSAMA CONFERENCE	LEGAL - PROSECUTION	364.00
	PCARD ONE TIME PAY	WSAMA MEMBERSHIP - WALKER	LEGAL-GENL	364.00
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	375.00
	PCARD ONE TIME PAY	LODGING - KEEFE	UTIL ADMIN	379.29
	PCARD ONE TIME PAY	ELECTRONICS STORES	COMPUTER SERVICES	382.89
	PCARD ONE TIME PAY	TOOLBOXES, SUPPLIES	POLICE INVESTIGATION	409.14
	PCARD ONE TIME PAY	EQUIPMENT	POLICE ADMINISTRATION	429.98
	PCARD ONE TIME PAY	RENT-A-CAR	POLICE ADMINISTRATION	432.16
	PCARD ONE TIME PAY	UNIFORM BOOTS	POLICE PATROL	448.49
	PCARD ONE TIME PAY	JOB POSTING	PERSONNEL ADMINISTRATION	450.00
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	450.00
	PCARD ONE TIME PAY	UNIFORM BOOTS	POLICE PATROL	461.83
	PCARD ONE TIME PAY	HOTEL FOR TRAINING	POLICE PATROL	470.52
	PCARD ONE TIME PAY		POLICE PATROL	470.52
	PCARD ONE TIME PAY		POLICE PATROL	470.52
	PCARD ONE TIME PAY	TRAVEL INV	POLICE INVESTIGATION	471.60
	PCARD ONE TIME PAY	CSO SUPPLIES	POLICE COMMUNITY SERVICES	480.48
	PCARD ONE TIME PAY	PARTS FOR #M005	EQUIPMENT RENTAL	481.88
	PCARD ONE TIME PAY	CONCRETE SPRAYER	PARK & RECREATION FAC	494.20
	PCARD ONE TIME PAY	200 CREDITS/PEACHJAR	RECREATION SERVICES	500.00
	PCARD ONE TIME PAY	ADVERTISING	POLICE ADMINISTRATION	500.00
	PCARD ONE TIME PAY		POLICE ADMINISTRATION	500.00
	PCARD ONE TIME PAY		POLICE ADMINISTRATION	500.00

CITY OF MARYSVILLE
INVOICE LIST

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CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
0	PCARD ONE TIME PAY	ADVERTISING	POLICE ADMINISTRATION	500.00
	PCARD ONE TIME PAY		POLICE ADMINISTRATION	503.76
	PCARD ONE TIME PAY	OFFICE SUPPLIES	MUNICIPAL COURTS	509.94
	PCARD ONE TIME PAY	BNB WSAMA CONFERENCE	LEGAL - PROSECUTION	511.15
	PCARD ONE TIME PAY	SAW BLADE/CHAIN SAW CHAINS	STORM DRAINAGE	516.48
	PCARD ONE TIME PAY	HOTEL FOR TRAINING	POLICE PATROL	538.52
	PCARD ONE TIME PAY		POLICE PATROL	538.52
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	554.40
	PCARD ONE TIME PAY	2 NEW AEDS	PERSONNEL ADMINISTRATION	565.05
	PCARD ONE TIME PAY		SUNNYSIDE FILTRATION PLANT	565.05
	PCARD ONE TIME PAY	LODGING FOR TRAINING	POLICE PATROL	565.57
	PCARD ONE TIME PAY		POLICE PATROL	565.57
	PCARD ONE TIME PAY	TRAVEL INV	POLICE INVESTIGATION	572.00
	PCARD ONE TIME PAY	ADVERTISING	POLICE ADMINISTRATION	596.24
	PCARD ONE TIME PAY	SPLASH PAD SEAL	PARK & RECREATION FAC	606.04
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	612.69
	PCARD ONE TIME PAY		POLICE TRAINING-FIREARMS	612.69
	PCARD ONE TIME PAY	COMMS VAN	TRIBAL GAMING-GENL	615.57
	PCARD ONE TIME PAY	UV REFERENCE SENSOR	SOURCE OF SUPPLY	620.35
	PCARD ONE TIME PAY	WAPA TRAINING	ENGR-GENL	630.00
	PCARD ONE TIME PAY	TRAINING EQUIP	POLICE TRAINING-FIREARMS	639.53
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	650.00
	PCARD ONE TIME PAY	HEAT UNIT	MAINT OF GENL PLANT	653.51
	PCARD ONE TIME PAY	WYNDHAM HOTEL	CITY CLERK	663.60
	PCARD ONE TIME PAY	TRAVEL	POLICE INVESTIGATION	721.61
	PCARD ONE TIME PAY	CONFERENCE REGISTRATION - LTOCCO	EXECUTIVE ADMIN	725.00
	PCARD ONE TIME PAY	VETERINARY SERVICES	POLICE COMMUNITY SERVICES	772.50
	PCARD ONE TIME PAY	TRAINING FBI LEEDA	POLICE TRAINING-FIREARMS	795.00
	PCARD ONE TIME PAY	CREDITS	PERSONNEL ADMINISTRATION	847.30
	PCARD ONE TIME PAY	BAGS AND CARABINERS	EXECUTIVE ADMIN	853.32
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	890.00
	PCARD ONE TIME PAY	SCHOOLS/EDUCATIONAL/TRAINING	COMMUNITY	950.00
	PCARD ONE TIME PAY		COMMUNITY	1,050.00
	PCARD ONE TIME PAY	FIREARMS EQUIP	POLICE TRAINING-FIREARMS	1,094.72
	PCARD ONE TIME PAY	2 NEW AEDS	WASTE WATER TREATMENT	1,130.10
	PCARD ONE TIME PAY	NAPA DEF FLUID	SOLID WASTE OPERATIONS	1,136.88
	PCARD ONE TIME PAY	EMERGENCY MANAGEMENT	EXECUTIVE ADMIN	1,241.95
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	1,248.00
	PCARD ONE TIME PAY	HANDWASHING STATION	COMMUNITY EVENTS	1,274.62
	PCARD ONE TIME PAY		COMMUNITY EVENTS	1,274.63
	PCARD ONE TIME PAY	CHIP READER	POLICE COMMUNITY SERVICES	1,371.88
	PCARD ONE TIME PAY	M365 LICENSES	COMPUTER SERVICES	1,496.60
	PCARD ONE TIME PAY	WALL DIVIDERS	POLICE INVESTIGATION	1,531.56
	PCARD ONE TIME PAY	TEMP SPEED BUMPS	TRAFFIC CONTROL DEVICES	1,555.86
	PCARD ONE TIME PAY	LIC/PLT/REGISTRATION P230	EQUIPMENT RENTAL	1,583.69
	PCARD ONE TIME PAY	JENNINGS SIGN LANDSCAPE	PARK & RECREATION FAC	1,658.78
	PCARD ONE TIME PAY	K9 STICKERS GIVE AWAYS	CRIME PREVENTION	1,694.30
	PCARD ONE TIME PAY	TRAVEL LODGING	POLICE TRAINING-FIREARMS	1,695.00
	PCARD ONE TIME PAY	MESH HOUSE ROOF	NON-DEPARTMENTAL	2,287.44
	PCARD ONE TIME PAY	APWA MEMBERSHIP FEES	UTIL ADMIN	2,296.00
	PCARD ONE TIME PAY	AERIFICATION MATERIAL	PARK & RECREATION FAC	2,449.73
	PCARD ONE TIME PAY	FIREARMS SMALL TOOLS	POLICE TRAINING-FIREARMS	2,457.11

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
0	PCARD ONE TIME PAY	COMPRESSOR MONITORING SYSTEM	SUNNYSIDE FILTRATION PLANT	2,489.12
	PCARD ONE TIME PAY	LODGING	POLICE TRAINING-FIREARMS	2,634.78
	PCARD ONE TIME PAY	TRAINING	POLICE TRAINING-FIREARMS	2,695.00
	PCARD ONE TIME PAY	CONEX BOX	PARK & RECREATION FAC	4,017.72
	PCARD ONE TIME PAY	WELDER	WASTE WATER TREATMENT	4,048.77
	PCARD ONE TIME PAY	LIC/PLT REGISTRATION P228	EQUIPMENT RENTAL	4,635.00
	PCARD ONE TIME PAY	REGISTRATION P227	EQUIPMENT RENTAL	4,635.00
	PCARD ONE TIME PAY	LIC/PLT REGISTRATION P229	EQUIPMENT RENTAL	4,635.00
	PCARD ONE TIME PAY	REGISTRATION LIC	EQUIPMENT RENTAL	4,635.00
	PCARD ONE TIME PAY	PUSH PAVER	ROADWAY MAINTENANCE	6,926.94
177659	PREMERA BLUE CROSS	CLAIMS PAID 4/20 TO 4/26/25	MEDICAL CLAIMS	64,347.01
	PREMERA BLUE CROSS	CLAIMS PAID 4/13 TO 4/19/25	MEDICAL CLAIMS	108,996.22
177660	FIRST AMERICAN TITLE	CLOSING FUNDS	GMA - STREET	16,420.50
177661	SALVATION ARMY	REIMBURSEMENT - HUMAN SERVICE	RENTAL PROGRAM	50,000.00
177662	COMMONSTREET	PROFESSIONAL SERVICE	GMA - STREET	35,382.59
177663	911 SUPPLY INC.	NAME PLATES	POLICE PATROL	22.78
	911 SUPPLY INC.	UNIFORM - CORPORAL CHEVRONS	POLICE PATROL	33.87
	911 SUPPLY INC.	NAME PLATE	POLICE PATROL	86.24
	911 SUPPLY INC.	UNIFORM - DELANTY	POLICE COMMUNITY SERVICES	99.28
	911 SUPPLY INC.	PATCHES	POLICE PATROL	171.48
	911 SUPPLY INC.	JUMPSUIT - FAKKEMA	POLICE PATROL	266.41
	911 SUPPLY INC.	JUMPSUIT - MCKENNA	POLICE PATROL	376.58
	911 SUPPLY INC.	BADGES	POLICE ADMINISTRATION	483.36
177664	A & A LANGUAGE SERV	INTERPRETER SERVICE	COURTS	75.00
	A & A LANGUAGE SERV		COURTS	89.10
	A & A LANGUAGE SERV		COURTS	170.00
	A & A LANGUAGE SERV		COURTS	170.00
	A & A LANGUAGE SERV		COURTS	170.00
	A & A LANGUAGE SERV		COURTS	170.00
	A & A LANGUAGE SERV		COURTS	170.00
	A & A LANGUAGE SERV		COURTS	170.00
	A & A LANGUAGE SERV		COURTS	170.00
	A & A LANGUAGE SERV		COURTS	190.00
	A & A LANGUAGE SERV		COURTS	233.00
177665	ALEXANDER PRINTING	BUSINESS CARDS	COMMUNITY	271.33
	ALEXANDER PRINTING	WINDOW ENVELOPES	FINANCE-GENL	493.00
177666	ALEXANDER, PAMELA S	UB REFUND	GARBAGE	166.58
177667	ALPHA COURIER INC	COURIER SERVICE	WASTE WATER TREATMENT	81.20
177668	AMERICAN CLEANERS	DRY CLEANING	DETENTION & CORRECTION	93.59
	AMERICAN CLEANERS		POLICE ADMINISTRATION	101.03
	AMERICAN CLEANERS		POLICE PATROL	409.76
177669	ANDERSON, GILLIAN	REFUND - BALLROOM DANCING	PARKS-RECREATION	78.00
177670	ASTOUND BUSINESS	I-NET LEASE, MAINTENANCE, INTERNET	WATER QUAL TREATMENT	111.30
	ASTOUND BUSINESS		CENTRAL SERVICES	513.71
	ASTOUND BUSINESS		COMPUTER SERVICES	2,308.53
177671	AT&T MOBILITY LLC	CELL PHONE SERVICE	CITY CLERK	39.44
	AT&T MOBILITY LLC		WASTE WATER TREATMENT	39.44
	AT&T MOBILITY LLC		ENGR-GENL	78.88
	AT&T MOBILITY LLC		LEGAL - PROSECUTION	78.88
	AT&T MOBILITY LLC		RECREATION SERVICES	78.88
	AT&T MOBILITY LLC		COMMUNITY	118.32
	AT&T MOBILITY LLC		PERSONNEL ADMINISTRATION	118.32

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177671	AT&T MOBILITY LLC	CELL PHONE SERVICE	UTIL ADMIN	118.32
	AT&T MOBILITY LLC		GIS SERVICES IS	157.76
	AT&T MOBILITY LLC		FINANCE-GENL	157.76
	AT&T MOBILITY LLC		MUNICIPAL COURTS	197.20
	AT&T MOBILITY LLC		LEGAL-GENL	197.20
	AT&T MOBILITY LLC		OFFICE OPERATIONS	276.08
	AT&T MOBILITY LLC		FACILITY MAINTENANCE	394.40
	AT&T MOBILITY LLC		EXECUTIVE ADMIN	433.84
	AT&T MOBILITY LLC		POLICE INVESTIGATION	552.16
	AT&T MOBILITY LLC		POLICE ADMINISTRATION	552.16
	AT&T MOBILITY LLC		DETENTION & CORRECTION	709.92
	AT&T MOBILITY LLC		COMMUNITY SERVICES UNIT	749.36
	AT&T MOBILITY LLC		COMPUTER SERVICES	828.24
	AT&T MOBILITY LLC		POLICE PATROL	2,681.76
177672	BATES, DORIS	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177673	BELISLE, TERI		PARKS-RECREATION	9.00
177674	BENS CLEANER SALES	PUMP PACKAGE - 899P	EQUIPMENT RENTAL	1,148.70
177675	BEZON, LOGAN	UB REFUND	WATER/SEWER OPERATION	62.40
177676	BICKFORD FORD	CORE RETURN P173 ALTERNATOR	EQUIPMENT RENTAL	-82.05
	BICKFORD FORD	EXHAUST PIPE GASKET - P185	EQUIPMENT RENTAL	13.72
	BICKFORD FORD	MIRROR LIGHT ASSEMBLY - J058	EQUIPMENT RENTAL	130.70
	BICKFORD FORD	MOTOR MOUNTS	ER&R	192.78
	BICKFORD FORD	TPMS SENSOR - P200	EQUIPMENT RENTAL	276.73
	BICKFORD FORD	A/C COMPRESSOR - J058	EQUIPMENT RENTAL	457.29
	BICKFORD FORD	ALTERNATOR - P173	EQUIPMENT RENTAL	473.16
	BICKFORD FORD	BRAKE PADS, ROTORS	ER&R	962.57
	BICKFORD FORD	VALVE ASSEMBLY, TRANSFER UNIT	EQUIPMENT RENTAL	1,486.92
	BICKFORD FORD	PUMP REPLACEMENT, PARTS, LABOR	EQUIPMENT RENTAL	4,941.02
177677	BILLING DOCUMENT SPE	PAYMENT PROCESSING - APRIL	UTILITY BILLING	2,383.83
	BILLING DOCUMENT SPE	BILL PRINTING	UTILITY BILLING	3,521.46
177678	BLEACHERS GRILL	SENIOR LUNCH	RECREATION SERVICES	437.60
177679	BOCZKIEWICZ, TONI	REFUND - LINE DANCING	PARKS-RECREATION	21.00
177680	BOERSEMA, LINDA		PARKS-RECREATION	9.00
177681	BOMAR, RICK	INSTRUCTOR PAYMENT	RECREATION SERVICES	262.50
177682	BRADLEY, KAM	REFUND - OPERA HOUSE DEPOSIT	GENERAL FUND	500.00
177683	CANTU, JASON	REFUND - OVERPAYMENT	COMMUNITY DEVELOPMENT	287.50
177684	CARSON-BLAKESLEY,VET	INSTRUCTOR PAYMENT	RECREATION SERVICES	768.00
177685	CARVER, VICKI		RECREATION SERVICES	421.20
177686	CENLAR FSB	PARTIAL RECONVEYANCE PAYDOWN	GMA - STREET	1,216.05
177687	CENTRAL WELDING SUPP	DANGER TAPE	ER&R	99.38
	CENTRAL WELDING SUPP	C02 TANK REFILLS	ER&R	110.41
	CENTRAL WELDING SUPP	VESTS	ER&R	117.61
	CENTRAL WELDING SUPP		ER&R	117.61
	CENTRAL WELDING SUPP	EAR PLUGS	ER&R	196.92
	CENTRAL WELDING SUPP	WELDING SHIELDS	EQUIPMENT RENTAL	228.33
	CENTRAL WELDING SUPP	GLOVES, EAR PLUGS, SHOVELS, RAKES	ER&R	2,245.00
	CENTRAL WELDING SUPP	SWEATSHIRTS, T-SHIRT	ER&R	7,356.06
177688	CITIES DIGITAL, INC.	LASERFICHE HOURS	COMPUTER SERVICES	4,625.00
177689	CNR INC	MAINTENANCE CONTRACT	COMPUTER SERVICES	1,365.78
177690	COAST INJURY MEDICIN	MEDICAL RECORDS FEE	RISK MANAGEMENT	6.50
177691	COMMERCIAL FIRE	FIRE EXTINGUISHERS	ER&R	833.56
177692	CONTRERAS, PRAVDA	REFUND - CREDIT BALANCE	PARKS-RECREATION	28.00

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177693	CORE & MAIN LP	HACH SENSORS	WASTE WATER TREATMENT	7,129.60
177694	CORRECTIONS, DEPT OF	INMATE MEALS	DETENTION & CORRECTION	9,511.40
177695	COSTLESS SENIOR SRVC	PHARMACY SERVICES	DETENTION & CORRECTION	436.02
177696	COUGHTRY, MARLA	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177697	COUNTRY SUPPLIER	UNIFORM - HANKINSON	UTIL ADMIN	122.52
	COUNTRY SUPPLIER	GROUNDS MAINTENANCE	WASTE WATER TREATMENT	126.85
	COUNTRY SUPPLIER	UNIFORM - HANKINSON	UTIL ADMIN	180.35
	COUNTRY SUPPLIER	GROUNDS MAINTENANCE	WASTE WATER TREATMENT	193.59
177698	CRAWFORD, SHANON	INSTRUCTOR PAYMENT	RECREATION SERVICES	1,182.72
177699	CRYSTAL SPRINGS	WATER COOLER RENTAL	SEWER MAIN COLLECTION	7.65
	CRYSTAL SPRINGS		WASTE WATER TREATMENT	99.69
	CRYSTAL SPRINGS	WATER SERVICE	RECREATION SERVICES	141.53
177700	DELL	MONITORS	MUNICIPAL COURTS	636.30
177701	DICKS TOWING	TOWING 25-24466	POLICE PATROL	77.54
	DICKS TOWING	TOWING 25-23946	POLICE PATROL	103.38
	DICKS TOWING	TOWING - RV DISPOSAL 25-8006	POLICE PATROL	946.51
177702	DOBBS PETERBILT	SENSOR - J068	EQUIPMENT RENTAL	164.85
	DOBBS PETERBILT	STEERING CYLINDER	ER&R	2,045.07
177703	DOO WOP DIVAS	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177704	E&E LUMBER	PURITY SAMPLES	WATER DIST MAINS	5.13
	E&E LUMBER	RESERVOIR GATE REPAIR	WATER RESERVOIRS	44.42
	E&E LUMBER	DISTRIBUTION	WATER DIST MAINS	68.52
	E&E LUMBER	FASTENERS, DOOR PULL - J080	EQUIPMENT RENTAL	345.67
177705	EARLY, HOLLY	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177706	EMERALD SERVICES INC	WASTE OIL DISPOSAL FEE	EQUIPMENT RENTAL	386.09
177707	ENVIRO-CLEAN EQUIP	GRABBER POLES	SEWER MAIN COLLECTION	722.50
	ENVIRO-CLEAN EQUIP		STORM DRAINAGE	722.51
177708	EUROFINS ENVIRONMENT	LAB ANALYSIS	WATER QUAL TREATMENT	20.00
	EUROFINS ENVIRONMENT		WATER QUAL TREATMENT	25.00
	EUROFINS ENVIRONMENT		WATER QUAL TREATMENT	25.00
	EUROFINS ENVIRONMENT		WATER QUAL TREATMENT	25.00
	EUROFINS ENVIRONMENT		WATER QUAL TREATMENT	25.00
	EUROFINS ENVIRONMENT		WATER QUAL TREATMENT	25.00
	EUROFINS ENVIRONMENT		WATER QUAL TREATMENT	25.00
	EUROFINS ENVIRONMENT		WATER QUAL TREATMENT	50.00
	EUROFINS ENVIRONMENT		WATER QUAL TREATMENT	50.00
	EUROFINS ENVIRONMENT		WATER QUAL TREATMENT	50.00
	EUROFINS ENVIRONMENT		WATER QUAL TREATMENT	460.00
177709	EVENS, MCCALLA	REIMBURSEMENT - TRAVEL	GENERAL FUND	322.60
177710	EVERETT HERALD	SUBSCRIPTION RENEWAL	UTIL ADMIN	297.24
177711	EVERETT TIRE & AUTO	TIRES	ER&R	1,589.38
177712	EVERETT, CITY OF	LAB ANALYSIS	WATER QUAL TREATMENT	47.70
	EVERETT, CITY OF		WATER QUAL TREATMENT	116.10
	EVERETT, CITY OF		WASTE WATER TREATMENT	962.10
177713	EWING IRRIGATION	HERBICIDE SPRAY/RESERVOIRS	WATER RESERVOIRS	398.62
177714	FERGUSON ENTERPRISES	METER KEYS	ER&R	195.78
177715	FISHER, JAMIE	UB REFUND	WATER/SEWER OPERATION	30.92
177716	FREITAS, TERI	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177717	GALL, EMILY	REFUND - BALLET/TAP	PARKS-RECREATION	48.00
177718	GEISE, DONNA	INSTRUCTOR PAYMENT	RECREATION SERVICES	210.00
177719	GLASS FIX LLC	WINDSHIELD REPLACEMENT - P130	EQUIPMENT RENTAL	301.94
177720	GLATTFELDER, KATIE	REFUND - LINE DANCING	PARKS-RECREATION	9.00

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177721	GMP CONSULTANTS	INTERIM CD DIRECTOR HOURS	COMMUNITY	9,973.25
177722	GRAINGER	GLOVES	EQUIPMENT RENTAL	308.94
	GRAINGER	BBP KITS	ER&R	495.59
	GRAINGER	GLOVES	ER&R	526.17
	GRAINGER	EARMUFFS	ER&R	539.82
	GRAINGER	DRINK MIX	MAINT OF GENL PLANT	680.40
	GRAINGER	SPRAY BOTTLES, GLOVES, GLASSES	ER&R	880.88
	GRAINGER	BUFFER, SAMPLE PORT PARTS	SOURCE OF SUPPLY	969.36
177723	GREENSHIELDS INDS	PRESSURE WASHER COUPLER, HANDLE	WATER RESERVOIRS	101.14
	GREENSHIELDS INDS	PLUGS, COUPLER	EQUIPMENT RENTAL	126.21
177724	HANKINSON, TREVOR	REIMBURSEMENT - TESTING	UTIL ADMIN	106.00
177725	HANSEN, APRIL	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177726	HANSON, LOIS		PARKS-RECREATION	9.00
177727	HD FOWLER COMPANY	CREDIT FOR INV I6967458	WATER DIST MAINS	-64.65
	HD FOWLER COMPANY	BLUE MARKING PAINT CANS	WATER RESERVOIRS	271.40
	HD FOWLER COMPANY	BRASS WATER PARTS	WATER/SEWER OPERATION	1,219.46
177728	HENNIG, JEANINE TULL	INSTRUCTOR PAYMENT	RECREATION SERVICES	536.40
177729	HEWLETT PACKARD	PRINTER SERVICE	FINANCE-GENL	1.41
	HEWLETT PACKARD		PARK & RECREATION FAC	1.86
	HEWLETT PACKARD		ENGR-GENL	16.68
	HEWLETT PACKARD		FINANCE-GENL	22.13
	HEWLETT PACKARD		FINANCE-GENL	87.96
177730	HILLIER, MADELYN	REFUND - BALLROOM DANCING	PARKS-RECREATION	156.00
177731	HOUSE OF UPHOLSTERY	FOAM SEAT REPAIR - V047	EQUIPMENT RENTAL	410.25
177732	HYLARIDES, LETTIE	INTERPRETER SERVICE	COURTS	187.50
	HYLARIDES, LETTIE		COURTS	187.50
	HYLARIDES, LETTIE		COURTS	187.50
177733	IDEMIA IDENTITY	MOBILE FINGERPRINT READER	DETENTION & CORRECTION	1,700.00
	IDEMIA IDENTITY		POLICE PATROL	1,700.00
177734	INTERMOUNTAIN LOCK	PADLOCK	ER&R	229.22
177735	INTOXIMETERS	SUPPLIES	POLICE PATROL	274.87
177736	INTRADO LIFE & SAFET	E911 SERVICE	COMPUTER SERVICES	929.90
177737	J & B TOOLS, LLC	SOCKETS, DRIVERS	EQUIPMENT RENTAL	1,538.84
177738	J. THAYER COMPANY	PACKING TAPE	ER&R	50.30
177739	J2 CLOUD SERVICES	FAX	LEGAL - PROSECUTION	16.43
	J2 CLOUD SERVICES		LEGAL-GENL	16.43
	J2 CLOUD SERVICES		UTILITY BILLING	32.85
	J2 CLOUD SERVICES		CITY CLERK	32.85
	J2 CLOUD SERVICES		COMMUNITY	32.85
	J2 CLOUD SERVICES		WASTE WATER TREATMENT	32.85
	J2 CLOUD SERVICES		WASTE WATER TREATMENT	32.85
	J2 CLOUD SERVICES		EXECUTIVE ADMIN	32.85
	J2 CLOUD SERVICES		POLICE ADMINISTRATION	32.85
	J2 CLOUD SERVICES		RECREATION SERVICES	32.85
	J2 CLOUD SERVICES		POLICE INVESTIGATION	32.85
	J2 CLOUD SERVICES		MUNICIPAL COURTS	32.85
	J2 CLOUD SERVICES		DETENTION & CORRECTION	32.85
	J2 CLOUD SERVICES		PROBATION	32.85
	J2 CLOUD SERVICES		FINANCE-GENL	32.85
	J2 CLOUD SERVICES		UTIL ADMIN	32.85
	J2 CLOUD SERVICES		ENGR-GENL	32.85
	J2 CLOUD SERVICES		PERSONNEL ADMINISTRATION	32.85

CITY OF MARYSVILLE
INVOICE LIST

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177739	J2 CLOUD SERVICES	FAX	WATER DIST MAINS	32.86
	J2 CLOUD SERVICES		COMPUTER SERVICES	32.87
	J2 CLOUD SERVICES		OFFICE OPERATIONS	65.70
	J2 CLOUD SERVICES		MUNICIPAL COURTS	98.56
177740	JOHNSON, MELODY	REFUND - CANVAS	PARKS-RECREATION	10.00
177741	JULZ ANIMAL HOUZ	K9 SUPPLIES	K9 PROGRAM	16.85
	JULZ ANIMAL HOUZ	FOOD - MOLLY	POLICE ADMINISTRATION	23.95
177742	KANE, GRACE	REFUND - PICKLEBALL	PARKS-RECREATION	75.00
177743	KANEHEN, GREGORY	CHAPLAIN STIPEND - KANEHEN	POLICE ADMINISTRATION	750.00
177744	KEIM, ERIN	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177745	KENDALL CHEVROLET	BRAKE PADS/ROTORS	ER&R	994.42
177746	KIM, JAMIE S.	PUBLIC DEFENSE/CONFLICT COUNSEL	PUBLIC DEFENSE	450.00
	KIM, JAMIE S.		PUBLIC DEFENSE	450.00
	KIM, JAMIE S.		PUBLIC DEFENSE	450.00
	KIM, JAMIE S.		PUBLIC DEFENSE	450.00
	KIM, JAMIE S.		PUBLIC DEFENSE	450.00
177747	KITSAP TRACTOR	FUEL FILTERS - H023	EQUIPMENT RENTAL	50.50
177748	KOVALCHUK, NAZARRI S	UB REFUND	GARBAGE	200.96
177749	LACEY, MICHAEL	UB REFUND	WATER/SEWER OPERATION	244.35
177750	LAYTON TREE CONSULT	DANGEROUS TREE ASSESSMENT	STORM DRAINAGE	510.45
177751	LAZO, TAMERA	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177752	LES SCHWAB TIRE CTR	TIRES	ER&R	1,915.64
177753	LINC NW	MOTEL CONTRACT	COUNTY HM GRANT	16,698.96
177754	LODGE, MAYA	REFUND - YOGA	PARKS-RECREATION	96.00
177755	LOHRKE, TREVOR	REIMBURSEMENT - EXAM	POLICE TRAINING-FIREARMS	175.00
177756	MARYSVILLE, CITY OF	1404 5TH ST	NON-DEPARTMENTAL	27.33
	MARYSVILLE, CITY OF	3RD ST & STATE AVE	NON-DEPARTMENTAL	27.33
	MARYSVILLE, CITY OF	1529 3RD ST IRRIGATION	WATER SERVICES	43.51
	MARYSVILLE, CITY OF	1049 STATE AVE	NON-DEPARTMENTAL	86.77
	MARYSVILLE, CITY OF	1221 3 ST	OPERA HOUSE	129.23
	MARYSVILLE, CITY OF	316 CEDAR AVE	STORM DRAINAGE	129.23
	MARYSVILLE, CITY OF	1019 CEDAR AVE FIELD	PARK & RECREATION FAC	133.64
	MARYSVILLE, CITY OF	514 DELTA AVE	NON-DEPARTMENTAL	136.68
	MARYSVILLE, CITY OF		PARK & RECREATION FAC	142.56
	MARYSVILLE, CITY OF	1050 COLUMBIA AVE	PARK & RECREATION FAC	144.38
	MARYSVILLE, CITY OF	10118 STATE AVE	ROADWAY MAINTENANCE	166.50
	MARYSVILLE, CITY OF	4TH ST & I-5 IRRIGATION	PARK & RECREATION FAC	191.24
	MARYSVILLE, CITY OF	80 COLUMBIA AVE	ROADWAY MAINTENANCE	237.22
	MARYSVILLE, CITY OF		MAINT OF GENL PLANT	238.58
	MARYSVILLE, CITY OF	6802 84 ST NE	GOLF ADMINISTRATION	240.05
	MARYSVILLE, CITY OF	61 STATE AVE	PARK & RECREATION FAC	244.46
	MARYSVILLE, CITY OF	1049 STATE AVE	NON-DEPARTMENTAL	265.80
	MARYSVILLE, CITY OF	514 DELTA AVE RESTROOM	PARK & RECREATION FAC	336.75
	MARYSVILLE, CITY OF	1010 BEACH AVE	PARK & RECREATION FAC	411.06
	MARYSVILLE, CITY OF	80 COLUMBIA AVE	EQUIPMENT RENTAL	434.18
	MARYSVILLE, CITY OF	1015 STATE AVE	RECREATION SERVICES	769.89
	MARYSVILLE, CITY OF	1225 3 ST	OPERA HOUSE	828.68
	MARYSVILLE, CITY OF	514 DELTA AVE	PARK & RECREATION FAC	834.59
	MARYSVILLE, CITY OF	80 COLUMBIA AVE	WASTE WATER TREATMENT	1,233.18
	MARYSVILLE, CITY OF	514 DELTA AVE	NON-DEPARTMENTAL	2,180.14
	MARYSVILLE, CITY OF	501 DELTA AVE	NON-DEPARTMENTAL	2,246.95
	MARYSVILLE, CITY OF	80 COLUMBIA AVE	WASTE WATER TREATMENT	3,093.53

CITY OF MARYSVILLE
INVOICE LIST

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177756	MARYSVILLE, CITY OF	80 COLUMBIA AVE	MAINT OF GENL PLANT	3,105.83
177757	MCKESSON MEDICAL	JAIL SUPPLIES	DETENTION & CORRECTION	67.13
177758	MCMASTER-CARR	WATERLINE REPAIR/DUMPSTERS	WASTE WATER TREATMENT	689.51
177759	MELLOTT, KAREN	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177760	MIRIAM TECHNOLOGIES	WEBCHECK SERVICE - APRIL	UTILITY BILLING	1,148.70
177761	MOFFITT, JOANN	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177762	MOTION INDUSTRIES	GEARBOX	WASTE WATER TREATMENT	2,870.26
177763	MPAC	INSTRUCTOR PAYMENT	RECREATION SERVICES	633.60
177764	NAPA AUTO PARTS	EXHAUST BAND CLAMP - J024	EQUIPMENT RENTAL	16.91
	NAPA AUTO PARTS	AIR FILTERS	ER&R	25.00
	NAPA AUTO PARTS		ER&R	60.88
	NAPA AUTO PARTS	FILTERS, LIGHT BULBS	ER&R	99.03
	NAPA AUTO PARTS	AIR/FUEL/OIL FILTERS	ER&R	154.43
	NAPA AUTO PARTS	OIL/AIR FILTERS	ER&R	262.51
177765	NORTH SOUND MEDIA	MARKETING	RECREATION SERVICES	400.00
177766	OLASON, MONICA	INSTRUCTOR PAYMENT	RECREATION SERVICES	1,903.20
177767	OLD REPUBLIC TITLE	PARTIAL RECONVEYANCE FEE	GMA - STREET	794.00
177768	OREILLY AUTO PARTS	WHEEL SEAL - P129	EQUIPMENT RENTAL	5.56
	OREILLY AUTO PARTS	BRAKE KIT - P129	EQUIPMENT RENTAL	9.19
	OREILLY AUTO PARTS	EXHAUST BAND CLAMP - J024	EQUIPMENT RENTAL	37.61
	OREILLY AUTO PARTS	SWAY BAR FRAME - P130	EQUIPMENT RENTAL	71.12
	OREILLY AUTO PARTS	EXHAUST PARTS -P178	EQUIPMENT RENTAL	72.54
177769	PALOMINO, BRENDA	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177770	PAPE MACHINERY	SWITCH - 899P	EQUIPMENT RENTAL	10.70
	PAPE MACHINERY	FILTERS - 899P	EQUIPMENT RENTAL	56.12
	PAPE MACHINERY	V-BELT - 899P	EQUIPMENT RENTAL	104.15
	PAPE MACHINERY	ROTARY SWITCH, FILTERS - 899P	EQUIPMENT RENTAL	745.80
177771	PARKER BROS ELECTRIC	REFUND - CITY LIMITS	COMMUNITY DEVELOPMENT	115.00
177772	PEACE OF MIND	COUNCIL REGULAR MEETING	CITY CLERK	186.20
177773	PEARSON, JUDY	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177774	PGC INTERBAY LLC	PAYROLL REIMBURSEMENT - GOLF	PRO-SHOP	15,331.20
	PGC INTERBAY LLC		MAINTENANCE	18,088.30
177775	PHAM, JOSEPH	INSTRUCTOR PAYMENT	COURTS	176.60
177776	PLATT ELECTRIC	SWITCH	WASTE WATER TREATMENT	23.14
	PLATT ELECTRIC	PIPE, PVC ELBOW	PARK & RECREATION FAC	287.03
177777	POLICE & SHERIFFS PR	CHAPLAIN UNIFORM ID	GENERAL FUND	-1.75
	POLICE & SHERIFFS PR		POLICE ADMINISTRATION	20.35
177778	POSTAL SERVICE	QTR NEWSLETTER MAILING	NON-DEPARTMENTAL	6,242.64
177779	POTTERY NOOK, THE	INSTRUCTOR PAYMENT	RECREATION SERVICES	86.40
	POTTERY NOOK, THE		RECREATION SERVICES	147.60
177780	PRIME ELECTRIC	FIBER PULL BACK/SPLICE PROJECT	I/NET	-1,573.90
	PRIME ELECTRIC		CENTRAL SERVICES	17,218.47
177781	PROVIDENT ELECTRIC	REFUND - PERMIT	COMMUNITY DEVELOPMENT	115.00
177782	PUD	ACCT #204259469	TRAFFIC CONTROL DEVICES	52.37
	PUD	ACCT #204260343	TRAFFIC CONTROL DEVICES	52.37
	PUD	ACCT #204262620	TRAFFIC CONTROL DEVICES	52.37
	PUD	ACCT #205481823	GOLF ADMINISTRATION	52.37
	PUD	ACCT #201346665	SEWER LIFT STATION	57.04
	PUD	ACCT #224411843	PARK & RECREATION FAC	65.54
	PUD	ACCT #201142155	TRANSPORTATION	73.10
	PUD	ACCT #204829691	STREET LIGHTING	77.32
	PUD	ACCT #202294245	SEWER LIFT STATION	81.45

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177782	PUD	ACCT #200660439	STREET LIGHTING	91.86
	PUD	ACCT #203996343	STREET LIGHTING	97.35
	PUD	ACCT #221610405	STREET LIGHTING	106.66
	PUD	ACCT #203291216	GENERAL	124.24
	PUD	ACCT #201909637	SEWER LIFT STATION	152.61
	PUD	ACCT #220020531	STREET LIGHTING	169.02
	PUD	ACCT #200812808	PUMPING PLANT	410.08
	PUD	ACCT #202461554	SEWER LIFT STATION	547.75
	PUD	ACCT #201098969	PUMPING PLANT	835.54
177783	PUGET SOUND ENERGY	ACCT #220002768939	NON-DEPARTMENTAL	19.29
	PUGET SOUND ENERGY	ACCT #220015485349	OPERA HOUSE	54.66
	PUGET SOUND ENERGY	ACCT #200007781657	GOLF ADMINISTRATION	80.58
	PUGET SOUND ENERGY	ACCT #220015485380	OPERA HOUSE	102.21
	PUGET SOUND ENERGY	ACCT #200007052364	MAINT OF GENL PLANT	110.85
	PUGET SOUND ENERGY	ACCT #220015485703	OPERA HOUSE	110.85
	PUGET SOUND ENERGY	ACCT #200023493808	ADMIN FACILITIES	165.54
	PUGET SOUND ENERGY	ACCT #220026412746	NON-DEPARTMENTAL	172.59
	PUGET SOUND ENERGY	ACCT #200004804056	RECREATION SERVICES	252.27
	PUGET SOUND ENERGY	ACCT #220009207345	OPERA HOUSE	286.64
	PUGET SOUND ENERGY	ACCT #220026419946	NON-DEPARTMENTAL	905.69
	PUGET SOUND ENERGY	ACCT #200013812314	MAINT OF GENL PLANT	957.66
177784	RAMOS, KINDRA	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177785	RATANA ROSA SHURTZ	INSTRUCTOR PAYMENT	RECREATION SERVICES	135.00
177786	REBOOT RECOVERY	RENTAL DEPOSIT - OPERA HOUSE	GENERAL FUND	250.00
177787	REECE TRUCKING	WASTE DISPOSAL	STORM DRAINAGE	195.40
177788	RIGHT SYSTEMS, INC.	MAINTENANCE RENEWAL	IS REPLACEMENT ACCOUNTS	12,154.80
177789	RONGERUDE, JOHN	PROTEM SERVICE	MUNICIPAL COURTS	277.50
	RONGERUDE, JOHN		MUNICIPAL COURTS	277.50
177790	RUDDELL, MICHAEL	REIMBURSEMENT - DINNER	UTIL ADMIN	20.00
177791	RUGWELL, DEAN & ANIT	UB REFUND	WATER/SEWER OPERATION	328.93
177792	RWC INTERNATIONAL	FUEL FILTER	ER&R	204.22
177793	SCHNEIDER, P DIANE	INTERPRETER SERVICE	COURTS	185.00
	SCHNEIDER, P DIANE		COURTS	185.00
177794	SCHNEIDER, SHERRIE	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177795	SECURITY SOLUTIONS	CAMERA PROJECT	RECREATION SERVICES	16,311.54
177796	SIX ROBBLEES INC	CONNECTOR PLUG	ER&R	159.90
	SIX ROBBLEES INC	IMPACT WRENCH, GRINDER, SOCKETS	EQUIPMENT RENTAL	209.81
	SIX ROBBLEES INC	IMPACT WRENCH, SOCKETS	EQUIPMENT RENTAL	223.08
177797	SMARSH INC	TEXT MESSAGE ARCHIVING	COMPUTER SERVICES	-38.37
	SMARSH INC		COMMUNITY	7.85
	SMARSH INC		YOUTH SERVICES	7.85
	SMARSH INC		CRIME PREVENTION	7.85
	SMARSH INC		PROPERTY TASK FORCE	7.85
	SMARSH INC		LEGAL-GENL	7.85
	SMARSH INC		GENERAL	7.85
	SMARSH INC		EQUIPMENT RENTAL	7.85
	SMARSH INC		FACILITY MAINTENANCE	7.85
	SMARSH INC		CITY COUNCIL	15.70
	SMARSH INC		FINANCE-GENL	15.70
	SMARSH INC		RECREATION SERVICES	15.70
	SMARSH INC		UTILITY BILLING	15.70
	SMARSH INC		SEWER MAIN COLLECTION	15.70

CITY OF MARYSVILLE
INVOICE LIST

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177797	SMARSH INC	TEXT MESSAGE ARCHIVING	MUNICIPAL COURTS	23.55
	SMARSH INC		COMMUNITY SERVICES UNIT	23.55
	SMARSH INC		CITY CLERK	23.55
	SMARSH INC		PERSONNEL ADMINISTRATION	23.55
	SMARSH INC		CUSTODIAL SERVICES	31.40
	SMARSH INC		COMMUNITY	39.25
	SMARSH INC		COMPUTER SERVICES	39.25
	SMARSH INC		LEGAL - PROSECUTION	47.10
	SMARSH INC		OFFICE OPERATIONS	47.10
	SMARSH INC		COMMUNITY SERVICES UNIT	47.10
	SMARSH INC		PARK & RECREATION FAC	47.10
	SMARSH INC		STORM DRAINAGE	47.10
	SMARSH INC		WATER QUAL TREATMENT	62.80
	SMARSH INC		GENERAL	94.20
	SMARSH INC		POLICE INVESTIGATION	102.05
	SMARSH INC		DETENTION & CORRECTION	109.90
	SMARSH INC		WASTE WATER TREATMENT	117.75
	SMARSH INC		EXECUTIVE ADMIN	125.60
	SMARSH INC		POLICE ADMINISTRATION	125.60
	SMARSH INC		SOLID WASTE CUSTOMER EXP	133.45
	SMARSH INC		UTIL ADMIN	149.15
	SMARSH INC		ENGR-GENL	188.40
	SMARSH INC		POLICE PATROL	549.50
177798	SMITH, BRAD	PNWK9 CONFERENCE	POLICE TRAINING-FIREARMS	473.00
177799	SNO CO AUDITOR	RECORDING OF EASEMENT	GMA - STREET	307.50
	SNO CO AUDITOR	RECORDING OF DEED OF RIGHT	GMA - STREET	309.50
177800	SNO CO CORRECTIONS	INMATE MEDICAL	DETENTION & CORRECTION	30,262.70
177801	SOUND PUBLISHING	NOA PA25-0008	COMMUNITY	63.76
	SOUND PUBLISHING	DNS PA24-031	COMMUNITY	77.52
	SOUND PUBLISHING	NOCPH NOTICE	COMMUNITY	87.84
	SOUND PUBLISHING	RFQ CAO 2025	COMMUNITY	87.84
	SOUND PUBLISHING	NOPH CA25-0002	COMMUNITY	91.58
	SOUND PUBLISHING	PA21-054	COMMUNITY	101.60
177802	SOUND PUBLISHING	CITY ORDINANCES	CITY CLERK	29.24
177803	SOUND SAFETY	UNIFORM - COBB	UTIL ADMIN	233.89
	SOUND SAFETY	NEEDLE/SYRINGE KEEPER	ER&R	1,575.16
177804	SPRAGUE PEST SOLUTION	EXTERIOR RODENT SERVICE	SOLID WASTE OPERATIONS	84.24
	SPRAGUE PEST SOLUTION		MAINT OF GENL PLANT	84.24
177805	STONEWAY ELECTRIC	PANEL	EQUIPMENT RENTAL	1,420.91
177806	STRATEGIES 360	PROFESSIONAL SERVICE	GENERAL	3,750.00
	STRATEGIES 360		WASTE WATER TREATMENT	3,750.00
	STRATEGIES 360		UTIL ADMIN	5,000.00
177807	SUPERIOR RESTROOMS	PORTABLE RESTROOM RENTAL	RECREATION SERVICES	450.00
	SUPERIOR RESTROOMS	PORTABLE RESTROOM	RECREATION SERVICES	750.00
177808	THOMSON REUTERS	ONLINE/SOFTWARE SUBSCRIPTION	LEGAL-GENL	858.90
	THOMSON REUTERS		LEGAL - PROSECUTION	858.90
177809	TRAVIS, AILEEN	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177810	TRUE NORTH EQUIPMENT	PIVOT PIN	ER&R	271.86
	TRUE NORTH EQUIPMENT	JOYSTICK	ER&R	672.64
177811	VEOLIA WATER TECH	UV PARTS	WASTE WATER TREATMENT	4,916.00
177812	VERIZON	WIRELESS SERVICE	POLICE ADMINISTRATION	20.96
	VERIZON		PURCHASING/CENTRAL STORES	30.64

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177812	VERIZON	WIRELESS SERVICE	SEWER MAIN COLLECTION	40.01
	VERIZON		COMMUNITY SERVICES UNIT	60.03
	VERIZON	WIRELESS MODEMS	COMMUNITY SERVICES UNIT	80.02
	VERIZON	WIRELESS SERVICE	FINANCE-GENL	84.16
	VERIZON		POLICE PATROL	100.04
	VERIZON		EQUIPMENT RENTAL	105.12
	VERIZON		EXECUTIVE ADMIN	171.26
	VERIZON		MUNICIPAL COURTS	210.40
	VERIZON		LEGAL - PROSECUTION	257.48
	VERIZON	WIRELESS MODEMS	POLICE INVESTIGATION	320.08
	VERIZON	WIRELESS SERVICE	FACILITY MAINTENANCE	362.60
	VERIZON		WATER QUAL TREATMENT	370.51
	VERIZON		PARK & RECREATION FAC	418.38
	VERIZON		RECREATION SERVICES	418.38
	VERIZON		COMMUNITY	450.46
	VERIZON		COMPUTER SERVICES	474.94
	VERIZON		WATER SUPPLY MAINS	573.34
	VERIZON		SOLID WASTE CUSTOMER EXP	619.75
	VERIZON		SEWER MAIN COLLECTION	726.72
	VERIZON		STORM DRAINAGE	872.02
	VERIZON		GENERAL	1,035.39
	VERIZON	WIRELESS MODEMS	POLICE PATROL	1,635.44
	VERIZON	WIRELESS SERVICE	ENGR-GENL	1,655.61
	VERIZON		UTIL ADMIN	2,474.96
177813	VESTIS GROUP INC.	UNIFORM CLEANING, SHOP RENTALS	EQUIPMENT RENTAL	23.83
	VESTIS GROUP INC.	UNIFORM CLEANING/SHOP RENTALS	EQUIPMENT RENTAL	24.38
	VESTIS GROUP INC.	UNIFORM CLEANING, SHOP RENTALS	EQUIPMENT RENTAL	44.02
	VESTIS GROUP INC.	UNIFORM CLEANING/SHOP RENTALS	EQUIPMENT RENTAL	44.57
177814	VESTIS GROUP INC.	CUSTODIAL/MCC CLEANING RENTALS	CUSTODIAL SERVICES	35.88
	VESTIS GROUP INC.		CUSTODIAL SERVICES	35.88
	VESTIS GROUP INC.		CUSTODIAL SERVICES	148.65
	VESTIS GROUP INC.		CUSTODIAL SERVICES	148.65
	VESTIS GROUP INC.	LINEN SERVICE	OPERA HOUSE	231.68
177815	VESTIS GROUP INC.		OPERA HOUSE	241.30
177816	WASTE MANAGEMENT	LATE CHARGE	WASTE WATER TREATMENT	6.80
	WASTE MANAGEMENT	SPECIAL SOLID WASTE SERVICE	WASTE WATER TREATMENT	2,711.31
	WASTE MANAGEMENT		WASTE WATER TREATMENT	5,496.36
177817	WEEKS, BRADLEY J	INSTRUCTOR PAYMENT	RECREATION SERVICES	60.00
177818	WEISS, SHARON	REFUND - LINE DANCING	PARKS-RECREATION	9.00
177819	WENE, KARA		PARKS-RECREATION	9.00
177820	WET RABBIT EXPRESS	CAR WASHES - PARKS	RECREATION SERVICES	7.20
	WET RABBIT EXPRESS	CAR WASHES - PW	EQUIPMENT RENTAL	129.60
	WET RABBIT EXPRESS	CAR WASHES - POLICE	POLICE PATROL	590.40
177821	WHISTLE WORKWEAR	UNIFORM - SCOTT	SOLID WASTE OPERATIONS	321.41
177822	WHITE CAP	BOTTLED WATER	MAINT OF GENL PLANT	1,100.91
177823	WICHERS, DENA	UB REFUND	WATER/SEWER OPERATION	127.05
177824	WILLIAMS, JANICE	REFUND - JUNK IN TRUNK	PARKS-RECREATION	35.00
177825	WILSON, JEFF	TRAVEL/PARKING/HOTEL	COMMUNITY	1,368.88
177826	ZIPLY FIBER	ACCT #3606517319	TRAFFIC CONTROL DEVICES	69.79
177827	ZIPLY FIBER	PHONE SERVICE	POLICE ADMINISTRATION	59.60
	ZIPLY FIBER		POLICE PATROL	59.60
	ZIPLY FIBER		COMMUNICATION CENTER	59.60

FOR INVOICES FROM 5/14/25 TO 5/14/25

CHK #	VENDOR	ITEM DESCRIPTION	ACCOUNT DESCRIPTION	ITEM AMOUNT
177827	ZIPLY FIBER	PHONE SERVICE	UTILITY BILLING	59.60
	ZIPLY FIBER		GENERAL	59.60
	ZIPLY FIBER		GOLF ADMINISTRATION	59.60
	ZIPLY FIBER		COMMUNITY	119.20
	ZIPLY FIBER		DETENTION & CORRECTION	119.20
	ZIPLY FIBER		OFFICE OPERATIONS	119.20
	ZIPLY FIBER		GOLF ADMINISTRATION	119.20
	ZIPLY FIBER		CITY HALL	178.79
	ZIPLY FIBER		RECREATION SERVICES	238.39
	ZIPLY FIBER		WASTE WATER TREATMENT	297.99
	ZIPLY FIBER		UTIL ADMIN	297.99

WARRANT TOTAL: **760,703.96**

PUGET SOUND ENERGY	CHECK LOST/DAMAGED	VOID	170355	$4,461.43
NIKOLE CRUTCHER	INITIATOR ERROR	VOID	177552	$219.00

REASON FOR VOIDS:

INITIATOR ERROR

CHECK LOST/DAMAGED

UNCLAIMED PROPERTY

WARRANT TOTAL: **$756,023.53**

AGENDA ITEM NO. 5.

MARYSVILLE
WASHINGTON
EST. 1891

Agenda Bill

CITY COUNCIL AGENDA ITEM REPORT

DATE: May 27, 2025

SUBMITTED BY: Kari Chennault, Engineering

ITEM TYPE: Agreement

AGENDA SECTION: **New Business**

SUBJECT: Subaward Between the Tulalip Tribes of Washington and the City of Marysville to Implement Portions of the Tulalip Fish Passage Collaborative I Project. *Resubmittal of Subaward with all referenced exhibits.

SUGGESTED ACTION: Recommended Motion: I move to authorize the Mayor to sign and execute the Subaward with the Tulalip Tribes of Washington.

SUMMARY: This Subaward was approved by Marysville Council Members on May 12, 2025, but lacked the referenced exhibits that are now provided. This Subaward is between the Tulalip Tribes of Washington and the City of Marysville to implement portions of the Tulalip Fish Passage Collaborative I Project. The Tribe will provide the city with a subaward amount of $1,400,000 to design the replacement of two culverts on Middle Fork Quilceda Creek, a tributary to Quilceda Creek, with bridge structures or similar, restoring access to miles of upstream intact spawning and riparian habitat. The two culvert locations are at 51st Avenue NE and 132nd Street NE.

ATTACHMENTS:
Final Subaward with Exhibit A, B, C.pdf

SUBAWARD BETWEEN THE TULALIP TRIBES OF WASHINGTON AND THE CITY OF MARYSVILLE TO IMPLEMENT PORTIONS OF THE TULALIP FISH PASSAGE COLLABORATIVE I PROJECT

This Subaward Agreement Between the Tulalip Tribes of Washington and The City of Marysville to Implement Portions of the Tulalip Fish Passage Collaborative I Project (this “Agreement”), is made and by and between the Tulalip Tribes of Washington, a federally-recognized Indian Tribe (“Tulalip”) and the City of Marysville (“Subrecipient”). Tulalip and Subrecipient may herein be referred to individually as Party or, collectively, the Parties.

The Tulalip Tribes was awarded grant funds from the U.S. Department of Commerce National Oceanic and Atmospheric Administration (NOAA) Restoring Fish Passage through Barrier Removal Notice of Funding Opportunity under the Infrastructure Investment and Jobs Act (IIJA) under Federal Award ID Number NA23NMF4630025 (the “Prime Award”) to implement the Snohomish Cooperative Salmon Barrier Removal Project.

The goal of the Prime Award is to achieve measurable and lasting benefits to native migratory or sea-run (Migratory) fish populations through fish passage barrier removal.

The Prime Award identifies the City of Marysville as a subrecipient to implement fish passage projects on West Fork Quilceda Creek.

<table>
<tr><td>Prime Recipient:
The Tulalip Tribes of Washington (Tulalip)</td><td colspan="4">Subrecipient:

EIN: 91-6001459</td></tr>
<tr><td>Tulalip primary point of contact:
Brett Shattuck</td><td colspan="4">City primary point of contact:
Kari Chennault</td></tr>
<tr><td>Prime Awards Project Title

Tulalip Fish Passage Collaborative I</td><td>FAIN:

NA24NMFX463C0038-T1-01.</td><td>Awarding Agency:
NOAA</td><td colspan="2">Award Date:

09/01/2024</td></tr>
<tr><td rowspan="2">Subaward Period of Performance:

Start: 09/01/2024
End: 8/31/2028</td><td colspan="2" rowspan="2">Subaward Amount Funded:

$1,400,000</td><td colspan="2">Is this Award R&D?</td></tr>
<tr><td>YES
☐</td><td>NO
☒</td></tr>
</table>

The Tulalip Tribes of Washington (“Tulalip”), a federally recognized Indian tribe located at 6406 Marine Drive, Tulalip WA 98271, hereby awards a subaward, as described above, to the undersigned Subaward Recipient, the City of Marysville (“Subrecipient”), [501 Delta Avenue, Marysville, WA 98270]. In consideration of the foregoing and the terms and conditions contained in this Agreement, Tulalip and Subrecipient hereby agree as follows:

The total project cost for this Agreement shall not exceed $1,400,000 without prior written authorization from Tulalip.

1. The statement of work ("Statement of Work") and budget ("Budget") for this Agreement are hereby incorporated as Exhibit A. This Agreement is subject to the terms and conditions of the prime federal grants awarded to Tulalip ("Prime Award"), which are hereby incorporated as Exhibit B. *Relevant guidelines, templates and documents to the Agreement are organized in Appendices A-L, hereby incorporated as Exhibit C.*
2. Total amount of NOAA Funds Awarded and Obligated to Tulalip per FAIN number is as follows:

   Table 1.

FAIN:	**Amount Awarded to Tulalip**	**Passed Through Amount to Subrecipient by Tulalip**	**Prime Awards Indirect Cost Rate**
NA24NMFX463C0038-T1-01.	$20,958,778	$1,400,000	21.49

3. Tulalip awarding official for this Agreement is: Veronica Iukes, Interim Grants & Self-Governance Department Manager, 360-716-4385 or viukes@tulaliptribes-nsn.gov.
4. Tulalip Program Manager for this for this Agreement is: Natasha Coumou Restoration Ecologist, 360-716-4635 or ncoumou@tulaliptribes-nsn.gov. All work under this Agreement shall be at the direction of the Tulalip Program Manager.
5. Subrecipient shall adhere to all applicable local, state, tribal, and federal laws and requirements, including but not limited to, the following:
   a. Title VI of the Civil Rights Act and other federal statutes and regulations prohibiting discrimination in Federal financial assistance programs, as applicable;
   b. Reporting requirements as described in 2 C.F.R. Sec. 200.328-.330, and 2 CFR Part 170; Department of Commerce Financial Assistance Standard Terms and Conditions Sec. A.01, C.03, and G.05. or successor sections; and Bureau-Specific NOAA Administrative Standard Award Conditions; including producing a comprehensive final report covering all activities during the award period is within 60 days after the end date of this Agreement;
   c. The Procurement Standards in 2 CFR Part 200 including those requiring competition are applied when the Subrecipient acquires goods and services from contractors (including consultants); and
   d. Records kept per this Agreement shall be made available for review by Tulalip Tribes and may be provided to federal auditors to verify compliance with applicable federal regulations. Examples of records may include:

i. Subrecipient's financial statements and reports related to this Agreement;
ii. Programmatic reports including information on environmental results; and
iii. Audit findings.

6. Invoicing and Payment. Subrecipient shall invoice Tulalip Tribes quarterly. Payment shall be made according to schedules set forth in Exhibit A, Scope of Work and Budget. Total compensation for this Agreement shall not exceed $1,400,000. Such payment will be considered full compensation for personnel, materials, supplies and equipment used to carry out work. All expenses submitted to Tulalip for reimbursement that exceed the maximum consideration under this Agreement will not be reimbursed. Every invoice shall contain a detailed accounting for services rendered and rates charged. Payments for properly submitted invoices shall be due to the Subrecipient within thirty (30) days of receipt.
7. Confidentiality. The Subrecipient agrees to maintain the confidentiality of any and all data information, records, forms and documents and/or any other proprietary or confidential information provided by Tulalip or acquired by the Subrecipient in the performance of work under this Agreement. The Subrecipient further agrees to promptly return to Tulalip any and all such data, information, records/forms/documents or other proprietary/confidential information that comes into the Subrecipient's possession by this Agreement upon written request by a duly authorized agent of Tulalip. The parties acknowledge that Subrecipient must comply with the Washington public records act, chapter 42.56 RCW. If Subrecipient receives a public records request for a record that may be considered confidential but which the Subrecipient believes is not exempt from disclosure, Subrecipient will promptly notify Tulalip in writing. If Tulalip does not obtain a court order enjoining disclosure in ten business days, Subrecipient may disclose the records.
8. Relationship of Parties. The relationship of the Parties under this Agreement is that of independent contractors and they are not agents, employees, partners, or joint ventures of one another. No Party has the authority to bind any other party in contract or to incur any debts or obligations on behalf of any other party, and no Party shall take any action that attempts or purports to bind any other party in contract or to incur any debts or obligations on behalf of any other Party, without the affected Party's prior written approval. Nothing in this Agreement shall be construed as creating an employer-employee relationship, as a guarantee of future employment or engagement or as a limitation upon Tulalip's discretion to terminate this Agreement at any time, with or without cause. The Subrecipient shall be responsible for all of applicable federal, state, tribal, and local taxes, withholding, social security, insurance and any other fees or other payments applicable and required to be paid to any government is to be paid by the Subrecipient as a result of payments received under this Agreement. Subrecipient agrees that all payments received by Subrecipient are gross payments and further that in the event that the Internal Revenue Service should formally determine that the Subrecipient is an employee subject to withholding and social security contributions, the Subrecipient is responsible for all taxes and social security payments and any other required fees as stated above.

9. Product/Service. The Subrecipient agrees it has no expressed or implied authority to obligate Tulalip for any product or service, except as authorized in writing by a duly authorize agent of Tribes.

10. Work Product. The work product and all documents produced under this Agreement shall be furnished by the Subrecipient to Tulalip, and upon completion of the Scope of Work, shall become the property of Tulalip, except that the Subrecipient may retain one copy of the work product and documents for its records. Subrecipient will be responsible for the accuracy of the work performed under this Agreement, the work product, and all documents produced under this Agreement, even though the foregoing have been accepted by Tulalip.

    In the event that the Subrecipient defaults on this Agreement or in the event that this Agreement is terminated prior to the completion of the work to be performed or the time for completion, all work product and all documents and other materials produced under this Agreement, along with a summary of work as of the date of default or termination, shall become the property of Tulalip. The summary of services provided shall be prepared at no additional cost to Tulalip. Upon request, the Subrecipient shall tender the work product, all documents, and the summary to Tulalip within five (5) business days. Tender of said work product shall be a prerequisite to final payment under this Agreement.

    Subrecipient will not be held liable for reuse of work product or documents produced under this Agreement or modification of the work product or documents for any purpose other than those identified in this Agreement without the written authorization of Tulalip.

11. Training Materials. Tulalip may use training materials provided by the Subrecipient as long as credit is given to the Subrecipient.

12. Termination. This Agreement may be terminated on ten days written notice by either Party. The termination provisions of Tulalip Government Employee Handbook do not apply to the Subrecipient. Upon termination, the Subrecipient shall be entitled to receive payment for all work completed prior to the date of termination, upon proper invoicing and authorization by the Tulalip Program Manager identified herein.

13. Tulalip Drug and Alcohol Policy. The Subrecipient shall abide by the Tulalip Tribes Drug and Alcohol policy. This requirement does not alter the termination provisions in Section 12.

14. Anti-Terrorist Compliance. Subrecipient hereby certifies that all funds, including sub-awards by it to lower-tier subrecipients, shall be used in compliance with all applicable United States anti-terrorist financing and asset control laws, regulations, rules, and executive orders.

15. Applicable Laws and Professional Standards. Subrecipient certifies that Subrecipient and those persons participating in the conduct of the Statement of Work under this Agreement shall conform to and obey all applicable laws, ordinances, rules, regulations, requirements, and orders of all municipal, country, state, tribal, or federal authorities or agencies and all professional standards applicable to the conduct of work performed under this Agreement.

16. Legal Compliance. The Parties intend for this Agreement to comply with all applicable laws, regulations, and requirements. The Parties further agree that this Agreement shall be applied and interpreted in a manner consistent with full compliance with all such laws, regulations, and requirements. If at any time either Party has reasonable grounds to believe that this Agreement, or the work performed thereunder, may not conform to the then-current requirements or interpretations relevant to such matters, both Parties agree that they will promptly negotiate in good faith for the purposes of bringing this Agreement into full compliance with such then-current requirements and interpretations.

17. Records. Subrecipient shall maintain acceptable financial management systems during this Agreement which shall include:

    a. Accurate, current, and complete disclosure of the financial activity of this Agreement;

    b. Records that identify the source and application of funds paid by Tulalip;

    c. Effective control over and accountability for all funds, property, and other assets;

    d. Comparison of actual outlays with budgeted amounts;

    e. Consistency with the applicable federal administrative requirements and cost principles, if applicable; and

    f. Accounting records supported by source documentation.

    Subrecipient agrees that Tulalip shall, until the expiration of three (3) years after final payment under this Agreement, have access to and the right to examine all aspects of the Statement of Work undertaken under this Agreement, and all books, records, and documents of any kind pertaining to the Agreement, including any directly pertinent records involving transactions related to this Agreement for the purpose of making audits, examinations, excerpts and transcriptions, if applicable. It is understood that, unless agreed to in writing by Subrecipient, such examination shall be made during Subrecipient's regularly established business hours. Records related to any audit initiated prior the expiration of the three-year period shall be retained until the audit findings involving such records have been resolved.

18. Indemnity. The Subrecipient agrees to indemnify, defend and hold Tulalip and its successors, officer, directors, agents and employees harmless from any and all actions, causes of actions, claims, demands, costs, liabilities, expenses and damages (including attorneys' fees) arising out of or in connection with any breach of this Agreement by the Subrecipient or any work provided by them.

19. Insurance. The Subrecipient shall maintain the following levels of insurance during the term of this Agreement. Tulalip shall be named as an additional insured on the Commercial General Liability and automobile Liability insurance policies.

    a. Worker's Compensation (and employer's Liability Insurance) – as required by applicable state statute.

    b. Commercial general Liability - $1,000,000 per occurrence of bodily injury, including death and property damage, and $2,000,000 in the aggregate.

c. Automobile Liability – minimum of $1,000,000 combined single limit for bodily injury and property damage.

d. Professional Liability (E&O) - $1,000,000 each claim and in the aggregate.

20. Governing Law; Dispute Resolution; Venue.

a. Governing Law. This Agreement shall be governed in all respects, including validity, construction, interpretation and effect, by the laws of the Tulalip Tribes, and federal law, as applicable, without giving effect to its principles or rules of conflict of laws to the extent such principles or rules would require or permit the application of the laws of another jurisdiction.

b. Dispute Resolution. Any dispute in relation to the interpretation of this Agreement shall be resolved by arbitration. Either Party may initiate arbitration by providing written notice of intent to arbitrate to the other Party, together with a statement of the matter in controversy. If the Parties are unable to agree upon a single arbitrator within thirty (30) days of such notice of intent, a mediator shall be selected and appointed by Judicial Arbitration and Mediation Services (JAMS). Once appointed, the mediator shall determine the specified controversy. The JAMS arbitration rules shall govern the arbitration. An award or decision rendered by the mediator appointed under this Agreement shall be final and binding on all Parties to the proceeding, and judgment upon any award or decision rendered by the arbitrators may be entered in any court having jurisdiction.

c. Venue. Any arbitration shall take place in Snohomish County, WA unless otherwise agreed in writing by the Parties.

21. Termination.

Either Party may terminate this Agreement upon thirty (30) days' prior written notice to the other Party. If this Agreement is so terminated, the Parties shall be liable only for performance rendered or costs incurred in accordance with the terms of this Agreement prior to the effective date of termination.

a. Non-Allocation of Funds. Tulalip's ability to make payments is contingent on availability of funding. In the event funding from state, federal or other sources is withdrawn, reduced, or limited in any way after the effective date and prior to the completion or expiration date of this Agreement, Tulalip, at its sole discretion, may elect to terminate the Agreement, in whole or part, or renegotiate the Agreement, subject to new funding limitations or conditions. Tulalip may also elect to suspend performance of the Agreement until Tulalip determines the funding insufficiency is resolved. Tulalip may exercise any of these options with no notification or restrictions, although Tulalip will make a reasonable attempt to provide notice. In the event of termination or suspension, Tulalip will reimburse eligible costs incurred by the Subrecipient through the effective date of termination or suspension. Reimbursed costs must be agreed to by Tulalip and the Subrecipient. In no event shall Tulalip's reimbursement exceed Tulalip's total responsibility under the Agreement and any amendments. If payments have been discontinued by Tulalip due to unavailable funds, the Subrecipient shall not be obligated to repay monies which had been paid to the Subrecipient prior to such termination.

b. If for any cause either Party does not fulfill in a timely and proper manner its obligations under this Agreement, or if either Party violates any of these terms and conditions, the aggrieved Party shall give the other Party written notice of such failure or violation. The responsible Party will be given the opportunity to correct the violation or failure within fifteen (15) working days. If failure or violation is not corrected, this Agreement may be terminated immediately by written notice of the aggrieved Party to the other.

22. Assignability. This Agreement may not be assigned by either Party without the prior written approval of non-assigning Party.
23. Limitation on Liability. Subrecipient hereby acknowledges and agrees that it shall not be entitled to payment for services or otherwise, including damages, in excess of the fee amount specified in this Agreement.
24. Damages. Notwithstanding any other provision of this Agreement, neither Party shall be liable to the other for any indirect, consequential, special, exemplary, or punitive damages.
25. Entire Agreement. This Agreement supersedes all prior discussions, agreements and understanding between the Subrecipient and Tulalip regarding the subject matter hereof and constitutes the entire Agreement between the Parties. This Agreement may be amended, modified or supplemented only by a written instrument executed by the Parties.

TULALIP TRIBES OF WASHINGTON

____
Date:____________________
Teri Gobin, Chairwoman

CITY OF MARYSVILLE

____
Date:____________________
Jon Nehring, Mayor

EXHIBIT A STATEMENT OF WORK

This statement of work is intended to more specifically describe the Marysville Subaward for the Tribes' Grant. If there are any conflicts between this scope of work and the Tribes' Grant, the Tribes' Grant governs.

TASK 1 MIDDLE FORK QUILCEDA CREEK DESIGNS

The City of Marysville will design the replacement of two (2) culverts on Middle Fork Quilceda Creek, a tributary to Quilceda Creek, with bridge structures, restoring access to miles of upstream intact spawning and riparian habitat. The habitat above the project site is forested and agricultural, along with some residential areas. The downstream habitat is complex and consists of mature riparian forest vegetation as well as more residential; there are documented adult and juvenile salmon present that utilize the existing crossing. When constructed, this would restore access to 13 miles of upstream intact spawning and riparian habitat.

The existing downstream box culvert is undersized for the 25-foot wide channel, which creates a velocity and depth barrier for juvenile salmonids. The downstream culvert was inspected in 2017 and the presence of a bend was observed in the downstream end of the culvert. The existing upstream cylindrical culvert is undersized for the 14-foot wide channel, which creates a velocity and depth barrier for juvenile salmonids. Mapped and observed species at the project sites include coho, chum, steelhead, chinook, resident trout, and searun cutthroat trout. A preferred alternative to maintain access and restore fish passage will be determined upon a stream survey and consultation with a fish passage engineer. The removal of the barriers and installation of replacement structures will improve safety, maintain access, and increase resiliency. The City of Marysville has strongly invested in fish barrier replacements in this basin with a multimillion-dollar bridge just downstream of this proposed replacement.

TASK 1 – EXPECTED OUTCOMES

- Permit ready planning/design for 2 fish passage barrier construction projects.
- All required permit applications and cultural resources assessments completed and submitted.
- Final designs for 2 fish passage barrier construction projects and all required permits obtained.

Task 1 – Deliverables

SCD shall provide the following deliverables, consistent with the Tribes' Grant and the more specific requirements as described below, as applicable

- Semiannual project report that describes progress toward the outcomes above and billings.
- All deliverables outlined will be provided to Tulalip directly, except in cases specified in the table below where information will be provided directly to NOAA and a copy provided to Tulalip.

- A comprehensive final report covering all activities during the award period is required and must be received by the Tribes within 100 days after the end date of this award, but a final semi-annual report is not required.

NOAA Fish Passage Project Milestones and Deliverables Table

* Deliverable send directly to NOAA grant award manager with Tulalip copied in correspondence

Subtask	Action	Description	Target Date	Deliverable
1. Project Management	1.1	Semiannual Project Reporting	March 31st and October 1st for the duration of the subaward	Completed report template updated for each project as bundled (see appendix B)
	1.2	SF-425 Federal Financial Reports	March 31st and October 1st for the duration of the subaward	Completed report template updated for each project as bundled (see appendix B)
	1.3	Data management per Data Management Plan	Duration of the subaward	Track Data management per Data Management Plan (Appendix F)
	1.4	Staff time tracking including the number of staff time hours	Task: Duration of the subaward Deliverable: Final Report	Number of staff time hours in Final Report
	1.5	Changes to grant award scope of work	100 days prior to change	Written description of proposed changes as necessary
2. Designs and Permitting	2.1	Cultural Resources Review	Within Period of Performance	*Completed Section 106 Consultation
	2.1.1	Proposed Area of Potential Effect (APE) for	30 days prior to initiating cultural resources survey	*Proposed APE Map per NOAA Fisheries: Scope of Work for Cultural

		all proposed ground disturbing activities		Resources for each project as bundled
	2.1.2	Consultation Invitation; request for review of the APE	30 days prior to initiating cultural resources survey	*Completed APE Consultation Invitation Letter Template for each project as bundled
	2.1.3	Cultural Resources Survey for Section 106 review compliance	8-24 months prior to ground disturbing activities	*Section 106 Cultural Resources Report per NOAA Fisheries: Scope of Work for Cultural Resources for each project as bundled
	2.1.4	Tribal and Other Parties Section 106 Consultation Invitation and SHPO Concurrence Letter Templates	Following completion of Cultural Resources Survey (8-24 Months prior to ground disturbing activities)	*Completed Consultation Invitation and SHPO Concurrence Letter Templates for each project as bundled
	2.2	Permit Ready Preliminary Designs	2027 / 6-12 months prior to construction	Preliminary (30-60%) permit ready designs for each project as bundled per NOAA Fisheries WCR Anadromous Salmonid Design Manual and NOAA Fisheries Guidelines for Salmonid Stream Crossings in WA, OR and ID
	2.3	All required issued permits	Within Performance Period / must be prior to construction	*Issued permits for each project as bundled
	2.3.1	PROJECTS Biological Opinion Action	2027 and 6-12 months prior to construction	*Initiate with NOAA, and answers to NOAA

		Notification Form Project Design Criteria – General Construction Measures for ESA Coverage/ESA Consultation Initiation		questions required to fill out Action Notification Form for each project as bundled
	2.3.2	Joint Aquatic Resources Permit Application Form (JARPA) and/or all other required local, State and Federal permit applications	2027 and 6-12 months prior to construction	*Written confirmation of Submitted JARPA and/or all other required permit applications for each project as bundled
	2.4	Final Designs	2028 and Prior to construction	*Final designs for each project as bundled per NOAA Fisheries WCR Anadromous Salmonid Design Manual and NOAA Fisheries Guidelines for Salmonid Stream Crossings in WA, OR and ID

- All Cultural resources activities will follow NOAA Fisheries Cultural Resources SOP (Appendix G). Marysville must confirm with NOAA Grant manager about current Cultural Resources SOPs that may supersede the guidelines included before beginning cultural resources work.
- All designs must follow guidelines outlined in 1.3.1 of NOAA Fisheries WCR Anadromous Salmonid Design Manual (Appendix H) and NOAA Fisheries Guidelines for Salmonid Stream Crossings in WA, OR and ID (Appendix I)

BUDGET

The budget for work to be performed under the Agreement is $1,400,000. The Tribes shall have no obligation to pay any invoice from Marysville that would cause the total payments made to the Tribes by Marysville under this Agreement to exceed $1,400,000. Appendix C is an example of details required with each invoice submittal.

Contract Task and Dollar Summary

Task	Description	SCD Grant
1	Middle Fork Quilceda Creek Designs	$1,400,000
	Interlocal Agreement Grand Total	$1,400,000

Department of Commerce
National Oceanic and Atmospheric Administration (NOAA)
Fisheries Habitat Conservation Program Office (HCPO)

Notice of Award (NoA)
NA24NMFX463C0038-T1-01

RECIPIENT INFORMATION

1. Recipient Name
TULALIP TRIBES OF WASHINGTON
6406 MARINE DR
TULALIP, WA 98271

2. Congressional District of Recipient
02

3. Employer Identification Number (EIN)
91-0557816

4. UEI
ELUVLMGA6RD1

5. Recipient Point of Contact
Brett Shattuck
bshattuck@tulaliptribes-nsn.gov

6. Authorized Official
Iukes, Veronica
viukes@tulaliptribes-nsn.gov

FEDERAL AGENCY CONTACT INFORMATION

7. Grant Specialist
Elana Felberg
Elana.Felberg@noaa.gov

8. Program Officer
Melanie L. Gange
melanie.gange@noaa.gov

9. Grant Officer
Olga Dixon
olga.dixon@noaa.gov

FEDERAL AWARD INFORMATION

10. Award Number / FAIN
NA24NMFX463C0038-T1-01 / NA24NMFX463C0038 / Mod 0

11. Award Type
Cooperative Agreement

12. Period of Performance Start Date & End Date
09/01/2024 – 08/31/2028

13. Federal Share of Cost
$20,958,778

14. Recipient Share of Cost
$0

15. Total Federal and Recipient Cost
$20,958,778

16. Opportunity Number
NOAA-NMFS-HCPO-2023-2008056

17. Project Title
Tulalip Fish Passage Collaborative I

18. Assistance Listing Number and Name
11.463 Habitat Conservation

19. Award Action Type
New Competing

20. Multiyear Award?
No

21. R&D Award?
No

22. Construction Award?
No

23. Grants Officer – Signature and Date
Olga Dixon – 08/15/2024

NOTICE OF NOAA AWARD COVER LETTER

Congratulations, you are the recipient of NOAA award Number NA24NMFX463C0038-T1-01.

This Notice of Award (NoA) approved by the NOAA Grants Officer, constitutes the official grant award and the obligation of Federal funding. The NoA serves as the official legal document issued to notify the recipient and others that an award has been made. The NoA contains all terms and conditions of the grant award.

The complete NoA can be found and downloaded under eRA Commons using the following instructions: View Notice of Award | eRA

This NoA was sent to the specified email address entered in the NoA email field by the recipient organization when completing the electronic Research Administration (eRA) Commons registration process. The Signing Official (SO) can update this email address through the Institutional Profile section in eRA Commons. The NoA can also be viewed from the Status Information page in eRA Commons. By accepting the award, the recipient agrees to comply with the award provisions specified on the award document.

As the Signing Official (SO) you are authorized to legally bind the institution in grant-administration matters. In providing your signature approval on the grant application submission you are responsible for monitoring grant related activities and authorizing expenditures under this award.

Additional Information about your award is shown below:

- Assistance Listing Number: 11.463
- Project Period: 09/01/2024 – 08/31/2028
- Program Office: Fisheries Habitat Conservation Program Office (HCPO)
- Program Officer: Melanie L. Gange
- Program Officer Phone:
- Program Officer Email: melanie.gange@noaa.gov
- Total Federal Funding: $20,958,778
- Total Non-Federal Funding: $0
- Organization Name: THE TULALIP TRIBES OF WASHINGTON
- Project Title: Tulalip Fish Passage Collaborative I
- Name of Principal Director/Project Investigator (PI/PD) as identified in the negotiated application:
    - Brett Shattuck

This email was sent from a source that is not monitored for responses. If you need assistance, contact your Program/Project Officer (for programmatic issues) or the eRA Help Desk (for technical issues).

SECTION I – BUDGET INFORMATION

Approved Budget

	Year 1 Federal	Year 2 Federal	Year 3 Federal	Year 4 Federal	Year 5 Federal	Total
Personnel(non-research)	$444,864	$0	$0	$0	$0	$444,864
Fringe Benefits	$133,464	$0	$0	$0	$0	$133,464
Travel	$8,787	$0	$0	$0	$0	$8,787
Supplies	$35,000	$0	$0	$0	$0	$35,000
Contractual	$3,107,416	$0	$0	$0	$0	$3,107,416
Other	$17,095,554	$0	$0	$0	$0	$17,095,554
Total Direct Charges	$20,825,085	$0	$0	$0	$0	$20,825,085
Indirect Charges	$133,693	$0	$0	$0	$0	$133,693
Federal	$20,958,778	$0	$0	$0	$0	$20,958,778
Non-Federal	$0	$0	$0	$0	$0	$0

Authorized

	Cumulative
Federal	$20,958,778
Non-Federal	$0
Total	$20,958,778

Authorized Funding Codes

					Cumulative
140X8LHCZ1	22P00	143013000000000000	41000100	IIJA Fish Passage	$11,738,608
140W8LHTZ1	22P00	143013000000000000	41000100	IIJA Fish Passage	$9,220,170
				Total	$20,958,778

SECTION II – NOAA STANDARD TERMS AND CONDITIONS

- 2 CFR PART 200, UNIFORM ADMINISTRATIVE REQUIREMENTS, COST PRINCIPLES, AND AUDIT REQUIREMENTS, AS ADOPTED PURSUANT TO 2 CFR § 1327.101
  https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200?toc=1

- DEPARTMENT OF COMMERCE FINANCIAL ASSISTANCE STANDARD TERMS AND CONDITIONS
  https://www.commerce.gov/oam/policy/financial-assistance-policy
  The Department of Commerce Financial Assistance Standard Terms and Conditions (ST&C) issued November 12, 2020, are incorporated by reference into this award.
- Bureau Financial Assistance Standard Terms and Conditions
  Administrative Standard Award Conditions for National Oceanic and Atmospheric Administration (NOAA) Financial Assistance Awards U.S. Department of Commerce

- Department of Commerce Pre-Award Notification Requirements for Grants and Cooperative Agreements (REF: 79FR 78390)
  https://www.govinfo.gov/content/pkg/FR-2014-12-30/pdf/2014-30297.pdf

SECTION III – SPECIFIC AWARD CONDITIONS

SPECIAL TERMS

New Award

This competitive award, number NA24NMFX463C0038, to THE TULALIP TRIBES OF WASHINGTON supports the work described in the Recipient's proposals entitled *Tulalip Fish Passage Collaborative I,* dated 10/13/2023, and *Tulalip Fish Passage Collaborative II,* dated 11/8/23, as revised on 6/10/2024, 6/13/2024 and 8/06/2024, which are incorporated into the award by reference. This award is made under the following statutory authorities: the Fish and Wildlife Coordination Act 16 U.S.C. 661, as amended by the Reorganization Plan No. 4 of 1970; Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, 16 U.S.C. 1891a; the Endangered Species Act, 16 U.S.C. 1535; the America COMPETES Act, as amended, 33 U.S.C. 893a. This award is also authorized under the Bipartisan Infrastructure Law (Public Law 117-58) and the Inflation Reduction Act (Public Law 117-169). Where the terms of the award and proposal differ, the terms of the award shall prevail.

The terms in Section II of the Notice of Award applicable to this award are the version in effect at the time of award, unless the award is amended. Historical versions of 2 CFR 200 are available by clicking links at the top of the eCFR weblink in the Notice of Award.

Required Use of American Iron, Steel, Manufactured Products, and Construction Materials

Buy America Preference. Recipients of an award of Federal financial assistance from the Department of Commerce (Department) for a program for infrastructure are hereby notified that none of the funds provided under this award may be used for an infrastructure project unless:

1. all iron and steel used in the project are produced in the United States – this means all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States;

2. all manufactured products used in the project are produced in the United States – this means the manufactured product was manufactured in the United States; and the cost of the components of the manufactured product that are mined, produced, or manufactured in the United States is greater than 55 percent of the total cost of all components of the manufactured product, unless another standard that meets or exceeds this standard has been established under applicable law or regulation for determining the minimum amount of domestic content of the manufactured product; and

3. all construction materials are manufactured in the United States – this means that all manufacturing processes for the construction material occurred in the United States. The construction materials standards are listed below.

Incorporation into an infrastructure project. The Buy America Preference only applies to articles, materials, and supplies that are consumed in, incorporated into, or affixed to an infrastructure project. As such, it does not apply to tools, equipment, and supplies, such as temporary scaffolding, brought to the construction site and removed at or before the completion of the infrastructure project. Nor does a Buy America Preference apply to equipment and furnishings, such as movable chairs, desks, and portable computer equipment, that are used at or within the finished infrastructure project but are not an integral part of the structure or permanently affixed to the infrastructure project.

Categorization of articles, materials, and supplies. An article, material, or supply should only be classified into one of the following categories: (i) Iron or steel products; (ii) Manufactured products; (iii) Construction materials; or (iv) Section 70917(c) materials. An article, material, or supply should not be considered to fall into multiple categories. In some cases, an article, material, or supply may not fall under any of the categories listed in this paragraph. The classification of an article, material, or supply as falling into one of the categories listed in this paragraph must be made based on its status at the time it is brought to the work site for incorporation into an infrastructure project. In general, the work site is the location of the infrastructure project at which the iron, steel, manufactured products, and construction materials will be incorporated.

Application of the Buy America Preference by category. An article, material, or supply incorporated into an infrastructure project must meet the Buy America Preference for only the single category in which it is classified.

Determining the cost of components for manufactured products. In determining whether the cost of components for manufactured products is greater than 55 percent of the total cost of all components, use the following instructions:

a. For components purchased by the manufacturer, the acquisition cost, including transportation costs to the place of incorporation into the manufactured product (whether or not such costs are paid to a domestic firm), and any applicable duty (whether or not a duty-free entry certificate is issued); or

b. For components manufactured by the manufacturer, all costs associated with the manufacture of the component, including transportation costs as described in paragraph (a), plus allocable overhead costs, but excluding profit. Cost of components does not include any costs associated with the manufacture of the manufactured product.

Construction material standards. The Buy America Preference applies to the following construction materials incorporated into infrastructure projects. Each construction material is followed by a standard for the material to be considered "produced in the United States." Except as specifically provided, only a single standard should be applied to a single construction material.

1. Non-ferrous metals. All manufacturing processes, from initial smelting or melting through final shaping, coating, and assembly, occurred in the United States.

2. Plastic and polymer-based products. All manufacturing processes, from initial combination of constituent plastic or polymer-based inputs, or, where applicable, constituent composite materials, until the item is in its final form, occurred in the United States.

3. Glass. All manufacturing processes, from initial batching and melting of raw materials through annealing, cooling, and cutting, occurred in the United States.

4. Fiber optic cable (including drop cable). All manufacturing processes, from the initial ribboning (if applicable), through buffering, fiber stranding and jacketing, occurred in the United States. All manufacturing processes also include the standards for glass and optical fiber, but not for non-ferrous metals, plastic and polymer-based products, or any others.

5. Optical fiber. All manufacturing processes, from the initial preform fabrication stage through the completion of the draw, occurred in the United States.

6. Lumber. All manufacturing processes, from initial debarking through treatment and planing, occurred in the United States.

7. Drywall. All manufacturing processes, from initial blending of mined or synthetic gypsum plaster and additives through cutting and drying of sandwiched panels, occurred in the United States.

8. Engineered wood. All manufacturing processes from the initial combination of constituent materials until the wood product is in its final form, occurred in the United States.

Waivers

When necessary, recipients may apply for, and the Department may grant, a waiver from these requirements.

To help federal agencies and recipients meet BABA requirements, the U.S. Department of Commerce, National Institute for Standards and Technology (NIST), Hollings Manufacturing Extension Partnership (MEP) National Network™ provides a service to connect stakeholders, including recipients, to U.S. manufacturers that have relevant production capabilities and capacities to help fulfill current market and supply chain needs. Recipients considering a BABA nonavailability waiver are strongly encouraged to contact the NIST/MEP for assistance with supplier scouting services prior to seeking a BABA nonavailability waiver. Further information on the NIST/MEP supplier scouting services is available at: https://nist.gov/mep/supply-chain/supplier-scouting.

When the Department has made a determination that one of the following exceptions applies, the awarding official may waive the application of the Buy America Preference in any case in which the Department determines that:

applying the Buy America Preference would be inconsistent with the public interest (public interest waiver);

the types of iron, steel, manufactured products, or construction materials are not produced in the United States in sufficient and reasonably available quantities or of a satisfactory quality (nonavailability waiver); or

the inclusion of iron, steel, manufactured products, or construction materials produced in the United States will increase the cost of the overall project by more than 25 percent (unreasonable cost waiver).

A request to waive the application of the Buy America Preference must be in writing. The Department will provide instructions on the format, contents, and supporting materials required for any waiver request. Waiver requests are subject to public comment periods of no less than 15 days and must be reviewed by the Made in America Office.

There may be instances where an award qualifies, in whole or in part, for an existing waiver described on the Department's Build America, Buy America website found at https://www.commerce.gov/oam/build-america-buy-america.

Definitions

"Buy America Preference" means the "domestic content procurement preference" set forth in section 70914 of the Build America, Buy America Act, which requires the head of each Federal agency to ensure that none of the funds made available for a Federal award for an infrastructure project may be obligated unless all of the iron, steel, manufactured products, and construction materials incorporated into the project are produced in the United States.

"Construction materials" means articles, materials, or supplies that consist of only one of the items listed in paragraph (1) of this definition, except as provided in paragraph (2) of this definition. To the extent one of the items listed in paragraph (1) contains as inputs other items listed in paragraph (1), it is nonetheless a construction material.

1. The listed items are:

i. Non-ferrous metals;

ii. Plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables);

iii. Glass (including optic glass);

iv. Fiber optic cable (including drop cable);

v. Optical fiber;

vi. Lumber;

vii. Engineered wood; and

vii. Drywall.

2. Minor additions of articles, materials, supplies, or binding agents to a construction material do not change the categorization of the construction material.

“Infrastructure” means public infrastructure projects in the United States, which includes, at a minimum, the structures, facilities, and equipment for roads, highways, and bridges; public transportation; dams, ports, harbors, and other maritime facilities; intercity passenger and freight railroads; freight and intermodal facilities; airports; water systems, including drinking water and wastewater systems; electrical transmission facilities and systems; utilities; broadband infrastructure; and buildings and real property; and structures, facilities, and equipment that generate, transport, and distribute energy including electric vehicle (EV) charging.

“Infrastructure project” means any activity related to the construction, alteration, maintenance, or repair of infrastructure in the United States regardless of whether infrastructure is the primary purpose of the project. See also paragraphs (c) and (d) of 2 CFR 184.4.

“Iron or steel products” means articles, materials, or supplies that consist wholly or predominantly of iron or steel or a combination of both.

“Manufactured products” means:

1. Articles, materials, or supplies that have been:

i. Processed into a specific form and shape; or

ii. Combined with other articles, materials, or supplies to create a product with different properties than the individual articles, materials, or supplies.

2. If an item is classified as an iron or steel product, a construction material, or a Section 70917(c) material under 2 CFR 184.4(e) and the definitions set forth in 2 CFR 184.3, then it is not a manufactured product. However, an article, material, or supply classified as a manufactured product under 2 CFR 184.4(e) and paragraph (1) of this definition may include components that are construction materials, iron or steel products, or Section 70917(c) materials.

“Predominantly of iron or steel or a combination of both” means that the cost of the iron and steel content exceeds 50 percent of the total cost of all its components. The cost of iron and steel is the cost of the iron or steel mill products (such as bar, billet, slab, wire, plate, or sheet), castings, or forgings utilized in the manufacture of the product and a good faith estimate of the cost of iron or steel components.

“Section 70917(c) materials” means cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives. See Section 70917(c) of the Build America, Buy America Act.

IMPLEMENTATION OF DOMESTIC SOURCING REQUIREMENT

Prior to initiation of any construction that may arise in this award, the Recipient is required to inform the NOAA Grants Officer and the Federal Program Officer whether it is using iron, steel, manufactured products, or construction materials as described in the Specific Award Condition in this award on Required Use of American Iron, Steel, Manufactured Products, and Construction Materials. In addition, the Recipient is required to inform the NOAA Grants Officer and the Federal Program Officer whether those materials are produced or manufactured in the United States, or alternatively, it is requesting one or more waivers, as described in the award condition. The Recipient is required to coordinate with NOAA regarding its compliance with this Term.

Signs (BIL/IRA)

The Recipient is responsible for constructing, erecting, and maintaining in good condition throughout the construction period a sign(s) satisfactory to NOAA that identifies the project and indicates that the project is Federally funded by the Bi-Partisan Infrastructure Law, and/or the Inflation Reduction Act (IRA). NOAA may require that the recipient maintain a permanent plaque or sign at the project site with the same or similar information. The temporary and permanent proposed signage implementation plans must be submitted to and approved by NOAA prior to installation.

Tangible Property Reporting and Disposition (New / Supplemental)

Tangible personal property has been identified and budgeted in the grant application. The Recipient must report such property to NOAA. The SF-428, SF-428-B (final report), and as needed, the SF-428-S (inventory list) must be submitted no later than 120 days after the project end date. The SF-428-C (the disposition report) must be submitted when the property is no longer required for the purpose of the project, and in accordance with 200.311-314. These forms can be accessed at https://www.grants.gov/web/grants/forms/post-award-reporting-forms.html.

SPECIAL CONDITIONS

Cooperative Agreement / Substantial Involvement

This award is a cooperative agreement as described in 2 C.F.R. Sec. 200.1 Definitions, meaning that NOAA is substantially involved in the project. NOAA Fisheries participation will be crucial to ensuring the timely implementation of the most beneficial habitat restoration project. NOAA may participate in one or more of the following ways:

--collaboration on the scope of work through participation in meetings and review of documents;

--providing assistance with technical aspects of the habitat restoration project such as assistance with permitting or development of detailed work plans and monitoring plans;

--review and comment on design plans at the beginning of the award, at various stages throughout any portion of the design process that occurs during the award (e.g. conceptual, 30%, 60%, and 90% completion), and at the final completion stage;

--review of procurement materials to the extent authorized by 2 C.F.R. Sec. 200 Procurement Standards;

--tracking the progression of the restoration from planning through implementation and post-construction monitoring, with particular emphasis on tracking Recipient achievement of targets for major milestones and performance metrics and sharing results;

--other involvement consistent with Office of Management and Budget Guidance on Substantial Involvement. See 43 Federal Register 36860 (Aug. 18, 1978).

Pre-award Cost Approval

Per 2 CFR 200.308 (e)(1), NOAA authorizes award recipients to expend pre-award costs up to 90 days before the period of performance start date at the applicant s own risk without approval from NOAA and in accordance with the applicant s internal policies and procedures. Such costs are allowable only to the extent that they would have been allowable if incurred after the date of the federal award. This does not include direct proposal costs (as defined at 2 CFR 200.460). In no event will NOAA or the Department of Commerce be responsible for direct proposal preparation costs. Pre-award costs will be a portion of, not in addition to, the approved total budget of the award. Pre-award costs expended more than 90 days prior to the period of performance start date require approval from the Grants Officer. This does not change the period of performance start date.

Performance Progress Reports

Reporting requirements are described in 2 C.F.R. Sec. 200.328-.330, and 2 CFR Part 170; Department of Commerce Financial Assistance Standard Terms and Conditions Sec. A.01, C.03, and G.05. or successor sections; and Bureau-Specific NOAA Administrative Standard Award Conditions, with the following supplement.

Progress reports must be submitted using the NOAA Community-based Restoration Program's Performance Progress Report (PPR) reporting form approved by OMB under control number 0648-0718, or a successor form. The NOAA Federal Program Officer will provide this form to the Recipient. Interim semi-annual progress reports are due no later than 30 days after the semiannual reporting periods ending March 31 and September 30 for the entire duration of the award. These follow the same frequency and have the same due dates (April 30 and October 30, respectively) as the SF-425 Federal Financial Reports, which also must be submitted as a condition of this award.

A comprehensive final report covering all activities during the award period is required and must be received by the NOAA Program Officer within 120 days after the end date of this award, but a final semi-annual report is not required.

Compliance with Applicable Laws, Obtaining Permits, and Consultation Requirements

The Recipient is required to comply with national policy requirements consistent with 2 C.F.R. Sec. 200.300 and Department of Commerce Financial Assistance Standard Terms and Conditions, Section G., or any successor Section. The Recipient will ensure that implementation of the project will meet all Federal laws and regulations by obtaining all Federal, state, and local permits and consultations applicable to the project prior to expenditure of award funds for those activities requiring permits and consultations. This includes, but is not restricted to, consultations required under the Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat), National Historic Preservation Act, and Coastal Zone Management Act. The Recipient will be cognizant of all conditions and restrictions required by their permits and consultations, and will immediately halt activities and contact their NOAA Technical Monitor if events occur that threaten to violate the conditions or restrictions required by their permits and consultations.

Verification of Permits and Consultations

Verification of permits and regulatory compliance related to this project must be presented to the NOAA Technical Monitor prior to project implementation. The Recipient should provide a list of Federal, tribal, state, and local permits acquired for this project by email or letter to the NOAA Technical Monitor.

Project Files

The Recipient must maintain project files for all restoration activities taking place under this agreement consistent with 2 C.F.R. Sec. 200.334. These files must contain, at a minimum, project work plans and copies of all federal and state permits/consultations associated with project implementation.

Outreach and Communications

Department of Commerce Financial Assistance Standard Term and Condition G.05.k.3., or any successor term, is supplemented as follows consistent with NOAA s collaboration on this project. The Recipient will coordinate with NOAA on outreach plans, events, products, and media coverage associated with the project. Please coordinate with the Federal Program Officer listed under the Contact Information award condition. Grantees will provide copies of final outreach products, website mentions, press materials, photos, videos, etc. via the standard progress reports to NOAA, or when available throughout the award period. Grantees will provide NOAA with high-resolution before, during, and post-implementation photos of the project. Photos of the site prior to construction and during project implementation should be submitted with progress reports or as requested by NOAA.

Acknowledgement of Project Contributors

The Recipient must display, where appropriate and practical, publicly visible signs indicating that the project has received funding from the NOAA Restoration Center. These signs should also identify other contributing partners. These contributions should also be acknowledged in all communications with the media and the public and in all outreach related to the projects, consistent with Department of Commerce Financial Assistance Standard Term and Condition G.05.k.3., or any successor term.

Project Safety

The Recipient must have a written safety plan for management of the project, which should specifically address safety of project personnel, associates, visitors, and volunteers. The Recipient must conduct a safety briefing for volunteers immediately prior to their participation in hands-on restoration activities under this award.

In addition, for any Self-Contained Underwater Breathing Apparatus (SCUBA) diving activities in a project, it is the responsibility of the Recipient to ensure that SCUBA divers are certified to a level commensurate with the type and conditions of the diving activity being undertaken. Furthermore, it is the responsibility of the Recipient to ensure that any SCUBA diving activities under this award meet, at a minimum, all applicable Federal, State, and local laws and regulations pertaining to the type of SCUBA diving being undertaken.

Outstanding NEPA Documentation and Restricted Availability of Funds

By accepting this award, the Recipient agrees to assist and cooperate with NOAA Fisheries in the preparation of any outstanding National Environmental Policy Act (NEPA) compliance documentation. For purposes of NEPA compliance, Phase 1 of the project includes pre-restoration monitoring, planning, design and permitting including cultural resource surveys. Bid packages may be developed and contractors selected. The activities for which work can proceed (as described above) will have no significant individual or cumulative adverse effects on the environment. The Recipient will not expend any funds for project implementation which includes culvert removal and replacement with fish-passable culverts or bridges until impacts have been assessed, and NEPA compliance documentation has been completed by NOAA. At this time, $10,475,000 of the total award funds are available to the Recipient to complete Phase 1 tasks outlined above that have no adverse impacts on the environment.

Project Milestones

To ensure adequate and timely progress towards project completion, NOAA and the Recipient have cooperatively identified several milestones as outlined in the proposal narrative on pages 13-25 of the revised, combined project narrative. Project progress will be evaluated throughout the award with particular emphasis on meeting these milestones. NOAA reserves the right to pursue enforcement action for the award under 2 C.F.R. 200.339-.343 at any time throughout the award period should NOAA determine that a Recipient is not meeting project milestones as outlined in the application submitted to the NOAA Grants Management Division for funding.

Changes to Scope of Work

By accepting this award, the Recipient agrees to assist and cooperate with NOAA Fisheries in the preparation of any outstanding National Environmental Policy Act (NEPA) compliance documentation. Recipients who plan any changes to the activities described in the award documentation approved by NOAA should contact their Federal Program Officer at least 90 days in advance of any changes, so that NOAA can confirm that all environmental compliance review is complete, and all documentation is in place. Other requirements related to changes in the Scope of Work are contained in the NOAA Standard Terms and Conditions.

Monitoring

To evaluate project implementation quality and effectiveness, and learn from your restoration project(s), recipients will execute appropriate project monitoring with guidance from NOAA. As your project proceeds, NOAA's substantial involvement will include further coordination to execute implementation and basic effectiveness monitoring, and potentially more detailed effectiveness monitoring, if applicable. The grantee will collaborate with NOAA to identify monitoring elements such as parameters, methods, sampling duration and frequency, and post implementation targets. NOAA s involvement will also include ongoing coordination on data management, analyses, and dissemination of results (see Administrative Standard Award Conditions for NOAA). The grantee will develop a data /information sharing plan, and submit appropriate monitoring information with progress reports, as well as at other appropriate times. Templates for the data/information sharing plan and other monitoring related guidance are provided at https://www.fisheries. noaa.gov/national/habitat-conservation/monitoring-and-evaluationrestoration-projects.

Outstanding Project Documentation and Restricted Availability of Funds

By accepting this award, the Recipient agrees to work with NOAA Fisheries staff to finalize design plans before spending funds on construction. The Recipient will not expend any funds for construction until NOAA staff have completed reviewing design plans and confirmed that they will lead to the appropriate conditions for passage of target fish species.

Contracts/Subaward Budget Undefined at Time of Award

This Project includes funding for contracts/subawards where contractors/subawardees either have not been identified at the time of the award, or have been identified at the time of the award, but do not have sufficient budget information. Per 2 CFR 200.308, recipients must request pre-approvals from the awarding Federal agency for subawarding, transferring or contracting out of any work under a Federal award, with the exception of the acquisition of supplies, material, equipment, or general support services. Please follow the procedures described below for each contract and note all subawards require pre-approval regardless of funding amount. Threshold amounts for contracts are determined for the life of the prime award (if multiple agreements are issued to the same contractor, threshold will be calculated based on their cumulative value). Recipients must retain complete procurement records which demonstrate that the procedures described below were followed.

Contracts under micro-purchase threshold: See 2 CFR 200.320(a)(1) for the definition of micro-purchase. Micro-purchases may be awarded without soliciting competitive price or rate quotations if the Recipient considers the price to be reasonable based on research, experience, purchase history or other information and documents it and files accordingly.

Contracts under small purchase threshold: See 2 CFR 200.320(a)(2) for the definition of small purchase and simplified acquisition threshold. For small purchase contracts, price or rate quotations must be obtained from an adequate number of qualified sources as determined appropriate by the Recipient. NOAA will not require prior approvals for contracts under $250,000 (unless a lower amount is used by the grantee as per 2 CFR 200.320(a)(2)(ii)) However, please be aware of financial assistance requirements for these contracts and keep your records, including a minimum of three price or rate quotations, for audits or the agency desk reviews/site visits.

Contracts over the simplified acquisition threshold ($250,000, unless a lower amount is used by the grantee as per 2 CFR 200.320(a)(2)(ii)) and all subawards: When contractors have been selected, the recipient is required to submit a Request in eRA Commons to obtain approval to Subaward, transfer or contract out work under the award and provide the following documentation for each contract/subaward: method of selection (competitive or noncompetitive); scope of work and budget (cost or price information, as applicable) for each contract/subaward award; and/or a justification if the subcontract/subaward was chosen noncompetitively.

Contact Information

Contact information for NOAA and the Recipient is maintained in eRA Commons. In addition: The Federal Program Officer for this award is: Melanie Gange; 301-427-8664; melanie.gange@noaa.gov. The Technical Monitor for this award is: Garrett Engelke; 206-526-6029; garret.engelke@noaa.gov.

DEPARTMENT OF COMMERCE

Public Interest Waiver for Financial Assistance Agreements to Indian Tribes

ACTION: Notice of Final Waiver

1. Summary
Agency: Department of Commerce.

Waiver: The Department of Commerce (DOC) is waiving the requirements of section 70914 of the Build America, Buy America Act (BABA) included in the Infrastructure Investment and Jobs Act (IIJA) (Pub. L. No. 117-58) (Buy America preference) for Federal financial assistance agreements in accordance with 2 CFR part 200 awarded to Federally recognized Indian Tribes, including their governmental arms and instrumentalities, or Tribal organizations because DOC has determine that applying the requirements of BABA to such agreements would be inconsistent with the public interest. This waiver is critical in keeping with the Federal Government's commitment to consult with Tribes and build Tribal capacity as established through Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments,* before applying Buy America preference to programs that affect tribal communities.

This waiver permits the use of non-domestic iron, steel, manufactured products, and construction materials in such projects that may otherwise be prohibited under section 70914(a) of BABA for DOC Federal financial assistance agreements in which the recipient or subrecipient is a Federally recognized Indian Tribe, including their governmental arms and instrumentalities, or Tribal organizations. The waiver applies to expenditures by Tribal awardees under any DOC financial assistance agreement incurred on or after the effective date of this waiver until September 30, 2024. However, this waiver does not apply to awards made under the DOC's National Telecommunications and Information Administration's (NTIA) Broadband Equity, Access, and Deployment (BEAD) Program or Tribal Broadband Connectivity Program (TBCP). A TBCP Waiver already separately applies to awards made under TBCP funding via the June 3, 2021, TBCP Notice of Funding Opportunity (NOFO). The BABA requirements that apply to BEAD awards, or to TBCP awards made under the July 27, 2023, NOFO, are included in the relevant NOFO for each program, and any specific waiver issued for each program.

2. Background
The Buy America preference set forth in section 70914 of BABA requires all iron, steel, manufactured products, and construction materials used for infrastructure projects under Federal financial assistance awards be produced in the United States.

Under section 70914(b), and in accordance with the Office of Management and Budget's (OMB) October 25, 2023 memorandum on the subject, *Implementation Guidance on Application of Buy America Preference in Federal Financial Assistance Programs for Infrastructure* (M-24-02), Federal agencies may waive the application of the Buy America preference, in any case in which it finds that: applying the domestic content procurement preference would be inconsistent with the public interest; types of iron, steel, manufactured products, or construction materials are not produced in the United States in sufficient and reasonably available quantities or of a satisfactory quality; or the inclusion of iron, steel, manufactured products, or construction materials produced in the United States will increase the cost of the overall project by more than 25 percent. All waivers must have a written explanation for the proposed determination; provide a period of not less than 15 calendar days for public comment on the proposed waiver; and require submission of the proposed waiver to OMB's Made in America Office (MIAO) for review to determine if the waiver is consistent with policy.

OMB's M-24-02 provides guidance to agencies to consult with Tribal Nations before applying a Buy America preference to a covered program that will affect Tribal communities. Since the enactment of BABA, DOC has conducted initial tribal consultations, and it participated in a Tribal consultation hosted by the White House Council on Native American Affairs (WHCNAA). [1]

The comments received from the Tribal leaders in response to these consultations expressed concerns related to implementation and potential project delays. Tribal leaders also expressed a desire to work with DOC to ensure that their projects are achieved in a sustainable manner and Federal trust and treaty responsibilities are fulfilled. Participating Tribal leaders broadly requested that Federal agencies provide for maximum flexibility in allowing waivers of Tribal participation in covered Federal programs. Based on the feedback received, it was determined that a waiver for Tribes is in the public interest to allow ample opportunity for ongoing consultations while also building the capacity of Tribes to work towards eliminating the need for a waiver. In this way, the waiver will serve as a tool to promote investment in our domestic manufacturing base while also promoting the well-being, equity, and justice for Tribes.

3. Waiver Justification

With the enactment of BABA, Federal financial assistance agreements with Tribes must now comply with the Buy America preference requirements. On January 26, 2021, the Biden administration released a "Memorandum on Tribal Consultation and Strengthening Nation-to-Nation Relationships" affirming the Administration's commitment to Executive Order (E.O.) 13175. Section 6 of E.O. 13175 requires each Federal agency to consider any application for a waiver by a Tribe with a "general view toward increasing opportunities for utilizing flexible approaches at the Indian tribal level" as "consistent with applicable Federal policy objectives" and "otherwise appropriate." Underpinning this provision is the Federal trust responsibility, a fiduciary obligation to provide for flexibility, as appropriate, to support program access, to recognize Tribes as sovereign entities, and to facilitate Tribal economic development interests.

Based on feedback provided from Tribes during initial consultations, DOC proposes that a waiver is critical to allow DOC to conduct consultations while also building the capacity of Tribes through technical assistance to work towards eliminating the need for a waiver. This waiver would allow for a more gradual modification of processes internally as additional funding

[1] On September 21, 2022, nine Federal agencies, including the U.S. Department of Commerce, participated in a consultation hosted by the White House Council on Native American Affairs. Based on the consultations held, Tribes were requested to provide written comments and feedback by October 20, 2022, for Federal agency consideration. The resulting comments were received by the White House Council and distributed to agencies on October 25, 2022.

is provided and allows time for Tribal businesses and partners to build capacity and resources to source domestic materials. A waiver will help to keep these projects moving forward during the transition toward compliance.

To further support the administration's priorities to steward investments to build a better America and promote domestic manufacturing and jobs, DOC also recognizes the public interest in job creation, domestic supply chain resilience and the national and economic security interests inherent in robust manufacturing of key products and materials needed to build our infrastructure and clean energy future. If DOC determines a waiver is appropriate, during the period the waiver is in place, DOC will aim to collect information from projects covered by this waiver to help evaluate the domestic market availability of commonly used infrastructure products.

Through this work, DOC will support government-wide efforts to catalyze domestic manufacturing, resilient supply chains, and good jobs while successfully delivering a wide range of infrastructure projects on Tribal lands. DOC supports the creation of resilient supply chains and manufacturing base for critical products here in the United States that will bring about investment in good-paying American manufacturing jobs and businesses, including jobs and businesses on Tribal lands. The creation of jobs in Tribal communities will also alleviate supply chain disruptions through cultivation of the domestic manufacturing base for a wide range of products commonly used in infrastructure but not yet made domestically.

4. Impact of the Waiver

Based on FY22 and FY23 data, entities identifying as Native American Tribes received about $150 million through DOC federal financial assistance agreements for a variety of projects, many of which included infrastructure. DOC anticipates a similar volume of awards in FY24. During the waiver period, DOC will continue to participate in Tribal consultations and will work with Tribes to identify commonly purchased items, to eliminate the need for a general applicability waiver going forward.

Since the enactment of BABA, DOC has worked diligently to implement Buy America preferences for financial assistance agreements while simultaneously evaluating the impact of the Buy America Preference to Tribes. DOC, in collaboration with other agencies, remains committed to obtaining input from Tribes and intends to continue dialogue with interest groups and stakeholders to continue working toward consistent, long-term compliance with the Buy America requirements while also continuing consultations and collaboration with Tribes. As consultations and collaboration efforts continue to develop, the need for ongoing waivers will be reevaluated.

5. Assessment of Cost Advantage of a Foreign-Sourced Product

Under M–24-02, Federal agencies are expected to assess "whether a significant portion of any cost advantage of a foreign-sourced product is the result of the use of dumped steel, iron, or manufactured products or the use of injuriously subsidized steel, iron, or manufactured products " as appropriate before granting a public interest waiver. This assessment is not applicable to this waiver as this waiver is not based on the cost of foreign-sourced products.

6. Duration of Waiver
The waiver applies to awards obligated or incrementally funded on or after the effective date, May 8, 2024, until September 30, 2024. In the case of awards obligated prior to the effective date, the waiver applies to expenditures on or after the effective date of the final waiver. DOC will review this waiver during the waiver period to assess whether it remains necessary to the fulfillment of DOC's missions and goals and consistent with applicable legal authorities. DOC may, based on the results of that review, terminate the waiver, or take action to develop a new waiver in consultation with MIAO.

7. Solicitation of Comments and Response
On March 14, 2024, DOC published its proposed public interest waiver for infrastructure projects for a 15-day public comment period on the Department's Build America, Buy America website. DOC received two comments during the public comment period. One commenter was supportive of the proposed waiver and requested that the proposed end date of September 30, 2024, be extended. The other commenter opposed the proposed waiver because they believed that there is ample domestic steel capacity to supply infrastructure projects funded by DOC.

The Department carefully considered both comments and information provided to the agency in support of the waiver. The Department determined that a public interest waiver, as proposed, is critical to keeping with the Federal Government's commitment to consult with Tribes and build Tribal capacity as established through Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*. Additionally, the proposed waiver is consistent with and follows the guidance provided by OMB in Implementation Guidance on Application of Buy America Preference in Federal Financial Assistance Programs for Infrastructure (M-24-02). Therefore, the Department is issuing the waiver with no substantive changes from the version that was published for public comment.

For more information on the Build America, Buy America preference, please reference DOC's Build America, Buy America website or MadeinAmerica.gov.

JEREMY PELTER Digitally signed by JEREMY PELTER Date: 2024.05.08 17:38:43 -04'00'

Jeremy Pelter
Deputy Assistant Secretary for Administration
performing the non-exclusive function and duties of
the Chief Financial Officer and Assistant Secretary
for Administration

NOAA Fisheries: Scope of Work for Cultural Resources

The current project is receiving funds from NOAA Fisheries. This means the project is considered a federal undertaking as defined in Title 36 of the Code of Federal Regulations (CFR) Section 800.17(y). As such, the project is subject to Section 106 of the National Historic Preservation Act (Section 106) (54 U.S.C. Section 306108).

NOAA is the lead federal agency for this undertaking. As a condition of receiving this award, the project proponent is responsible for obtaining and submitting the supporting cultural resources documentation necessary for Section 106 compliance to NOAA Fisheries. This includes a cultural resources study or studies documenting the following: the undertaking's **Area of Potential Effect (APE),** efforts undertaken to identify Historic Properties, and the **identification, assessment,** and **resolution of adverse effects** to Historic Properties if any are identified within the APE. This documentation and the study supporting it must be prepared by, or under the direct supervision of, a person or persons meeting, at a minimum, the Secretary of Interior's (SOI) Professional Qualifications Standards (PQS) for Archaeology, History, or Architectural History, as appropriate (48 CFR 44738-39).

The project proponent shall use the following guidance to help identify a qualified cultural resource professional to complete the Section 106-compliant work described above. The scope descriptions below refer responsibility for the deliverables to the project proponent; however, all work should be completed by the SOI PQS qualified professional. If there are any questions about this scope guidance document, please reach out to NOAA Fisheries' archaeologist Theadora Fuerstenberg (theadora.fuerstenberg@noaa.gov; [971] 373-6994).

CULTURAL INVENTORY STUDY

The type of documentation ultimately required to support a finding under Section 106 will be contingent upon the initial findings of a Cultural Resources Inventory study. The initial inventory study shall consist of the following parts:

Area of Potential Effect Delineation

Title 36 CFR Part 800.16(d) defines an APE as the "geographic area or areas within which a project may directly or indirectly cause changes in the character or use of historic properties if any such property exists." In accordance with 36 CFR 800.16(b), the project proponent will delineate a project-specific APE in consultation with NOAA Fisheries to identify properties that have the potential to be affected by the undertaking.

The purpose of the APE map is to provide a visual depiction of the project and its relation to known or potential Historic Properties. It should help the reviewers understand how the planned project activity may affect any known above or below ground Historic Properties, or any potential Historic Properties that may be identified on the surface during a field survey or below surface during project related ground disturbance. The APE map can be a single map or a series of maps depicting all areas that have the potential to be directly and indirectly affected by the Project and will include the boundaries of any and all Historic Properties within the APE. Direct effects may include any land modifications, soil disturbance, equipment staging, areas of access (ingress and egress), vegetation management or removal, or any other activity that may have a direct effect on the area. Indirect effects may include viewshed blockages, downstream or upstream flooding or dewatering, or inhibition of future vegetation growth. The APE map or series of maps should also depict the proposed project activity so it is clear where certain activities will occur, and how close the activities are to known or potential Historic Properties. The APE must include a depiction of the depth and breadth of any ground disturbing activities, and be accompanied by a description of the APE which includes both vertical and horizontal dimensions.

Cultural Resources Records Search

The study shall include a search of:

California [California Historical Resources Information System (CHRIS) of the proposed project site as well as a 0.50-mile radius around the APE at the appropriate CHRIS records repository]. **Oregon** [Oregon Archaeological Records Remote Access (OARRA) database system for the APE plus a 1-mile radius] **Washington** [Washington Information System for Architectural and Archaeological Records Data (WISAARD) system for the APE plus a 1-mile radius]; **Alaska:** [Alaska Heritage Resources Survey (AHRS) for the APE plus a 1-mile radius]; **Hawaii:** [Hawai'i Cultural Resource Information System (HICRIS) for the APE plus a 1-mile radius on land, and an appropriate radius in the water depending on project location. Both land and ocean portions of the APE need to be included in the search. An information inquiry with the Hawai'i Underwater Research Laboratory (HURL) is necessary for undertakings that extend into the ocean]; **Idaho:** [The Archaeological Survey of Idaho (ASI) **please note this will soon change to ICRIS** and the Idaho Historic Sites Inventory (IHSI) for the APE plus a 1-mile radius]. The search radius surrounding the APE can be adjusted as appropriate for the study as long as the reasoning is defensible.

The primary purpose of the records search is to identify any previously recorded cultural resources known to exist within or near the APE. The records search will also reveal the nature and extent of any cultural resources work previously conducted within the APE and vicinity. In addition to the records search, an examination should be made of historical maps, the National Register of Historic Places (NRHP), and relevant state registries of historical places, resources, and landmarks. A description of these search results should be included in the study to provide reviewers context for the types and frequency of cultural resources that may be expected in the area of the APE, and to inform an assessment of the APE's cultural sensitivity.

Native American and Local Interested Party Consultation

To ensure the supporting documentation meets the requirements of Section 106, the project proponent will assist NOAA Fisheries in facilitating consultation with outreach to Native American tribal contacts and other local interested parties that may have knowledge of Historic Properties in the area of the APE.

California: This will include a request for a search of the Sacred Lands File (SLF) from the Native American Heritage Commission (NAHC). The SLF search will indicate whether cultural resources important to Native American Tribes are present within the vicinity of the APE. The NAHC will also provide a tribal contact list for the vicinity of the APE. **Oregon:** This will include outreach to local Native American Tribes that may have ancestral ties to the APE and vicinity guided by the Legislative Commission on Indian Services as well as the Tribal Directory Assessment Tool (TDAT; https://egis.hud.gov/tdat/). **Washington:** This will include outreach to local Native American Tribes that may have ancestral ties to the APE and vicinity guided by the Washington Department of Archaeology and Historic Preservation's (DAHP) interactive mapping: https://dahp.wa.gov/tribal-consultation-information). **Alaska:** This will include outreach to Alaska Natives that may have ancestral ties to the APE and vicinity; **Hawaii**: This will include outreach to Native Hawaiian Organizations that may have ancestral ties to the APE and vicinity, guided by the Native Hawaiian Organization List from the Department of the Interior); **Idaho:** This will include outreach to local Native American Tribes that may have ancestral ties to the APE and vicinity guided by the TDAT (https://egis.hud.gov/tdat/).

The SOI PQS qualified professional may author the individual outreach letters to Native American Tribes or individuals; however, NOAA Fisheries will send the outreach letters formally inviting the Tribes to consult.

The SOI PQS qualified professional authoring the study shall additionally provide a list of other local interested parties, including local government agencies and historical societies or advocacy groups that may have knowledge of Historic Properties in the area of the APE. As with the Tribal outreach letters, the SOI PQS qualified professional may author letters for NOAA Fisheries. However, NOAA Fisheries will officially contact all applicable local interested parties to invite them to consult. NOAA Fisheries will share the results of the consultation efforts, which should be summarized in the Cultural Resources study and documented in detail in an appendix to the study.

Cultural Resources Field Investigation

Upon completion of the records search and review of the referenced literature, a field investigation of the APE will be conducted under the supervision of a SOI PQS qualified archaeologist and, if applicable, architectural historian. The field inventory shall consist of a surface investigation using pedestrian survey methods and, if necessary, subsurface investigation methods appropriate for the landscape. The field archaeologist may consult with NOAA Fisheries beforehand to ensure their methods are appropriate for identification of Historic Properties. NOAA Fisheries urges the consideration of the safety and well-being of in-field professionals and is willing to consult on alternative methods of investigation for identification of Historic Properties should surveying all areas of the APE prove hazardous. A Field Coverage Map should be included in the documentation showing all areas surveyed, all subsurface testing locations, and any areas that were not accessed, accompanied by a narrative description of the field investigation.

Please note that subsequent fieldwork may be required in order to evaluate potential Historic Properties that are identified during the inventory. The project proponent and qualified professional are encouraged to coordinate with NOAA Fisheries prior to engaging in the evaluation phase of field study and/or excavation. However, NOAA Fisheries does not require submission of an archaeological excavation plan prior to the evaluation phase of field study.

DOCUMENTATION/REPORTING

If no potential Historic Properties are identified during the records search, consultation, and field investigation, the negative results of the study will be documented in a **Negative Cultural Resources Inventory Report**. If cultural resources are identified during the study, they should be evaluated for eligibility for inclusion in the NRHP in a **Cultural Resources Inventory and Evaluation Report,** which may also include a **Finding of Effect (FOE)**. Documentation should follow the Secretary of the Interior's

Standards and Guidelines for Archaeological and Historic Documentation (Secretary's Standards)(Federal Register, Vol. 90, No. 140:44716). The instructions for the content of the documents described herein should conform to the Secretary's Standards, described further below.

Negative Cultural Resources Inventory Report

This section describes the document NOAA Fisheries requires when no cultural resources/potential Historic Properties are identified in the APE. A Section 106-compliant **Negative Cultural Resources Inventory Report** documents the results of a negative study as well as provides management recommendations for unanticipated discoveries of cultural items or human remains. The report should contain the following information:

- **Table of Contents:** This should list chapters, subchapters, figures and tables.
- **Executive Summary:** Ideally one-page synopsis of the study identifying purpose and scope, dates, negative results, and 106 finding of No Historic Properties Affected.
- **Introduction:** Includes a description of the proposed undertaking, the legal location of the APE, and lists the personnel who completed the study and their qualifications. The APE map should be referred to in this section.
- **Regulatory Context:** This should include a description of the NHPA/Section 106 regulatory framework. It also may include framework for other state and local laws with which the study complies.
- **Natural and Cultural Context:** This section should include the environmental and geological setting of the APE, a synopsis of the ethnographic setting of the area, the precontact-era archeological setting, and the post-contact historic era setting of the APE.
- **Methods:** This should include the background research and field methods used in the study, as well as the outreach efforts of NOAA Fisheries to invite consulting parties.
- **Results:** Include the results of the background research and field study. The field study map(s) should be referred to in this section.
- **Conclusions and Recommendations:** Include a synopsis of the research and how it supports the conclusion of No Historic Properties Affected. Factors such as field APE access, subsurface sensitivity, and overall area sensitivity should be considered in drawing conclusions. Management recommendations for Section 106 shall refer to the process at 36 CFR 800.13 Post-Review Discoveries. The recommendations may include reference to state guidelines and processes governing unanticipated discoveries of cultural resources or human remains.
- **References:** Cite any references used in the study.
- **Appendices:** These should include copies of the Tribal and other interested party outreach letters and a record of responses/requests to consult on the project.

The project proponent shall transmit a draft of the report to NOAA Fisheries for review. NOAA will return the draft report with comments, suggested edits, or requested information prior to its finalization, or alternatively will inform the project proponent that it can be finalized and sent to the appropriate State Historic Preservation Officer (SHPO) with a request for comment within a 30-day review period. The project proponent has the option of retaining a SOI PQS qualified professional to prepare the SHPO letter(s) and documentation transmittal for NOAA Fisheries to review in instances where timing is a deciding factor.

Cultural Resources Inventory and Evaluation Report/Finding of Effect*

This section describes the documentation NOAA Fisheries requires when the study identifies cultural resources/potential Historic Properties in the APE. A Section 106-compliant **Cultural Resources Inventory and Evaluation Report** documents the results of the inventory and an evaluation of any and all cultural resources identified in the APE for eligibility to the NRHP to determine if they constitute a Historic Property per the criteria listed at 36 CFR Part 60.4. A **Finding of Effect** should be included for all resources determined to be eligible for listing in the NRHP (Historic Properties), and recommendations for further work to avoid/minimize/mitigate adverse effects should also be included.

The report should contain the following information:

- **Table of Contents:** This should list chapters, subchapters, figures and tables.
- **Executive Summary:** A one- to two-page synopsis of the study identifying purpose and scope, dates, study results, and 106 finding of either No Adverse Effect or Adverse Effect to Historic Properties.
- **Introduction:** Includes a description of the proposed undertaking, the legal location of the APE (Assessor Parcel Number(s)), and lists the personnel who completed the study and their qualifications. The APE map should be referred to in this section.
- **Regulatory Context:** This should include a description of the NHPA/Section 106 regulatory framework, and should specifically include the significance criteria and integrity aspects used for evaluating properties listed at 36 CFR 60.4. If the reporting includes a Finding of Effect, the criteria of adverse effect should also be listed in this section. The report may also include the framework for other state and local laws with which the study complies.
- **Natural and Cultural Context:** This section should include the environmental and geological setting of the APE, a synopsis of the ethnographic setting of the area, the precontact-era archeological setting, and the post-contact historic era setting of the APE. Additionally, it should include contexts specific to any resource type being evaluated for the NRHP.
- **Methods:** This should include the background research and field methods used in the study, as well as a brief synopsis of NOAA's outreach efforts to invite consulting parties. It should also include the methods used to relocate, document/record, and evaluate any previously identified cultural resources in the APE, as well as methods used to document/record and evaluate newly discovered cultural resources identified as a result of the study. It should identify where records and documentation produced as a result of the study will be housed.
- **Research Design:** If archaeological field investigations (excavations, grid recording/mapping) is required to glean data potential for archaeological resources that are identified during the inventory, a research design that includes regionally specific research topics, research questions for each topic, and data thresholds to answer those questions should be included to support the NRHP evaluation of these resources under NRHP Criterion D.
- **Results:** Include the results of the background research and all field studies. The field study map(s) should be referred to in this section. Any and all previously identified and newly identified resources should be described in this section, along with the history of any previous descriptions and investigations of the resources.

- **Evaluations:** All cultural resources identified must be evaluated for listing in the NRHP, applying all four NRHP Criteria (A, B,C, D) and must be clearly identified as "eligible" or "not eligible" for listing in the NRHP. Each resource should be considered within its appropriate context as outlined in the Natural and Cultural Context sections, and archaeological site evaluations under Criterion D should include analyses of the data potential against the thresholds in the research design.
- ****Finding of Effect:** **This applies only if resources are recommended eligible for listing in the NRHP and considered Historic Properties. For all Historic Properties identified in the APE, consider the proposed project design and implementation and apply the criteria of adverse effect to these Historic Properties. Include a finding of No Adverse Effect or Adverse Effect for each Historic Property considered in this section.
- **Conclusions and Recommendations:** Include a synopsis of the research, NRHP evaluations, considerations for adverse effects, and how they support one of the following findings: No Historic Properties Affected (if the study identified no Historic Properties in the APE; this includes instances where potential Historic Properties were identified in the APE but determined to be ineligible for listing in the NRHP); No Adverse Effect to Historic Properties (if the study identified Historic Properties in the APE but demonstrates that the proposed project(s) will not affect the aspects of those Historic Properties that lend to their significance) or Adverse Effect to Historic Properties (if the study identified Historic Properties in the APE and demonstrates that the proposed project(s) will adversely affect the significance of the Historic Property).
    - With a conclusion of No Historic Properties Affected or No Adverse Effects to Historic Properties, management recommendations for Section 106 shall refer to the process outlined in 36 CFR 800.13 Post-Review Discoveries. The recommendations may include reference to state guidelines and processes governing unanticipated discoveries of cultural resources or human remains.
    - With a conclusion of Adverse Effect to Historic Properties, the study should recommend appropriate measures to avoid, minimize, and/or mitigate the adverse effects as next steps. NOAA Fisheries encourages the measures proposed to be commensurate with the specific effects to the Historic Properties themselves. This could entail proposing the preparation of documents such as a Historic Property Management Plan or Historic Property Treatment Plan to be developed in consultation with NOAA Fisheries and all consulting Tribes and other interested parties, or other appropriate measures.
- **References:** Cite any references used in the study.
- **Appendices:** These should include records search results, copies of the Tribal and local interested party outreach letters and a record of responses/requests to consult on the project, resource records/documentation of cultural resources, field forms/notes and photographs, or any other type of information furnished for the study that supports the conclusions and recommendations.

*Please note that under Exemption 3 of the federal Freedom of Information Act (5 USC 5), because the disclosure of cultural resources location information is prohibited by the Archaeological Resources Protection Act of 1979 (16 USC 470hh) and Section 307103 of the NHPA, it is also exempted from disclosure under the Freedom of Information Act. All documentation containing archaeological resources locations must be kept confidential.

Additional Documentation for Resolution of Adverse Effects (Memorandum of Agreement [MOA], Programmatic Agreement (PA), Historic Property Treatment Plan [HPTP], Historic Property Management Plan [HPMP], Cultural Resources Mitigation and Monitoring Plan [CRMMP])

In the event that the Historic Properties have the potential to be adversely affected by the project, additional documentation may be necessary to memorialize the Resolution of Adverse Effects. In these instances, NOAA Fisheries shall consult with the appropriate SHPO/Tribal Historic Preservation Officer (THPO) and all consulting parties and Tribes and notify the Advisory Council on Historic Preservation (ACHP) prior to determining additional documentation needs to memorialize the Resolution of Adverse Effects. NOAA Fisheries will coordinate with the project proponent on what type of documentation to prepare pursuant to the resolution of adverse effects.

Attachments:

A. Frequently Asked Questions (FAQs)

B. NRHP Criteria of Significance and Criteria of Adverse Effect

C. Example Research Design

Attachment A: Frequently Asked Questions

FAQs:

Can the consultant coordinate with NOAA Fisheries directly? Yes, this is encouraged. It increases the likelihood the study will meet the Section 106 standards of NOAA Fisheries and move on to SHPO review following the first submittal. It additionally facilitates open communication for questions and/or the development of strategy for meeting the required standards and increases efficiency related to Tribal and other interested party outreach and consultation.

Do the title, content, and chapters of the cultural reports have to follow the exact names and order listed for Documentation/Reporting? No. Any similar title order is fine as long as all the information listed is somewhere in the report, the study results are documented and described coherently, and the results support the findings. Reports that lack a clear finding supported by evidence may be returned with comments, which could cause project delays.

Can the APE Map and the Survey Coverage Map be the same map? This may be appropriate if there are no Historic Properties present in the APE. Typically, it's simpler to provide two separate maps. If maps are difficult to interpret, project delays could result.

Can the inventory, evaluation, and FOE be presented in one single report? Yes. This would be the ideal way to present the information to NOAA Fisheries to move forward efficiency.

Sometimes larger projects identify multiple resources of the same or very similar type (e.g five low-density surface lithic scatters related to expedient tool manufacture by Native Americans in the late-period precontact-era, or seven historic-era cattle watering stations related to late 19th century ranching). Is it OK to evaluate similar types of resources as a group? Yes. Grouping evaluations of like resources is preferred as long as the resource descriptions demonstrate they are similar enough in make-up to be evaluated in the same context.

Is "Finding of Effect" the same thing as "Assessment of Effect" or "Effects Determination"? Yes; all refer to the application of the criteria of adverse effects to a Historic Property to determine a finding under Section 106 (No Adverse Effect or Adverse Effect). NOAA Fisheries encourages open communication if there are questions about the appropriate finding for individual situations.

Can the studies be written to comply with other state and local laws in addition to Section 106? Yes; as long as the study clearly presents a finding under Section 106 as well as any other findings or conclusions to comply with state or local laws.

If we need to do more field testing or excavation (also called Phase II Testing or Evaluation Testing) in order to help determine the eligibility of an archaeological site, does NOAA require submittal of an archaeological testing/evaluation plan to be approved before the work can commence? NOAA Fisheries does not require submittal of an archaeological excavation plan study prior to the evaluation phase field work, but encourages coordination prior to these studies.

Attachment B: Criteria of Significance and Criteria of Adverse Effect

Historic properties include any district, site, building, structure, or object included in or eligible for inclusion in the NRHP, per the criteria listed below (36 CFR 60.4):

The quality of significance in American, state, and local history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects meet one or more of the following criteria:

- **Criterion A:** Are associated with events that have made a significant contribution to the broad patterns of our history
- **Criterion B:** Are associated with the lives of persons significant in our past
- **Criterion C:** Embody the distinctive characteristics of a type, period, or method of installation, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction
- **Criterion D:** Have yielded, or may be likely to yield, information important in prehistory or history.

In addition to meeting at least one of the above designation criteria, resources eligible for the NRHP must also retain integrity. The National Park Service recognizes seven aspects or qualities that, considered together, define historic integrity. To retain integrity, a property must possess several, if not all, of these seven qualities, defined in the following manner:

- **Location:** The place where the historic property was constructed or the place where the historic event occurred
- **Design:** The combination of elements that create the form, plan, space, structure, and style of a property
- **Setting:** The physical environment of a historic property
- **Materials:** Materials are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property
- **Workmanship:** The physical evidence of the crafts of a particular culture or people during any given period in history or prehistory
- **Feeling:** A property's expression of the aesthetic or historic sense of a particular period of time
- **Association:** The direct link between an important historic event or person and a historic property.

According to Section 106 (36 CFR § 800.5) adverse effects to historic properties are assessed by applying the criteria of adverse effect, stated below.

Criteria of Adverse Effect: An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the NRHP. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative. Adverse effects to historic properties include, but are not limited to the following:

- Physical destruction of or damage to all or part of the property;
- Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation, and provision of handicapped access, that is not consistent with the Secretary's standards for the treatment of historic properties (36 CFR part 68) and applicable guidelines;
- Removal of the property from its historic location;
- Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;
- Introduction of visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features;
- Neglect of a property which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization; and
- Transfer, lease, or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

Attachment C: Sample Research Design

This section presents a working research design that identifies important regional research issues, relevant data requirements, and research questions for a pre-contact era archaeological site in Calaveras County, California. The research topics and questions concerning precontact research are largely drawn from research designs developed for previous work in the area. For detailed examples of site types identified in each occupational era, and discussion of potential site significance relative to the research issues, refer to Fitting, Costello, and Crew (1979); Peak and Crew (1990), and Moratto, Tordoff, and Shoup (1988).

Precontact-era Research Issues

Archaeological testing and evaluation programs be should be guided by an appropriate research design, which includes testable hypotheses. To assist this resource evaluation, the following discussion presents a series of topical research themes pertaining to precontact-era cultural resources, and the data requirements necessary to address those themes. As the evaluations of significance are carried out, and as more information becomes available, the set of applicable research questions may change.

This precontact-era site is located near a secondary drainage and has bedrock milling features. The principal activity at this site was likely vegetal processing.

A variety of precontact settlement models for the foothills and lower elevations of western Sierra Nevada in the period after AD 1100 (or the Emergent Period as defined by Rosenthal et al. 2007) generally posit settlement expansion into more marginal resource areas along secondary drainages as a result of population increase and a climate shift to colder, wetter, and more stable conditions. The major villages described in the ethnographic sources were located along the primary drainages, such as the Stanislaus River. As population increased, secondary villages or base camps were established along secondary drainages such as Mill Creek and San Domingo Creek.

Such sites have been found within 0.25 mile of the APE along Mill Creek. Such sites were primarily used for acorn or other vegetal processing, including medicinal herbs. Most sites in the vicinity contain only bedrock mortars, sites with bedrock mortars and sparse surface flake scatters, and sites with bedrock mortars, surface lithics, and subsurface midden deposits.

Although the majority of precontact-era sites in the vicinity contain only bedrock mortars, several satellite sites within the vicinity along Mill Creek contain midden or petroglyphs along with bedrock mortars. Other nearby sites contain beads and human burials. Other artifacts common on sites in the area are low densities of flakes and a limited range and quantity of tools such as utilized flakes, and ground stone tools.

Research Topics

Research topics for the precontact era sites in the APE include activities and site function, internal site organization, subsistence patterns, and chronology and temporal patterning.

Activities and Site Function

What activities other than vegetal processing, if any, took place at the site? Is there a full range of activities represented such as would be characteristic of a habitation site or only a limited set of activities? Is there evidence for lithic tool production and what techniques were used? Did techniques change over time? Data requirements to address these questions include tools classified functionally and debitage classified technologically. If subsurface features (hearths, ovens) are present, the type and number of features will also help address these questions.

Internal Site Organization

Are there distinct manufacturing, processing, or food preparation areas within the site? Were male and female activities carried out in different areas of the site? Are distinct activity areas associated with each outcrop containing bedrock mortars or was a single activity area used by everyone using any of the bedrock mortars at the site? Data requirements include maps of the spatial distribution of tools, debitage, subsistence remains, and features. If the site is small and there are few categories that do not vary spatially, this domain cannot be addressed.

Subsistence Patterns

Were resources brought to the site, prepared, and consumed? Is there evidence for specialization or intensification of resource use? Specialization would be indicated by large numbers of the remains of a single species. Intensification would be indicated by reliance on resources that require greater amounts of labor to procure or process. To address questions about subsistence, a reliable sample of plant or animal subsistence remains would be necessary.

Chronology and Temporal Patterning

Does site use date to after AD 1100? Was the site used at the same time as other nearby sites or sequentially? Was the site used continuously for a short or long period of time? Were there periods of time when the site was not used (continuous occupation or periodic abandonment)? Data requirements include datable material such as obsidian, sufficient charcoal for radiocarbon dating, and/or temporally diagnostic artifacts, such as beads or projectile point type.

Summary

The results from the testing program at the site will not directly address these research topics, but the test program results will be used to evaluate whether the site has the potential to yield data with which to address them during a data recovery program. If so, the site will be considered eligible for the NRHP. The test program is also designed to provide information on subsurface site boundaries, the integrity of subsurface deposits, and the internal distribution of concentrations of subsurface material. This information would be used in planning a data recovery program for eligible sites that cannot be avoided.

Theadora Fuerstenberg
NOAA Restoration Center
1201 NE Lloyd Blvd., Suite 1100
Portland, OR 97232
206-771-0944 CELL, 503.231.2339 FAX
theadora.fuerstenberg@noaa.gov

00/00/000
Addressee
Xxxx
xxxx

RE: **Section 106 Consultation Invitation: Project Name (RCO Project ID #), City, County, State**

Honorable Chairperson XXXXX

The [project proponent: 'grantee' or agency or entity implementing the project] is proposing to [brief project description such as 'modify the passage of water over Tioga Falls to facilitate creation of 14 miles of critical habitat for salmon, steelhead, Pacific Lamprey, and cutthroat trout'] in [Location, City, County, State] (proposed undertaking). The project is being funded by the National Oceanic and Atmospheric Administration's (NOAA's) Restoration Center's Community-Based Restoration Program; therefore, it is considered a federal undertaking and is subject to Section 106 of the National Historic Preservation Act (Section 106). NOAA Fisheries will be the federal lead agency under Section 106, and NOAA's Restoration Center is conducting the Section 106 process pursuant to the regulations at 36 C.F.R. 800 *et seq*.

The proposed undertaking will consist of [a slightly more detailed project description including dimensions, extent of surface and subsurface disturbance, such as 'The proposed undertaking involves approximately 82 square feet of targeted bedrock cutting in the stream, using a 6-inch bedrock cutter blade on a backhoe and disturbing as much as 3 feet of the stream bank to a maximum disturbance depth of 1.5 feet. Vegetation cutting will be conducted by hand in an approximately 10 square foot area upland of the stream bank.'] An area of potential effects (APE) has been established for the undertaking in accordance with 36 Code of Federal Regulations Part 800.3 to encompass areas that may be directly or indirectly affected by the proposed undertaking. The APE depicted on the attached maps and includes portions of the U.S. Geological Survey 7.5-minute topographic map XX Quad, Township XX, Range XX, Section[s] XX. The undertaking is slated to occur during the [summer of 2023].

[list any work that has been done for the project and the results –if a cultural study has already been completed, explain why it was completed prior to this invitation. For CA: A Sacred Lands File (SLF) Search be performed by the Native American Heritage Commission (NAHC). The results of the SLF search were positive/negative]. Additional studies for the project shall include [cultural resources investigations – if these have not been done] and consultation with local historical groups.

NOAA Restoration Center is inviting the [Tribe] to consult and provide comments on the undertaking and APE map. If the Tribe knows of any cultural resources that may be of religious or cultural significance to your community, or if you would like more information, please contact me at [Phone number] or the above address, or my email at theadora.fuerstenberg@noaa.gov. The NOAA Restoration Center requests the Tribe's written response within 30 days of this letter.

Sincerely,

[Thea will add signature]
Theadora Fuerstenberg
Archaeologist

Enclosure: APE Map(s)

Cc: Admin email, THPO, Cultural department people

Theadora Fuerstenberg
NOAA Restoration Center
1201 NE Lloyd Blvd., Suite 1100
Portland, OR 97232
206-771-0944 CELL, 503.231.2339 FAX
theadora.fuerstenberg@noaa.gov

[DATE]
[Insert SHPO name and address]

RE: Consultation initiation; request for review of the 'Area of Potential Effect' for the [Project Name and RCO Project ID #] [City or Locality, County, State]

Dear [Name],

The U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) is writing to initiate consultation [and request your review of an Area of Potential Effect (APE)] for a [brief one-sentence project description] project that is funded by NOAA's Restoration Center (undertaking). NOAA Restoration Center is the lead federal agency for Section 106 compliance for this undertaking, entitled [Project Name].

Description of Undertaking and Area of Potential Effects

[Include a more detailed project description and legal location such as: The proposed undertaking is located on the [insert year of map] United States Geological Survey [insert *quadrangle name], [STATE]*, 7.5-minute topographic quadrangle, on private land encompassing an approximately [XX]-acre parcel (if applicable: Assessor's Parcel Number XXX-XXX-XXX) in the city of [insert city or town name], [insert county name] County. The property is currently [describe current state of development].

The APE for the current undertaking was delineated by NOAA Restoration Center, the [Grantee and any additional agencies or entities party to the project area development and delineation], and developed to consider both direct and indirect effects to potential historic properties. The APE for the Project encompasses approximately [XX] acres and includes the footprint of all proposed ground-disturbance for the undertaking, including the locations of [replace the following example text with undertaking specific details: *all three habitat restoration footprints, all staging areas for restoration equipment and parking, and all access roads that will be modified to support the undertaking. The APE does not include any portion of the channelized segment of Cache Creek located to the south and east as the undertaking will not have effects related to the creek. The vertical APE includes the maximum depth of anticipated ground disturbance, which may be up to 10 feet below the surface for primrose removal. Therefore, the vertical APE for the current undertaking is 10 feet below-ground surface and 40 feet above ground which is the anticipated height of the proposed hawk nest.*]

Tribal Consultation
NOAA Restoration Center is aware of [two] Tribes whose ancestral area is within this APE, and whom NOAA Restoration Center is inviting to consult via written correspondence:
1) List Tribe
2) List Tribe

A 30-day comment period will be provided to each Tribe and NOAA will provide SHPO copies of any correspondence or comments from concerned tribes that are received.

Other Party and Public Coordination:

NOAA Restoration Center is aware of three [certified local governments, local conservation groups, historical

societies, etc.] whom NOAA Restoration Center is inviting to consult and/or notifying about the undertaking via written correspondence:
1) List Party [inviting to consult OR notifying]
2) List Party [inviting to consult OR notifying]

A 30-day comment period will be provided to each invited interested party and NOAA will provide SHPO copies of any correspondence or comments that are received.

NOAA Restoration Center requests SHPO's review the information for this undertaking and APE map, and requests SHPO's response within 30 days. In response, please include any additional cultural resource issues to be considered, or any Tribes or other parties SHPO feels NOAA Restoration Center should include in outreach efforts. SHPO's response and comments are greatly appreciated. If you have any questions, feel free to contract me directly at (206) 771-0944 or theadora.fuerstenberg@noaa.gov. Thank you for the review.

Sincerely,

[Thea will insert signature when reviewed].

Theadora Fuerstenberg, M.A., RPA
Archaeologist

Attached: APE Map(s)

CC: Include project manager and all relevant parties at NOAA restoration

Theadora Fuerstenberg
NOAA Restoration Center
1201 NE Lloyd Blvd., Suite 1100
Portland, OR 97232
206-771-0944 CELL, 503.231.2339 FAX
theadora.fuerstenberg@noaa.gov

00/00/000
Addressee
Xxxx
xxxx

RE: Section 106 Consultation Invitation: Project Name (RCDB #), City, County, State

To Whom This May Concern:

The [project proponent: 'grantee' or agency or entity implementing the project] is proposing to [brief project description such as 'modify the passage of water over Tioga Falls to facilitate creation of 14 miles of critical habitat for salmon, steelhead, Pacific Lamprey, and cutthroat trout'] in [Location, City, County, State] (proposed undertaking). The project is being funded by the National Oceanic and Atmospheric Administration's (NOAA's) Restoration Center's Community-Based Restoration Program; therefore, it is considered a federal undertaking and is subject to Section 106 of the National Historic Preservation Act (Section 106). NOAA Fisheries will be the federal lead agency under Section 106, and NOAA's Restoration Center is conducting the Section 106 process pursuant to the regulations at 36 C.F.R. 800 *et seq*.

The proposed undertaking will consist of [a slightly more detailed project description including dimensions, extent of surface and subsurface disturbance, such as 'The proposed undertaking involves approximately 82 square feet of targeted bedrock cutting in the stream, using a 6-inch bedrock cutter blade on a backhoe and disturbing as much as 3 feet of the stream bank to a maximum disturbance depth of 1.5 feet. Vegetation cutting will be conducted by hand in an approximately 10 square foot area upland of the stream bank.'] An area of potential effects (APE) has been established for the undertaking in accordance with 36 Code of Federal Regulations Part 800.3 to encompass areas that may be directly or indirectly affected by the proposed undertaking. The APE depicted on the attached maps and includes portions of the U.S. Geological Survey 7.5-minute topographic map XX Quad, Township XX, Range XX, Section[s] XX. The undertaking is slated to occur during the [summer of 2023].

Additional studies for the undertaking shall include cultural resources investigations and consultation with Native American Tribes.

NOAA Restoration Center is inviting the [Party] to consult and provide comments on the undertaking. NOAA's Restoration Center is interested in receiving input from your community regarding any concerns related to the proposed undertaking. If your community knows of any cultural resources that may be of historical or cultural significance to your community, or if you would like more information, please contact me at [Phone number] or the above address, or my email at theadora.fuerstenberg@noaa.gov. The NOAA Restoration Center requests a written response within 30 days of this letter.

Sincerely,

[Thea will add signature]
Theadora Fuerstenberg
Archaeologist

Enclosure: APE Map(s)

SHPO Concurrence Letter Template

(use only for final submittal pursuant to 36 CFR 800.4(d)(1) or 800.5(c); and/or 800.6(a))

Theadora Fuerstenberg
NOAA Restoration Center
1201 NE Lloyd Blvd., Suite 1100
Portland, OR 97232
206-771-0944 CELL, 503.231.2339 FAX
theadora.fuerstenberg@noaa.gov

[Insert Date]

Dr. Allyson Brooks, Ph.D.
State Historic Preservation Officer
Director of Washington Department of Archaeology and Historic Preservation
1110 S. Capitol Way, Suite 30
Olympia, WA 98501

RE: [SHPO ref #] Request for Comment or Concurrence on "Section 106" Compliance Finding of "[No Effect to Historic Properties Under Section 106/No Adverse Effect to Historic Properties/Adverse Effects to Historic Properties]" for the [Insert project name]

Dear [name]:

Pursuant to compliance with Section 106 of the National Historic Preservation Act and its implementing regulations at 36 CFR Part 800, The NOAA Restoration Center is seeking comments from your agency to complete the federal review process and requesting your comment or concurrence that the enclosed cultural resources studies/information are adequate and complete, and that [no effect to historic properties/no adverse effect to historic properties/adverse effects to historic properties] will occur as a result of the undertaking described herein.

Description of Undertaking

NOAA's Restoration Center is providing federal funding to the [Grantee/project implementor], thus making this an undertaking as defined in 36 C.F.R. 800.16(y). The proposed undertaking is located on the [insert year of map] United States Geological Survey [insert *quadrangle name], [STATE]*, 7.5-minute topographic quadrangle, on private land encompassing an approximately [XX]-acre parcel (if applicable: Assessor's Parcel Number XXX-XXX-XXX) in the city of [insert city or town name], [insert county name] County. The property is currently [describe current state of development].

The proposed undertaking consists of [insert description of undertaking]. This information can be found on pages X through X of attached supporting documentation.

Area of Potential Effects

The APE was established in accordance with the definition of an undertaking as defined in 36 CFR 800.16(d), which defines an APE as:

the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking.

The APE for the current undertaking was delineated in consultation with [project proponent, other agency or Tribal consulting parties] and developed to consider both direct and indirect effects to potential historic properties. The APE for the Project encompasses approximately [XX] acres and includes the footprint of all proposed ground-disturbance for the undertaking, including the locations of [replace the following example text with undertaking specific details: *all three habitat restoration footprints, all staging areas for restoration equipment and parking, and all access roads that will be modified to support the undertaking. The APE does not include any portion of the channelized segment of Cache Creek located to the south and east as the undertaking will not have effects related to the creek. The vertical APE includes the maximum depth of anticipated ground disturbance, which may be up to 10 feet below the surface for primrose removal. Therefore, the vertical APE for the current undertaking is 10 feet below-ground surface and 40 feet above ground which is the anticipated height of the proposed hawk nest.*] APE information can be found on pages X through X of attached supporting documentation.

NOAA consulted with SHPO on the APE on [date], SHPO [offered no comment].

Cultural Resources Studies

[Insert consultant or other entities that performed the cultural study(ies)] prepared a cultural resources study. The cultural resources study included a delineation of the APE, a cultural resources records search of the [State database system for the project footprint plus a 0.5 to 1-mile radius], invitations to consult to Tribes whose ancestral territory overlaps the project area, and [replace sample text here and add specific study information: an archaeological sensitivity assessment to inform the overall sensitivity of the project location.]

[insert results of records search, tribal outreach, field survey (if applicable), and the cultural resources technical study(ies).

List all cultural resources identified during the identification (studies, Tribal correspondence/consultation, other interested party correspondence), and list whether they were determined to be historic properties and under which criteria they are eligible. Refer to the page number in supporting documentation.]

[Replace the following example text with conclusions from cultural resources technical report and/or other supporting documentation] In conclusion, due to the age of the landform and the negative results of the recent and previous studies regarding archaeological resources, subsurface sensitivity of the APE is low for both historic-era and pre-contact era archaeological sites. Furthermore, the project footprint is currently vacant, and there are no built environmental resources to assess.

Tribal Consultation

NOAA sent invitations to consult to Tribes whose ancestral territory overlaps the project area, including the [Sauk-Suiattle Tribe and The Swinomish Indian Tribal Community. Invitation to consult on the undertaking and APE were sent on May 05, 2023]. Follow-up emails were sent on [DATE] and [DATE]. No response was received from either Tribe OR write a brief synopsis of responses. This supporting documentation for NOAA's outreach efforts is attached.

Other Party Consultation

NOAA sent invitations to consult to the following other potentially interested parties:

were sent on [DATE] and [DATE]. No response was received from either. This supporting documentation for NOAA's outreach efforts is attached.

Public Involvement

NOAA fostered public participation in the process by XXXXX methods

Effects Determination

Based on the results of the cultural resources investigation, NOAA reached a determination of [no historic properties effected/no adverse effects to historic properties/ *adverse effects to historic properties with proposed measures included] pursuant to 36 CFR Section 800.4(d)(1) is appropriate for the referenced project.

[If finding is "no adverse effects," insert synopsis of supporting information and refer to the page number in supporting documentation]

* [If the finding is "adverse effects," you may insert synopsis of proposed measures to resolve adverse effects and refer to the page number in supporting documentation, add date ACHP was notified, and/or request further consultation on resolution]

Attached for your review is a copy of the [*Insert Name of supporting technical study(ies) and/or other documentation]* which includes photographs and a map showing the location of the APE, and a record of Tribal and other party consultation and outreach efforts. This documentation satisfies requirements set forth at Section 800.11(d).

The NOAA Restoration Center respectfully requests your response within 30 days of receiving this request. If you or any members of your staff have questions, please do not hesitate to call me at (206) 771-0944 or transmit email to theadora.fuerstenberg@noaa.gov

Sincerely,

[Thea will insert signature when reviewed].

Theadora Fuerstenberg, M.A., RPA
Archaeologist

Attached: List supporting documentation, including a record of tribal outreach letters and list of any follow up calls

EXHIBIT D
Data Management and Implementation Monitoring Plan

DATA MANAGEMENT PLAN

The Snohomish Cooperative Salmon Barrier Removal Project, implemented by The Tulalip Tribes and subawardees (Snohomish County, Snohomish Conservation District) will generate environmental data and information including pre and post-implementation data on fish passage/site passibility, presence/absence of anadramous salmonids (adult, juvenile), channel width metrics, and channel gradient metrics, as well as riparian species assemblage, and invasive species presence/absence. Data will be collected and compiled by staff from representative sponsor organizations. The data will be stored on data servers hosted by the project proponent and project sub-recipients. The data will be readily available at the request of NOAA agency personnel, or other agencies on an as needed basis no later than two years after the date collected/created. Contact Brett Shattuck, Restoration Program Manager for Tulalip Tribes at 360.716.4618 or e-mail to bshattuck@tulaliptribes-nsn.gov to make a data request. All sub-awardees will have a condition of their contract acceptance of this data sharing plan. Any additional data sharing stipulations for future subawardees may be outlined at that time and described in their contract.

IMPLEMENTATION MONITORING PLAN

FISH IMPLEMENTATION MONITORING AND EVALUATION: TIER I

The Tulalip Tribes and project sub-awardees (Snohomish County, Snohomish Conversation District) will follow NOAA's Tier I monitoring guidelines to conduct pre and post barrier removal site monitoring including site passability, presence of targeted fish, operational cost assessment, safety, and community enhancement evaluations. Data will be collected, compiled, and stored following the Data Management Plan, and data will be made available on each of the listed Tier I metrics in a timely manner to NOAA representatives or others on an as needed basis.

NOAA TIER I MONITORING METRICS SUMMARY TABLE:

Metric	Method	Schedule		Target	References
		Pre	Post		
Channel Width	Average Measurement	Prior to Implementation	Soon Following Implementation	Emulate Natural Channel Width	Adjacent Channel Widths
Channel Slopes	Longitudinal Profile	Prior to Implementation	Soon Following Implementation	Emulate Natural Channel Slopes	Upstream Channel Slopes
Max Jump Height	Measured	Prior to Implementation	Soon Following Implementation	Emulate Natural Jump Height	Upstream Jump Height
Target Species Presence	Spawner Surveys; Electroshocking	Prior to Implementation	Until Detected Min 1yr max 3yr	Coho Presence Above Culvert	N/A
Costs	Calculate	Estimate 5-Year Cost With Dam	Estimate 5-Year Post-Dam	Reduced Cost With Removal	N/A
Safety	Describe	Prior to Implementation	Soon Following Implementation	Lower Hazard With Removal	N/A
Community Enhancement	Describe	Prior to Implementation	Soon Following Implementation	Enhancement Achieved	N/A

MONITORING METRICS:

1) **Site Passability:** A pre-implementation survey will be conducted at each site to document conditions before culvert barrier removal. Pre-implementation culvert passability impairment will be calculated using Level A and B culvert assessment criteria and all culverts will be ranked as either 0, 33, 66, or 100% impassible. Post implementation surveys will be conducted at each location soon after project

implementation to document as-built conditions and observe presence/absence of diadromous fishes within and upstream from each project area.

a. **Channel width** will be determined by taking the average of three measurements of the active channel width immediately within each barrier removal site. Pre-implementation measurements will be taken immediately upstream and downstream of the culvert to be removed and above/below the areas of influence created by pooling water or other artifactual habitat features created by the culvert itself.

b. **Channel gradient** will be determined by taking a longitudinal profile through the project reach, defined by the extent of barrier influence on channel and/or water surface slope. Average channel slope from just upstream of the influence of the barrier to just downstream of its influence (below the scour pool) will be determined. Areas of maximum channel slope pre- and post-implementation will be identified visually from plotted longitudinal profiles and then computed. Maximum channel slopes will be identified and computed for channel distances greater than 5-10 feet. Significant changes in channel elevation over shorter distances will be considered as jump heights (see below).

c. **Maximum jump height** is the largest abrupt discontinuity in the channel slope that would require a fish to jump to transit the site. These will also be identified visually from the pre-and post-implementation longitudinal profile plots and then measured, where applicable. Residual pool depths will be determined associated with these discontinuities to assess fish passage potential.

2) Presence of Target Fish Species

Coho and Chinook salmon are the primary target species for these projects and will be monitored for presence following culvert removal. Electrofishing surveys and spawning surveys may be conducted pre and post culvert removal along accessible habitats immediately upstream of the removed culvert(s). Photography of the site will be documented pre and post project to document geomorphological, habitat, or other changes over time.

3) Annual Operating and Maintenance Costs

a. Pre-implementation: We will calculate the expected average annual operating, maintenance, and/or liability costs over the next 5 year period if the barrier were to remain in place. Periodic or less frequent costs that may occur during this period (e.g. structural upgrades to meet safety or regulatory requirements) may be incorporated into the estimate.

b. Post-implementation: We will calculate the expected average annual operating, maintenance, and/or liability costs over the next 5 year period with the barrier removed.

4) Safety Hazard

a. Pre-implementation: We will describe the safety hazards caused by the culvert structures and how they will be eliminated or diminished through culvert removal and replacement for each location and structure to be modified.

b. Post-implementation: After implementation, we will confirm that the identified public safety hazard has been eliminated or diminished. The goal of each project implementation is to promote unimpeded natural processes of the stream course through the project area with no calculable manmade influence on the hydrologic functions of the waterway.

5) Community Enhancement

a. Pre-implementation: We will determine local community, civic enhancement associated with the barrier removal project.

b. Post-implementation: We will confirm that the enhancement associated with the barrier removal was realized.

Restoration Center Performance Progress Report
Terms and Definitions

A. Project Activities

Grant Administration:
Explain progress on the administrative activities required to adhere to Department of Commerce (DOC) and NOAA Terms and Conditions. These administrative activities include: submitting Award Action Requests, participating in the audit process, maintaining all project files including at a minimum: project work plans; copies of all federal and state permits/consultations associated with project implementation; and documentation of onsite construction supervision/project management (i.e.; performing oversight of sub-recipients and sub-contractors, etc.)

Data Management Plan:
The Data Management Plan is a required component of the application, and the plan is typically finalized during award negotiations. Please enter the date of acceptance for the plan. If revisions are required during the course of the award, please indicate. If your project generates environmental data under this award, please include the website address where the data will be shared. Guidelines for creating Data Management Plans can be found here: https://www.fisheries.noaa.gov/webdam/download/57228743.

FFATA Reporting Requirement:
The Federal Funding Accountability and Transparency Act (FFATA) requires Recipients to report on sub-awards greater than $30K within the FFATA Subaward Reporting System (https://www.fsrs.gov/). For more information, review your DOC Terms and Conditions (CD-450).

Selection of Sub-awards and/or Sub-contracts:
Note if /when the project is in the bidding phase (in progress), and when a contractor is selected (complete).

Photo Submission:
Provide high-resolution photos of before, during, and post-implementation phases of the project. Photos of the site prior to construction and during project implementation should be submitted with progress reports, or as requested by NOAA. Further guidance can be found in your Specific Award Conditions.

Partner Coordination:
Note the progress of coordination with necessary partners to complete the planned project, and indicate whether any problems have been encountered.

Landowner Coordination:
Note the progress of coordination with the landowner of the project site or adjacent properties (for example, right-of-way negotiations). If the Recipient is also the landowner, please indicate in the Explanation of Progress column.

Engineering and Design:
Document the progress on engineering and design drawings, if applicable. The percent design plan can be noted in the Explanation of Progress column.

Permitting and Compliance:
Ensure that implementation of the project will meet all permitting requirements as outlined in your Specific Award Conditions. Provide a list of Federal, tribal, state, and/or local permits acquired for this project, by email or letter to the NOAA Technical Monitor.

Construction:
Indicate the date that construction is anticipated to begin, and when it is anticipated to be complete. Use the Explanation of Progress column to provide details about the construction process.

Monitoring Activities:
Describe the status of pre- and post-implementation monitoring activities (i.e., not started, in progress, complete).

Adaptive Management or Maintenance Activities:
Describe any adaptive management or maintenance activities that were completed or are planned for the future, as applicable. For example, were activities modified to meet project goals? Were there additional activities completed to maintain the project and enhance its sustainability?

Outreach and Education and Volunteer Coordination:
Provide copies of final outreach products, website mentions, press materials, photos, etc. Otherwise, indicate if outreach projects or events are planned and provide details. Further outreach and education guidance can be found in your Specific Award Conditions.

Acknowledgement of Project Contributors:
State whether a publicly visible sign is planned and developed, that indicates the project has received funding from the NOAA Restoration Center. Further guidance is described in your Specific Award Conditions. This includes any signage requirements for the Bipartisan Infrastructure Law, if that's listed in your Specific Award Conditions.

Safety Plan and Briefing on Site:
Indicate whether a written safety plan is on file, as stated in your Specific Award Conditions.

Monitoring Plan and Monitoring Report:
Indicate the date of completion for the Monitoring Plan. If a standalone Monitoring Report will be submitted to NOAA, please indicate the date of submission. If monitoring results will be described within the progress report narrative rather than as a standalone report, please indicate the status. Information about monitoring and evaluation for restoration projects can be found here.

Improve Public Safety/ Removal of Pre-existing Safety Hazards:
Please consult with your award's Technical Monitor related to the specific Tier 1 Monitoring Guidance for your specific project type (as applicable).

Community Enhancement:
Please consult with your award's Technical Monitor related to the specific Tier 1 Monitoring Guidance for your specific project type (as applicable).

Foundations for Meaningful Engagement of Tribes or Underserved Communities (**NEW for 2023**)

The following text is intended to provide definitions as well as a non-comprehensive list of examples to aid grantees completing the meaningful engagement metric on progress reports. This section provides a list of all possible meaningful engagement categories, however, the project FPO will identify which categories are to be reported on for a specific project.

Strategic Foundation 1 (SF1): Underserved Community Identification

Describes the grantee's methodology and/or data of how they systematically identified underserved communities or tribes affected by this project. I.e.; the grantee demonstrated a systematic effort to identify or describe the underserved communities with potential nexus to the project site or project activities and/or service flows using existing data resources.

Examples:

- grantee used a GIS-based environmental justice screening tool to identify underserved communities likely to have environmental justice concerns in proximity to the project site. Example screening tools include but are not limited to: EPA's EJScreen, CEQ's CEJST, NFWF's CREST, and other state-based tools.
- grantees reviewed local archives, local census day from local governments/school districts, or other existing demographic and/or historical records used to identify communities with ties to the project site or related resources.
- grantee surveyed site visitors to identify relevant communities using the project site.
- grantee conducted interviews with local residents to identify communities with ties to the project site or related resources.
- Where the grantee has self-identified as an underserved community, the proposal provides a description of the local community - supported by local knowledge/histories/experience.
- grantee has otherwise solicited information from local residents and stakeholders to identify underserved communities following best practices.
- Documentation of this criterion could include adequate description of methodology and summary of findings.

Strategic Foundation (SF2): Barrier Identification

Describes how the grantee worked with underserved community members to address barriers to engaging in project planning and/or accessing benefits provided by the project. Provide lessons learned if applicable. In consultation with local community members, potential barriers keeping underserved communities from having the opportunity to meaningfully engage in and/or from accessing the project benefits have been evaluated and addressed wherever feasible.

Examples:

- grantee interviewed, conducted focus groups, held public meetings or otherwise directly engaged with community members to identify potential barriers following best practices.
- Documentation of this criterion might include adequate description of methodology, summary of findings, and description of how barriers were ultimately addressed.

Strategic Foundation 3 (SF3): Priority Alignment
Describes the needs of the underserved community, including how the grantee identified them and aligned project activities with these needs. Project demonstrates alignment with existing priorities and needs of local underserved community groups or tribal entity as stated in an organizational/government document/website.

Examples:

- Project incorporates goals and/or priorities of existing official planning document (e.g., watershed management plan), press-release, website developed by or endorsed by a representative community organization or tribal government entity.
- Project implements decisions recommended by community members during a previous and recent outreach effort (e.g., public meeting, focus groups, door surveys) where there is evidence that outreach effort was robust.
- Proposal describes early and robust engagement with the community to identify priority needs that align with intended project outcomes.
- Evidence of alignment might be established through a letter of endorsement and/or by clearly describing the community priorities, origin of priorities, and how project is in alignment.

Strategic Foundation (SF4): Strong Community Support
Describe the support received from a tribal government or underserved community organization affirming that the proposed project is in alignment with the needs of the tribe or underserved community. Project has been endorsed by (or application was submitted by) underserved community organization or tribal government affirming that the proposed project is in alignment with needs of the community/tribes they represent.

Examples:

- grantee or sub-grantee is a self-reported member or a group composed of members from an underserved population within a close geographic proximity and a clear nexus to the project. Examples: neighborhood association, grassroots organization, etc.
- grantee is a tribal government or tribal government endorsed representative organization.
- Organization with demonstrated record of working with the community/composed of community members endorsed project seeking funding.
- Through engagement with tribal government, grantees received Tribal government endorsement letters/official public statements endorsing the project.
- Documentation might include a letter of endorsement, news release, or other statement originating from the target underserved community or tribal government.

Strategic Execution 1 (SE1): Ongoing Community-based Decision-making
Describe how tribes or underserved community members are integral to the vision and are actively participating in project decision-making. Local underserved community members are integral to and actively participating in decision-making related to vision and execution of the project. Proposal clearly describes how community input is/will be incorporated into project decisions.

Examples:

- grantee has established, or plans to establish a Community Advisory Group or other governing body with decision making power where members are representative of the target underserved population(s).
- Proposal describes a series of workshops, interviews, and/or focus groups with underserved community members throughout the life of the project.
- Proposal describes a robust and ongoing outreach/engagement strategy intended to solicit input into decisions.
- Documentation might include: description of outreach efforts to date; an outreach plan describing planned efforts, explicitly stating what decisions community input will affect; an endorsement letter from community members and/or community organization being consulted by project team; advisory group charter with resumes/short bios of advisory group members, etc.

<u>Strategic Execution 2 (SE2): Compensation (decision-maker)</u>
Describes the ways in which the grantee has been compensating, such as through a paid position, tribal or underserved community members for their decision-making role in the project. Local member(s) from underserved communities are compensated/paid for their time in roles integral to project decision-making (priority setting, direction, vision).

Examples:

- Member(s) of underserved communities consulted for their knowledge of the community, local or tribal ecological knowledge, or other expertise are paid fair compensation for their time.
- Project includes paid position(s) or internship(s) whereby members of the underserved community are paid to make decisions regarding project vision, design, and/or direction.
- Documentation might include: published job posting description, compensation range, and short bio (s) of compensated community member(s). Ideally, documentation would also include a description of the recruitment process, and, if applicable, how the position is/was advertised in order to reach potential job grantees.

<u>Strategic Execution 3 (SE3): Compensation ("other" position)</u>
Describes the ways in which the grantee have been compensating tribal or underserved community members for their time in contributing to the project. Project creates jobs, employing member(s) from underserved communities - i.e. positions that fall outside of those captured in the "Compensation (Decision-maker)" criterion.

Examples:

- Project provides paid position(s) for local community members in areas including, but not limited to: project management, volunteer coordination, construction, engineering, DEIJ engagement, research and ecological monitoring etc.
- Project contracts with a local company with a Minority Business Enterprise certification (or equivalent certification).

- Documentation might include: published job posting description, compensation range, and employee bios. Documentation could also include a description of the recruitment process/ how the position is advertised in order to reach potential grantees.

Strategic Execution 4 (SE4): Professional Development
Describe how you have created opportunities for professional development of tribal, underserved or underrepresented community members. Project provides professional development opportunities to underserved or underrepresented community members.

Examples:
- Formal internship, formal job training, formal involvement of educational institutions through incorporation into curriculum, research project or field site; skilled-job training or apprenticeship.
- Documentation might include: description of opportunity, recruitment process and desired curriculum/internship/training learning outcomes; resumes or short bios of participants; and endorsement letters from partnering organizations receiving training.

Strategic Execution 5 (SE5): Outreach and educational programs
Describes how the grantee has collaborated with tribal or underserved community members to develop and incorporate outreach, education, volunteer, or hands-on opportunities that are tailored to meet the needs of their communities. Project collaborates with local underserved community members to incorporate volunteer, education and/or hands-on opportunities for their communities.

Examples:
- The grantee worked with a nearby school in a low-income district to develop a repeatable lesson plan and planned field trip to the restoration site.
- The grantee is working with community service organizations to develop specific volunteer/education/outreach activities that benefit underserved communities.
- A nearby nature center submits a letter of support describing plans to incorporate the restored site into ongoing outreach/education/volunteer programs for underserved populations
- Documentation of this criterion might include description of outreach activities, how the grantee will collaborate with local community members, and how the grantee will engage participants. Partners might provide endorsement letters describing their role/ commitments in implementation of this activity.

Domestic Sourcing Considerations:
Indicate how you have considered the Domestic Sourcing Specific Award conditions in purchasing iron, steel, manufactured products or construction materials for infrastructure projects. *Please consult with your award's Federal Program Officer to discuss the Build America Buy America requirements for your award.*

B. Performance Measures

Habitat Restored: (# acres)
Record the target and actual acres of habitat restored. For in-stream projects (e.g., large wood placement, side-channel habitat, reconnection or re-meander): to calculate the acres of habitat for large wood placement projects, consider the extent to which placement has resulted in maximum biological function. For projects that return a stream to its original channel (e.g., channel reconnection or re-meander): calculate in-stream acreage as length of modified channel by bankfull width, and if the reconnected floodplain will be used by target species, please include the impacted floodplain as freshwater wetland or riparian acres. *Please consult with your award's Technical Monitor for more information.*

Stream Habitat Made Available: (# miles)
Record the target and actual number of stream miles opened for fish passage. *Please consult with your award's Technical Monitor for more information.*

Volunteer Involvement (hours): (#)
Record the target and actual number of hours that volunteers provided to the project.

Volunteer Involvement (participants): (#)
Record the target and actual number of individual volunteers that participated on the project.

Guidance for Reporting Labor Hours and Expenses (**NEW for 2023**)
Bipartisan Infrastructure Law (BIL) grantees will be required to report two economic-related pieces of information in their Performance Progress Reports (PPRs):

1. *In each PPR, provide the number of labor hours supported by grant funds;*
2. *In the final PPR, report the NAICS (industry) code and county location for each activity supported by grant funds. Common NAICS codes for restoration activities can be found below.*

This information is important for NOAA's ongoing efforts to understand and communicate the value of habitat restoration projects to local communities and the economy.

Reporting Labor Hours (Jobs Created or Retained)

One indicator of the economic benefits of BIL grants is the number of people who are directly employed using grant funds. NOAA will use reported labor hours to track and report the number of jobs directly created or retained due to BIL grants. Grantees should report the cumulative labor hours supported by the BIL grant in Section B (Performance Measures) of their semi-annual PPRs, as shown in the example below. This should include all BIL-funded work by the grantee, subgrantees, and contractors.

Reporting labor hours of contractors and subgrantees

Grantees are responsible for reporting labor hours for contractors and subgrantees paid with BIL funds. As such, grantees are encouraged to discuss labor hour reporting requirements with their partners early in the project and arrange for contractors and subgrantees to track relevant hours worked. Contractors and subgrantees paid through fixed-price contracts may not routinely track labor hours spent on specific projects. If partners cannot track actual hours worked on the project, grantees may report partners' best estimate of labor hours.

Avoiding over-reporting

Grantees only need to report the cumulative labor hours worked on the project that were funded by the grant. They do **not** need to report:

- Work funded from other sources (e.g., a cash or in-kind match, leveraged funds);
- Labor hours separated by individual employees, organizations, or project tasks;
- Labor hours associated with overhead or indirect costs (i.e., administrative or other expenses of doing business not readily identified with a particular grant);
- Volunteer hours (though these may be reported separately);

Example: reporting labor hours

To illustrate the process for reporting labor hours, imagine that the following five people are working on a project supported by a BIL grant:

- Amy is an employee of the grantee and works on the project full time. However, the BIL grant only pays for 50% of her salary; the other 50% comes from a local government grant. The grantee should report *only* the labor hours supported by the BIL grant: 520 hours per six-month reporting period.
- Bill works for a subgrantee paid with BIL grant funds. He spends 10% of his time on the project: 104 hours per reporting period.
- Carla is a self-employed consultant hired through a fixed-price contract with BIL grant funds. Her bid for the contract was based on her hourly rate and the hours required for the contract tasks. Averaged over the term of the contract, Carla budgeted for 100 hours of work per reporting period.
- Desmond and Esther work for a contractor hired with BIL grant funds. The contractor's bid did not specify the labor hours required for contracted tasks, so the grantee reached out to the contractor to explain that a contract provision would be part of the contract to meet BIL reporting requirements and report estimated labor hours at the end of each reporting period. At the end of the first reporting period, the contractor estimated that Desmond and Esther had spent a combined 160 hours working on the project.

The grantee would report all five workers' labor hours funded by the BIL grant in its semi-annual PPR, as shown below. Note that the grantee does not need to separate hours worked by employee, organization, or task. The grantee is responsible for keeping the cumulative labor hours number up-to-date in subsequent PPRs.

B. Performance Measures						Click to Add New Performance Measure
1. Objective/Goal Description	2. Measure (Unit)	3. Baseline	4. Target Year	5. Target	6. Actual To Date (cumulative)	7. Explanation
Jobs supported by grant funds	Labor hours				884	Hours of work supported by grant funds through the end of the current reporting period.

Reporting Expenses with NAICS Codes

BIL habitat restoration spending will have local economic benefits beyond directly creating and retaining jobs. Grantees will spend part of their BIL budget on goods and services, indirectly benefiting those suppliers. For example, a small dam removal project might indirectly benefit firms supplying construction materials, fuels, rented equipment, and office supplies. Similarly, workers employed on BIL projects will spend a portion of their paychecks in the local economy. NOAA will use spending data from grantees to estimate BIL projects' overall impacts on employment and economic output. This analysis will provide important information about the value of restoration projects to communities, communicate those benefits, and identify restoration types that are particularly effective in supporting local jobs and businesses.

In addition to the requirement to summarize how grant funds were spent by object codes. BIL grantees will be required to provide a North American Industry Classification System (NAICS) code for each organization funded by the grant and the location (county) of that organization's work on the project. Grantees must submit this information in the Performance Measures (Section B) of their final PPR (the "final report"). However, grantees may find it useful to identify NAICS codes and work locations as they implement tasks rather than waiting until the end of the project.

NAICS is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. The U.S. Census Bureau maintains NAICS reference and guidance documents at https://www.census.gov/naics/. Note that NAICS codes are assigned to businesses, not individual workers. As such, BIL grantees only need to identify the code associated with the primary activity of organizations working on the project, even if employees with many different specialties worked on the project.

Common NAICS codes for habitat restoration projects

Several frequently-used NAICS codes are listed below. Please note, however, that this list does not include all potentially-relevant codes. If an organization working on your project does not clearly fall within one of the industries listed below, please visit https://www.census.gov/naics/ for a full, searchable guide to NAICS codes.

NAICS Code	Industry
237990	Other Heavy and Civil Engineering Construction *(includes anchored earth retention, dredging, flood control project construction, marine construction, outdoor recreation facilities construction, pier construction, seawall and wave protection)*
238910	Site Preparation Contractors *(includes culvert or bridge removal, dam or dike removal, excavation, and grading)*
237310	Highway, Street, and Bridge Construction
541330	Engineering Services
541620	Environmental Consulting Services *(includes ecological restoration consulting, site remediation consulting, and wetland restoration planning)*
541690	Other Scientific and Technical Consulting Services *(includes agricultural, biological, economic, horticultural, and hydrology consulting)*
562910	Remediation Services *(includes environmental remediation, hazardous material storage tank removal and disposal, oil spill cleanup, soil remediation, and toxic material removal)*
813312	Environment, Conservation and Wildlife Organizations
813319	Other Social Advocacy Organizations *(includes community action, hunting, fishing, neighborhood development, social change, and social service advocacy organizations)*
924120	Administration of Conservation Programs *(includes conservation and reclamation agencies, fish and game agencies, land management program administration, and government recreation programs)*
112512	Shellfish farming
115310	Support Activities for Forestry *(includes forestry services and reforestation)*

Reporting work location(s)

The grantee should identify a work location for each organization receiving BIL grant funds. The work location is the county where most of that organization's grant-supported work took place: typically the county containing the project site(s) or the county containing the organization's offices.

Grantees may list multiple work locations for an organization if it performed major grant-supported work in more than one county (e.g., for projects with multiple work sites). However, they should list only the counties most relevant to the organization's work on the project; it is not necessary to include all counties where grant-related activities took place or grant funds were spent.

Example: reporting expenses with NAICS codes on the final report

For example, imagine that the BIL grantee is a conservation nonprofit based in Alpha County, DE that led the removal of a small dam in nearby Beta County. The nonprofit was responsible for project oversight, public engagement, and post-project monitoring. It hired a local contractor to deconstruct the dam and an out-of-state contractor to develop engineering plans. The grantee's NAICS code is 813312 (Environment, Conservation and Wildlife Organizations). The construction and engineering contractors fall under NAICS codes 238910 (Site Preparation Contractors, which includes dam removal) and 541330 (Engineering Services), respectively.

The grantee would report the total amounts spent from the BIL grant by each organization in Section B of its final PPR. They should include the NAICS code, work location, and amount spent by each organization. Note that the table below lists a single NAICS code and a single dollar amount for each organization; grantees do not need to report NAICS codes and costs for each project task. In this example, the list of work locations includes the county containing the dam removal site, as well as the county containing the home offices of the grantee and one of its contractors. The grantee lists Alpha and Beta Counties as its work location because it performed major grant-funded work in both counties. Project oversight took place at its headquarters in Alpha County; public engagement and post-project monitoring took place at and near the project site in Beta County. The work location for the local construction contractor is Beta County (the dam removal project site). The out-of-state engineering contractor's work location is the county containing its offices.

B. Performance Measures

Click to Add New Performance Measure

1. Objective/Goal Description	2. Measure (Unit)	3. Baseline	4. Target Year	5. Target	6. Actual To Date (cumulative)	7. Explanation
BIL grant spending: Home County Land Conservancy (grantee)	$				$500,000	NAICS CODE: 813312 WORK LOCATION: Alpha County, DE and Beta County, DE
BIL grant spending: X & Y Construction	$				$1,000,000	NAICS CODE: 238910 WORK LOCATION: Beta County, DE
BIL grant spending: ABC Engineering	$				$500,000	NAICS CODE: 541330 WORK LOCATION: Gamma County, FL

Questions

Federal Program Officers and Technical Monitors are grantees' principal points of contact for questions about monitoring and reporting requirements. Grantees may also contact the Restoration Center Economist (James Maples - james.maples@noaa.gov) about reporting jobs and expenses.

****

The project activities listed below are options to be included in a progress report form based on the scope of project activities. The Federal Program Officer, the Technical Monitor, and the grantee will determine which metrics are appropriate.

<u>Generic Performance Measures</u>

<u>Implementation Metrics</u>:
Provide the metrics collected for the implementation. Please note which metrics were used.

<u>Basic Effectiveness Metrics</u>: (E.g. fish presence/absence)
What type of monitoring was conducted to show the project was effective at meeting its stated goals? Add comments if the project was not implemented as designed.

<u>ESA Recovery Plan Actions Addressed</u>: (#)
How many ESA Recovery Plan actions are addressed through this project? In the comments, please identify the name of the Recovery Plan and the action(s) the project activities contribute to or address.

<u>Fishery Management Plan Actions Addressed</u>: (Y/N)
Is a Management Plan action addressed? In the comments, please identify which action(s).

NOAA Fisheries WCR Anadromous Salmonid Design Manual - NMFS 2022

NOAA FISHERIES

NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual

Authors

National Marine Fisheries Service
West Coast Region
Environmental Service Branches

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

For questions or to provide comments please contact the following:

For Washington, Oregon, and Idaho:

NOAA Fisheries West Coast Region
Environmental Services Branch
1201 Northeast Lloyd Boulevard, Suite 1100
Portland, Oregon 97232

503-230-5400

For California:

NOAA Fisheries West Coast Region
Environmental Services Branch
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

707-387-0737

Web address:
http://www.westcoast.fisheries.noaa.gov/

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Acknowledgments

These engineering guidelines were developed through decades of work conducted by past and present NMFS fish passage engineers and biologists who laid much of the foundation for this document. We are grateful for their hard work and dedication. We also thank the numerous tribal, agency, and utility researchers; biologists; and engineers who contributed to an improved understanding of how juvenile and adult salmonids behave when approaching and passing structures. The state of knowledge on fish passage engineering has improved substantially over the course of developing these guidelines and will continue to do so over time as new engineering designs, evaluation techniques, and methods are developed and tested. We are also grateful to our reviewers who took the time to provide thoughtful and constructive comments to assist in updating these guidelines.

Acronyms and Abbreviations

Symbol or Acronym	Term or Title
°C	degrees Celsius
°F	degrees Fahrenheit
ASP	Alaska steeppass
AWS	auxiliary water system or auxiliary water supply system
BOR	U.S. Bureau of Reclamation
ft^3/s	cubic feet per second
EDF	energy dissipation factor
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FERL	Fisheries-Engineering Research Laboratory
FPA	Federal Power Act
ft^2	square foot
ft^3	cubic foot
ft/s	foot per second
$ft\text{-}lb/ft^3/s$	foot pounds per cubic foot of flow per second
GCF	grade control fishway
gpm	gallon per minute
HDM	Hydraulic Design Method
HGMP	Hatchery and Genetic Management Plan
lb	pound
LSSS	Low Slope Stream Simulation
MSA	Magnuson-Stevens Fishery Conservation and Management Act
mm	millimeter
NMFS	National Marine Fisheries Service

Symbol or Acronym	Term or Title
NOAA	National Oceanic and Atmospheric Administration
O&M	operations and maintenance
PIT	passive integrated transponder
R/D	ratio of radius of curvature to pipe diameter
SSD	Stream Simulation Design
USACE	U.S. Army Corps of Engineers
VFD	variable frequency drive
WCR	West Coast Region

1 Introduction

The Environmental Service Branches provide technical and engineering assistance to National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) West Coast Region (WCR) fisheries biologists. NMFS also plays a supportive and advisory role in the management of living marine resources in the areas under state jurisdiction. This document is intended to assist with improving conditions for salmonids that must migrate past barriers to complete their life cycle. Effective Fish passage requires the integration of numerous scientific and engineering disciplines including, but not limited to, fish behavior, ichthyomechanics, hydraulics, hydrology, fluvial geomorphology and engineering. Installing a fish passage structure does not constitute providing satisfactory fish passage unless all of the above components are adequately factored into the design.

This document is intended to: provide internal assistance to NMFS biologists in designing effective fish passage; encourage consistency across the WCR region; while supporting the implementation of NMFS's statutory authorities related to the conservation and protection of marine resources; and provide technical assistance to project proponents.

The efficacy of any fish passage structure, device, facility, operation, or measure is highly dependent on local hydrology, target species and life stage, obstacle orientation relative to the stream, facility operation, and many other site-specific considerations. While the information provided herein will apply to many structures, it should be regarded as general guidance for the design, operation, and maintenance of fishways throughout the WCR. The criteria described in this document are not universally applicable and should not replace site-specific recommendations.

This document provides general guidance and is not intended as an alternative to active consultation with NMFS biologists and engineers. Application of these criteria in the absence of consultation does not imply approval by NMFS. This document provides criteria and additional guidelines for the design and operation of facilities at barriers to fish migration and water intakes in California, Washington, Oregon, and Idaho. The facilities are designed to create safe passage routes for adult and juvenile salmonids in rivers and streams and through reservoirs, restore habitat connectivity within watersheds, and enhance salmonid population productivity. NMFS's manual for fish passage facility design is meant to help NMFS staff advise project applicants on the engineering design of future fish passage projects and modifications to existing projects. The criteria are based on decades of experience developing, testing, operating fish passage systems and relies on the best available scientific information.

The WCR has developed a flow chart for how to use their various fish passage guidance documents (Figure 1). Prior to designing a fish passage facility, NMFS recommends the project proponent familiarize themselves with the "NOAA Fisheries WCR Guidance to Improve the Resilience of Fish Passage Facilities to Climate Change" (Improving Resilience) guidance document. The Improving Resilience document outlines how to incorporate projected future flows the facility may experience over the life of the project and should be the starting point for the design process.

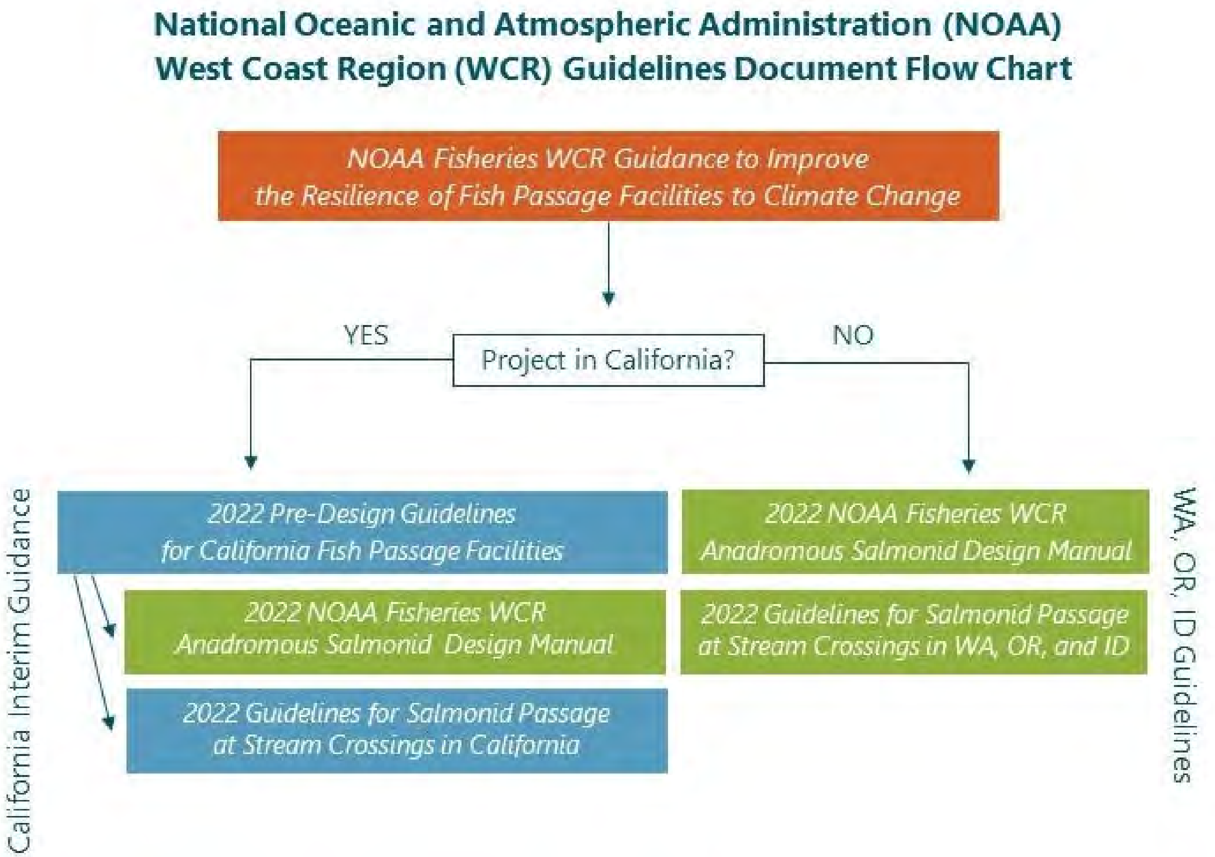


Figure 1-1. West Coast Region Fish Passage Guideline Flow Chart

In 2013, the Northwest and Southwest regions of the National Oceanic and Atmospheric Administration's (NOAA) NMFS were merged to form the WCR. This document is the first step in integrating fish passage design criteria and guidelines of the two former regions. This document, *NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Guidelines* supersedes the following documents:

- Northwest Region's *Anadromous Salmonid Passage Facility Design*, dated July 2011
- Southwest Region's *Fish Screening Criteria for Anadromous Salmonids*, dated January 1997
- Southwest Region's Experimental Fish Guidance Position Statement, dated January 1994
- Southwest Region's Water Drafting Specifications, dated August 2001

This document provides criteria and guidance for passage of anadromous salmonids only. For additional passage guidance concerning non-salmonids, refer to applicable state and federal entities.

This document contains introductory chapters, technical chapters, and appendices. The introductory chapters (Chapters 1 and 2) provide the statutory and biological background for the requirement to provide safe, timely, and effective passage of salmonids around barriers and definitions of key terms. The technical chapters (Chapters 3 through 10) present design criteria and guidelines that result in hydraulic conditions salmonid fish require to successfully pass barriers and minimize effects to salmonid populations, along with the scientific basis for criteria for which applicable references are available. The appendices provide information on aspects of fish passage facility design that are under development and may change over time after additional testing. Additionally, the appendices contain background information that was removed from the technical chapters to make the chapters more streamlined, but still needs to be available to the reader because the information is informative and relevant.

Throughout the chapters all criteria are italicized to be easily identifiable. In addition, chapter and appendix sections are cross-referenced where applicable. For example, the chapter on screens may direct the reader to the chapter on design flows so a reader interested in screens will understand that additional information is available in another chapter.

NMFS has separated these fish passage engineering guidelines into two volumes. This first volume entitled *NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual* provides design guidance for structural fish passage, protection, and exclusion projects not associated with river or stream crossings. This first volume represents guidelines that are based on decades of research, monitoring, and NMFS' experience with these types of passage systems. NMFS considers material in this volume to be in a mature state and does not anticipate it will change significantly over time.

The guidance in Chapter 4 of this volume applies to projects located in Washington, Oregon, and Idaho over the range of anadromous salmonid habitat in those states. Due to significantly different hydrologic conditions in California and those conditions impact on life history of NMFS trust species, project proponents should work with NMFS engineering staff to determine the appropriate design flows following the 2022 Pre-Design Guidelines for California Fish Passage Facilities.

The second volume, entitled *Guidelines for Salmonid Passage at Stream Crossings in Oregon, Washington, and Idaho* (NMFS 2022b) represents a growing body of work relating to fish passage at stream crossings that NMFS expects will expand significantly in the future. Separating these guidelines into two volumes will allow NMFS to refine and expand this additional volume in the near future as new information becomes available, without having to reopen and modify the entire guidelines document. NMFS 2022b includes introduction matter as well as two technical chapters relating to stream crossings and grade control fishways.

The guidance in Chapters 3 and 4 of NMFS 2022b applies to projects located in Washington, Oregon, and Idaho over the range of anadromous salmonid habitat. Given significantly different hydrologic conditions, stream crossing projects in California should refer to: *Guidelines for Salmonid Passage at Stream Crossings in California* (NMFS 2019, addendum).

These criteria and guidelines were developed based on 60 years of agency experience in creating successful fish facility designs and have been further refined through a collaborative process with regional fish facility design experts. The criteria and guidelines in Volume 2 address more emerging fields of fish passage engineering and stream restoration. The criteria and rationale provided will be revised as needed if new information suggests that updated criteria would further improve passage conditions for fish.

1.1 Statutory Background

NMFS is mandated by U.S. Congress to manage, conserve, and protect living marine resources within the U.S. Exclusive Economic Zone. NMFS is authorized to conduct these actions under the Federal Power Act (FPA; administered by the Federal Energy Regulatory Commission [FERC]), the Fish and Wildlife Coordination Act (administered by the U.S. Fish and Wildlife Service), the Endangered Species Act (ESA), and the Magnuson-Stevens Fishery Conservation and Management Act (MSA). This document provides criteria and technical assistance to project proponents on the design of fish passage facilities in order to provide safe, timely, and effective fish passage, consistent with NMFS responsibilities under the ESA, FPA, and MSA.

The requirement of safe, timely and effective passage derives from the unofficial but reliable definition of a fishway presented by Congress in a report related to the Energy Policy Act of 1992. The definition of "safe and timely passage" was expanded to include both passage structures and operations "necessary to ensure the effectiveness" of such structures. None of the terms "safe," "timely," or "effective" are further defined. However, in practice NMFS typically includes provisions which give these terms meaning. Regarding "safe" passage, NMFS requires licensees to design and operate their fishways so that they minimize the occurrence of injury or mortality experienced by fish while attempting to utilize the fishway. Regarding "timely" passage, a fishway prescription may include provisions for reducing the time in which a fish utilizing the fishway is subjected to stressful interactions, such as time spent in a trap or in transit, or a requirement for flows which will attract fish to a passage facility. Regarding "effective" passage, NMFS typically includes provisions requiring the operator to ensure that its facility succeeds in passing as close to 100% of the fish attempting to migrate through the system as possible.

Following these criteria will likely streamline processes, improve certainty, and improve the likelihood of success. NMFS also provides support and advice to states regarding the management of living marine resources in areas under state jurisdiction. This includes salmon (*Oncorhynchus spp.*) and steelhead (*O. mykiss*) due to their economic, cultural, recreational, and symbolic importance to society (NRC 1996).

NMFS pursues fish passage to contribute to its fishery management and ESA recovery goals. In reviewing, planning, designing, and implementing fish passage facilities, NMFS engineers will coordinate with NMFS biologists to make sure the particular target species, population numbers, migration timing and recovery goals are met.

1.2 Biological Background

Fish species within the family Salmonidae spawn in fresh water. Some species spend their entire lives in fresh water. Others spend a portion of their lives in marine waters where they grow and become sexually mature before returning to fresh water to spawn (Quinn 2005). The life history pattern that involves marine residence is known as anadromy, and salmonid species that display this pattern are referred to as anadromous salmonids.

NMFS has identified several key parameters that are used to judge the overall status and viability of salmon and steelhead populations. These include abundance, genetic diversity and life history diversity, productivity, and spatial structure (McElhany et al. 2000). NMFS considers a population to be viable if over a 100-year timeframe it can withstand threats and the risk of extinction from demographic variation, local environmental variation, and genetic diversity changes (McElhany et al. 2000). For examples of how these population parameters are used in viability assessments and recovery planning, see Lindley et al. (2007) and NMFS (2014). NMFS assesses any effects of barriers to migration and water intake structures on anadromous salmonids in the context of these parameters and overall population viability. The viability parameters are briefly described as follows:

<u>Abundance.</u> This is a commonly used species conservation and management parameter that refers to the number of organisms in a population.

<u>Genetic diversity and life history diversity.</u> Diversity refers to the distribution of traits within and among populations, which range in scale from DNA sequence variation at single genes to complex life history traits (McElhany et al. 2000). Genetic diversity and life history diversity are interrelated; thus, this parameter is not as straightforward as abundance. For example, a unique characteristic of anadromous salmonids is their high degree of fidelity to natal streams or rivers (Quinn 2005), which is a genotypic trait. This trait in turn facilitates local adaptations that result in phenotypic expressions of highly variable life history patterns (Taylor 1991; Waples 1991).

Life history diversity is often cited as a crucial component of salmonid population resiliency. This is based on evidence that maintaining multiple and diverse salmon stocks that fluctuate independently of each other reduces extinction risk and long-term variation in regional abundances (Roff 1992; Hanski 1998; Hilborn et al. 2003). Schindler et al. (2010) describe this as the portfolio effect, where risk is spread across multiple stocks. Preserving and restoring life history diversity is an integral goal of many salmonid conservation programs (Ruckelshaus et al. 2002). In addition, it is increasingly recognized that strengthening a population's resilience to environmental variability, including climate change, will require expanding habitat opportunities to allow a population to express and maintain its full suite of life history strategies (Bottom et al. 2011).

<u>Productivity.</u> Productivity represents the ability of a population to grow when conditions are suitable, which is essential to conservation success. In the absence of density-dependent factors, productivity is a measure of a population's ability to survive to reproduce and its reproductive success (McElhany et al. 2000). Populations that are below cohort replacement rate

or have limited ability to respond to favorable environmental conditions are less viable and at higher risk of extinction.

Spatial structure. This parameter refers to the geographic distribution of individuals in a population or populations. A population's spatial structure comprises the geographic distribution of individuals and the processes that generate that distribution (McElhany et al. 2000). The structure of a population depends on the quality of habitat available to the population, how the habitat is configured spatially, the dynamics of the habitat, and the dispersal characteristics of individuals in the population among the available habitats (McElhany et al. 2000).

The viability of salmonid populations can change over time, and NMFS considers the potential for this to occur when reviewing fish passage designs. Changes in population viability could occur from multiple factors, including the following:

- Terminating or adding new hatchery supplementation programs
- Recolonization of historical habitats after removal of a migration barrier
- Increased partitioning of the spatial structure of a population due to new barriers being installed and loss of access to habitat
- Habitat degradation and restoration
- Shifts in river hydrology and water temperature due to climate change
- Disasters (fires, landslides, etc.)
- Changes in water management

1.3 Migration Barriers

Anthropogenic barriers include, but are not limited to, hydroelectric dams, water storage projects, irrigation diversions, water withdrawals, and tide gates. Dams can have significant effects on the structure and function of river ecosystems (Ward and Stanford 1979), and change in flow regulation is considered one of the most pervasive changes to rivers worldwide (Stanford et al. 1996). The effects of restricted access to migrating fish caused by dams and weirs have been broadly implicated in population declines of freshwater species around the world (Northcote 1998).

Dams can block access to habitat, eliminate habitat in the footprint of a dam and reservoir, affect the amount and timing of water flow, and result in mortality during passage (Ruckelshaus et al. 2002). Columbia River dams have blocked access to nearly 40% of the habitat historically available to salmon (NRC 1996). Construction of Hells Canyon Dam resulted in the loss of 90% of the historical spawning habitat of fall-run Chinook salmon (*O. tshawytscha*) in the Snake River, Idaho (McClure et al. 2001). In California, approximately 95% of Chinook salmon spawning habitat has been lost or is no longer accessible (Yoshiyama et al. 1996). Smaller water diversions can block access to habitats as well as cause mortality from entrainment at unscreened (or improperly screened) diversions and predation above or below the diversion. Another example, is the substantial amount of historical spawning and rearing steelhead habitat rendered unavailable in the Santa Clara River (due to the construction of dams). Santa Felicia Dam blocks 95% of the steelhead habitat within the Piru Creek watershed; more than 30 miles of stream lies between Santa Felicia Dam and Pyramid Dam (NMFS 2006 and references therein).

Dams blocking passage of steelhead to upstream habitats constitute an obstruction within a freshwater migration corridor for the species and, therefore, an impact to steelhead habitat.

In summary, some anadromous salmonid populations migrate hundreds of miles in fresh water, and barriers in their migration corridors can affect population viability (Ruckelshaus et al. 2002). This includes barriers that are complete blockages as well as barriers that are partial blockages due to localized hydraulic conditions or poorly functioning passage facilities. NMFS is responsible for evaluating the degree to which barriers affect anadromous salmonid populations and providing guidance on how to resolve any migration effects.

1.4 Design Process

Resolving effects on salmonid migrations from barriers involves the integration of information on fish behavior and physiology, biomechanics, hydraulic and hydrologic conditions, and civil engineering. Simply installing a fish passage structure does not constitute providing satisfactory fish passage. A successful design requires that information on each of these components be factored into the design.

Instances can also occur where a fish passage facility may not be a feasible solution for correcting a passage impediment due to biological, societal, or economic constraints. In these situations, removal of the impediment or altering project operations may be a suitable surrogate in lieu of constructing fish passage facilities (Clay 1995).

When determining whether NMFS will promote or prescribe solutions to fish passage issues, NMFS will rely on a collaborative approach that considers the views of other fisheries resource agencies, Native American tribes, non-governmental organizations, citizen groups, and other governmental agencies. The approach strives to consider fish passage objectives developed by other parties (e.g., well-placed stakeholder groups) to support fisheries restoration and habitat enhancement actions identified in conservation plans.

This document addresses design features that may provide for to the safe, timely, and effective passage of fish. It is the responsibility of the design engineer to ensure that other design requirements are met such as the structural integrity of the facility and public safety.

This document provides specific fish passage facility design criteria and technical assistance for actions within the WCR pertaining to the various authorities of NMFS. When reviewing fish passage proposals by project proponents, NMFS will apply the criteria to major upgrades to existing facilities and the design of new fish passage facilities to the extent practicable. Existing facilities that are not compliant with this document may have to be modified using the criteria identified herein if fish passage problems are observed at these facilities. If the project is unable to meet the criteria, then the project proponent should continue to work with NOAA staff in developing a recommended solution that would best attain fish passage goals for the project.

1.5 Experimental Technologies

Experimental technologies include devices or systems that have demonstrated some potential for protecting or passing fish, but for which adequate scientific evidence has not been collected to verify effectiveness and gain agency acceptance or to be considered for general application (AFS 2000). Experimental technologies are new, innovative and unproven technologies that could be broadly applied, rather than deviations from criteria applying to a single site.

NMFS considers experimental technologies to include designs with major departures from conventional fish passage technologies as covered in this document. Experimental technologies may also include application of proven techniques to unusual environmental conditions or facility operations. Site specific deviations from criteria may not rise to the level of experimental designs, but rather warrant a conversation between the applicant and appropriate NMFS staff.

Proponents of experimental fish passage designs should provide NMFS with a sound biological or scientific basis to support the proposed design. This may include the following proof-of-concept steps as appropriate:

- A demonstrated, favorable fish behavioral response in a laboratory setting
- An acceptable plan for evaluating the prototype installation
- An acceptable alternate fish passage design developed concurrently with the unproven fish passage design that satisfies the criteria listed herein, should the prototype not perform as anticipated nor adequately protect fish

Appendix C (Experimental Technologies) provides additional information on the NMFS approval process for unproven fish passage technologies.

1.6 Temporary and Interim Passage

Where construction and/or modifications to artificial impediments (e.g., dams), natural impediments (rockslides, other natural issues) or upstream passage facilities are planned, upstream and downstream passage may be adversely impacted or interrupted. If possible, these activities should be scheduled for periods when migrating fish are not present, as specified in the in-water work period allowable for construction of facilities in streams. However, this may not always be possible or advisable. In these cases, an interim fish passage plan should be prepared and submitted to NMFS for review, in advance of work in the field.

In the interim plan, upstream and downstream fish passage should be provided for any adult or juvenile fish likely to be present in the action area during construction, unless passage did not exist before construction or where the stream reach is naturally dry at the time of construction. Methods for work area isolation and dewatering, as necessary, should be determined in consultation with NMFS.

Design criteria listed elsewhere in this document also apply to the interim passage plan. Where this is not possible, project owners should seek NMFS review of alternate interim fish passage design criteria, and a final interim passage plan. Coordination with NMFS ahead of time is advised to determine appropriate work windows and other recommended alternatives or both.

1.7 Section 7 Consultation under the Endangered Species Act

This fish passage manual can be useful during ESA Section 7(a)(2) and Essential Fish Habitat (EFH) consultations. Incorporating the criteria within this document will help project proponents design projects that provide fish passage in a variety of situations. During the design process project developers can incorporate criteria within this document and work with NMFS engineers and biologists to ensure their projects meet these fish passage criteria. While this document provides substantial criteria related to fish passage, there are aspects of project design that are beyond the scope of this document. For instance, this manual does not identify or endorse specific construction best management practices. Project developers should coordinate with NMFS on project elements that fall outside the scope of this document.

This manual can also be used to achieve regulatory streamlining by aiding in the development of programmatic ESA and EFH consultations on activities involving fish passage. By incorporating these criteria into programmatic actions, action agencies and other stakeholders can help ensure their actions provide fish passage and appropriate conservation for protected resources, while streamlining the regulatory process.

1.8 Additional Information

Additional information on fish passage is available at the WCR website: http://www.westcoast.fisheries.noaa.gov/. Questions regarding this document and requests for assistance from NMFS fish passage specialists can be directed to the following offices:

For Washington, Oregon, and Idaho:

NOAA Fisheries West Coast Region
Environmental Services Branch
1201 Northeast Lloyd Boulevard, Suite 1100
Portland, Oregon 97232

503-230-5400

For California:

NOAA Fisheries West Coast Region
Environmental Services Branch
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

707-387-0737

2 Definition of Terms

***Anadromous* –** pertaining to a fish species that displays the life history pattern known as anadromy in which adults spawn in fresh water and juveniles migrate to sea to grow to their final size and then return to fresh water to spawn (Quinn 2005).

***Active screens* –** juvenile fish screens equipped with efficient mechanical cleaning capability that are automatically cleaned as frequently as necessary to keep the screens free of any debris that may restrict flow through the screen area. NMFS requires active screen designs in most cases.

***Applicant* –** a person or entity that proposes to design, modify, or construct a fish passage facility at an existing or new barrier, water diversion, or water conveyance that NMFS will review under its authorities identified in Chapter 1.

***Approach velocity* –** the vector component of canal velocity that is normal (perpendicular) to, and immediately upstream of, the screen surface. Approach velocity is calculated based upon the submerged area of the screen for conical screens, all cylindrical screens (torpedo, T-screen, and end-of-pipe or hose screens) where submergence and clearance criteria are met, and inclined screens where angle and submergence requirements are met. For rotary drum screens, approach velocity is the vector component of canal flow velocity that is normal to, and immediately upstream of, the vertical projection of the screen surface.

Approach velocity is a design parameter that is used to calculate the minimum amount of effective screen area required to protect fish. The amount of effective screen area required to meet screen performance criteria is calculated by dividing the maximum diversion flow by the approach velocity. Approach velocity can be measured in the field with precise flow measurement equipment, and average operating approach velocity can be calculated by dividing the measured screen flow by the effective screen area. Approach velocity should be measured as close to the boundary layer of turbulence generated by the screen face as is physically possible. Chapter 8 provides a more detailed discussion of approach velocity.

***Apron* –** a flat or slightly inclined slab of concrete below a flow control structure that provides erosion protection and produces hydraulic characteristics suitable for energy dissipation or, in some cases, fish exclusion.

***Attraction flow* –** flow that emanates from a fishway entrance with sufficient velocity and quantity, and in the proper location and direction, to attract upstream migrants into the fishway entrance. Attraction flow consists of gravity flow from the fish ladder and any auxiliary water system (AWS) flow added at points within the lower fish ladder.

***Auxiliary water system or auxiliary water supply system (AWS)* –** a hydraulic system that augments fish ladder flow at various points in a passage facility for upstream migrating fish. Large amounts of auxiliary water flow are typically added near the fishway entrance pool to increase the amount of attraction flow emanating from the fishway entrance and the attractiveness of the entrance to fish.

Backwash **–** a system that removes debris from dewatering screens by using pressurized flow against the screen surface in the opposite direction of the approach flow.

Backwater **–** a condition whereby a hydraulic drop is influenced or controlled by a water surface control feature located downstream of the hydraulic drop.

Baffles **–** physical structures placed in the water flow path designed to dissipate energy or redirect flow to achieve more uniform flow conditions.

Bankfull flow– the bank height when a stream or river channel is inundated under a flow that occurs at the 1.2-year to 1.5-year average flood recurrence interval. Bankfull height may be estimated by morphological features in the channel such as: 1) a topographic break from a vertical bank to a flat floodplain or from a steep to a gentle slope; 2) a change in vegetation from bare ground to grass, moss to grass, grass to sage, grass to trees, or no trees to trees; 3) a textural change of depositional sediment; 4) the elevation below which no fine debris (e.g., needles, leaves, cones, seeds) occurs; and 5) a textural change of fine sediment deposits (matrix material) between cobbles or rocks.

Bedload **–** sand, silt, gravel, soil, and rock debris transported by moving water on or near the streambed.

Bifurcation (trifurcation) pools **–** pools in a fish ladder below which the fish ladder (and flow) is divided into two or three separate routes.

Brail **–** a device that is moved upward (vertically) through a water column to crowd fish into an area for collection.

Bypass flow **–** in the context of dewatering screen design, the portion of diverted flow that is specifically used to return fish to the river.

Bypass reach **–** the portion of the river between the point of flow diversion and where bypassed flow and fish are returned to the river.

Bypass entrance **–** an unscreened opening in a facility that fish can enter, and after which are conveyed in flow to a sampling facility or back to the stream or river. The number and locations of entrances at a facility can range from one to several and are discussed in Chapter 8.

Bypass system **–** the component of a downstream fish passage facility that conveys (transports) fish from the diverted flow back into the body of water from which they originated. Bypass systems typically consist of entrance, conveyance (flume or pipe), and outfall structures.

Canal velocity **–** the water particle speed (feet per second) in a canal flowing parallel to the streambank.

Channel bed width **–** the width of the streambed under bankfull channel conditions.

Conceptual design **–** an initial design concept based on the site conditions and biological needs of the species intended for passage, also sometimes referred to as preliminary design or functional design. This is the first phase in the design process of a fish passage facility and is discussed in Chapter 3.

Crowder **–** a combination of static or mobile panels installed in a fishway, raceway, or holding pool for the purpose of moving fish into a specific area for sampling, counting, broodstock collection, or other purposes. Crowder panels are usually porous and constructed of perforated plate or picket bars. The panels can also be fabricated using solid, non-porous materials. Also, see the definition for picket leads in this chapter.

Diffuser **–** a system of hydraulic components arranged to control water flow rate and convert high-velocity, high-pressure, non-uniform flow into low-energy, uniform flow. A diffuser also includes one or more panels of narrowly spaced horizontal or vertical bars to prevent fish from passing through the bars and entering the area upstream of the panels.

Distribution flume **–** a channel used to route fish to various points in a fish trapping system.

Effective screen area **–** the total wetted screen area minus the area occluded by major structural elements.

End of pipe screen **–** juvenile fish screening devices attached directly to the intake of a diversion pipe.

Entrainment **–** the diversion of fish into an unsafe area or passage route.

Exclusion barriers **–** facilities that prevent upstream migrants from continuing to migrate upstream. These are typically used to prevent fish from entering areas that have no egress route or may result in fish being injured.

Exit control section **–** the upper portion of an upstream passage facility that provides suitable passage conditions to accommodate varying forebay water levels. Water level fluctuation is accommodated by adjusting the pool geometry and weir design, and by adding or removing flow at specific locations.

False weir **–** a specialized floor diffuser used to introduce water at the top of a fishway or entrance to a distribution flume for the purpose of attracting and encouraging fish to move into a specific area. The device usually creates a strong upwelling flow that cascades over a weir. Fish are attracted to the cascading flow and swim through the upwelling into a distribution flume.

Fish ladder **–** the structural component of an upstream fish passage facility (or fishway) that allows fish to move over a barrier by dissipating the potential energy caused by the head differential that results from a barrier being placed in a waterway. The ladder dissipates energy using a series of discrete pools, a series of baffled chutes and resting pools, or uniformly with a single baffled chute placed between an entrance pool and an exit pool.

Fish lift **–** a mechanical component of an upstream passage system that provides fish passage by lifting fish in a water-filled hopper or other lifting device into a conveyance structure that delivers upstream migrants past the impediment.

***Fish lock* –** a mechanical and hydraulic component of an upstream passage facility that raises fish over a dam by attracting or crowding fish into a chamber, closing access to the chamber, and filling the chamber until the water surface in the lock chamber reaches (or comes sufficiently close to) the reservoir forebay level. Once at this water surface elevation, a gate to the chamber is opened, allowing fish to swim into the reservoir above the dam (Clay 1995). Fish locks can also be used as part of a trap and haul system to lift fish from the river level to a higher elevation for sorting, or transportation, or both.

***Fish passage season* –** the range of dates that characterize when juvenile or adult life stages of a species will arrive at a specific location during their downstream or upstream migration. The locations could include, for example, a dam or an existing or proposed fishway.

Fish weir (also called picket weir, picket lead, or fish fence) **–** a device with closely spaced pickets or bars that allows water flow to pass, but precludes fish from migrating farther upstream. This term is normally applied to the device used to guide adult fish into a trap or counting window. This device is not a weir in the hydraulic sense.

***Fishway* –** the suite of facilities, structures, devices, measures, and project operations that constitute and are essential to the success of an upstream or downstream fish passage system. The suite provides a water passage route around or through an obstruction that is designed to dissipate the energy in such a manner that enables fish to ascend the obstruction without undue stress (Clay 1995).

***Fishway entrance* –** the component of an upstream passage facility that discharges attraction flow into the tailrace of a barrier and that upstream migrating fish use to enter the facility.

***Fishway entrance pool* –** the pool immediately upstream of the fishway entrance(s) where fish ladder flow combines with AWS flow to form the attraction flow.

***Fishway exit* –** the component of an upstream fish passage facility where flow from the forebay of the dam or barrier enters the fishway, and where fish exit the ladder and enter the forebay upstream of the dam.

***Fishway weir* –** the partition that divides two pools in a fishway and passes flow between adjacent pools.

***Flood frequency* –** the probable frequency that a streamflow will recur based on historical flow records. For example, a 100-year flood event refers to a flood flow magnitude that is likely to occur on average once every 100 years or has a 1% chance of being exceeded in any given year. Although calculating possible flood recurrence is often based on historical records, there is no guarantee that a 100-year flood will occur within the 100-year period, or not occur several times within that period.

***Floodplain* –** the area adjacent to a stream that is inundated during periods of flow that exceed the channel capacity the stream has established over time.

Flow control structure **–** a structure in a water conveyance designed to maintain flow in a predictable fashion.

Flow duration exceedance curve **–** the plot of the relationship between the magnitude of daily flow and the percentage of time during a specific period that flow is likely to be equaled or exceeded. Flow exceedance curves may use flow data from an entire year or part of a year. For example, the 1% annual exceedance flow is the flow level exceeded 1% of the time within the entire year (i.e., 3.6 days on average), whereas the 1% exceedance flow for the fish migration window is the flow level exceeded 1% of the time during the fish passage season for a particular species and location. Exceedance values are usually derived using daily average flow data.

Forebay **–** the waterbody located immediately upstream of a dam that results from the dam impounding river flow behind the structure.

Freeboard **–** the height of a structure that extends above the maximum water surface elevation.

Fry **–** a juvenile salmonid with an absorbed egg sac that is less than 60 millimeters in total length (as defined for the purposes of this document). An embryo develops within an egg until it hatches. The hatchling (alevins) feeds off the large external yoke sac for nourishment, grows, and emerges from the spawning gravel as a fry when it can feed on its own (Quinn 2005).

Functional design **–** an initial design concept based on the site conditions and biological needs of the species intended for passage. This is also sometimes referred to as preliminary design or conceptual design. Also, see the definition for conceptual design in this chapter. The functional design commonly includes the general layout, interior dimensions, and specifications covering the hydraulic features of the fishway (Clay 1995).

Hatchery supplementation **–** hatchery programs designed for hatchery-origin fish to spawn in the wild and make a contribution to the conservation of a species or population (HSRG 2009).

Head loss **–** the irreversible reduction in total head (total energy per unit weight) of water as it flows through conduits, open channels, spillways, turbines, and other hydraulic structures. Total head is the sum of elevation head, pressure head, and velocity head. Head is described in units of length, usually in feet or meters.

Hopper **–** a device used to lift fish in water from a collection or holding area for release upstream of a barrier or into a transportation truck.

Hydraulic drop **–** the difference in total head between an upstream water surface and a downstream water surface. It includes the sums of the elevation head, pressure head, and velocity head at the upstream and downstream water surface locations. Also, see the definition for head loss in this chapter.

For fishway entrances and fishway weirs, the differences in velocity head and pressure head are usually negligible, and only water surface elevation differences are considered when estimating hydraulic drop across the structure.

Impingement – the condition where a fish comes in contact with the surface of a dewatering screen and remains on the screen. This occurs when the approach flow velocity immediately upstream of the screen exceeds the swimming capability of a fish given its size and condition. Impingement can injure a fish, and prolonged contact with a screen surface or bar rack can result in mortality. One objective of NMFS' approach velocity criterion is to eliminate the possibility for healthy salmonid fry or larger fish to become impinged on a screen surface or bar rack.

Infiltration gallery **–** a facility used to withdraw surface water from beneath the streambed.

Intermediate bypass entrance **–** a bypass entrance installed upstream of the main bypass entrance. Also, see the definition of bypass entrance in this chapter. Chapter 8 provides guidelines on the number of bypass entrances needed in a bypass facility and their location.

Invert **–** the lowest inside surface of a culvert or flume.

Kelts **–** an adult steelhead that survived spawning and is migrating downstream (Quinn 2005).

Off-ladder trap **–** a facility or system for capturing fish located adjacent to a fish ladder in a flow route that is separate from the normal fish ladder route. This system allows fish to pass a barrier via the ladder or be routed into the trap, depending on the management objectives for the species or population at the facility.

Minimum effective screen area **–** the maximum screen flow divided by the allowable approach velocity.

Passive screens **–** juvenile fish screens that do not have an automated mechanical cleaning system.

Picket leads or pickets **–** a set of narrowly spaced vertical or inclined flat bars or slender circular cylinders designed to exclude fish from a specific route of passage. Picket leads are similar to diffusers, but picket leads generally lack the ability to control the flow rate or significantly alter the flow distribution. Also, see the definitions of a fish weir and crowder in this chapter.

PIT-tag detector **–** a device used to scan fish for the presence of a passive integrated transponder (PIT) tag implanted in the fish. While passing through the detector, PIT tags transmit a unique identifying number that can be read at a short distance, depending on the tag size, type, and antenna design. These passive tags operate in the radio frequency range and are inductively charged and read by the detector. They do not have a battery and can remain operational for decades.

Plunging flow **–** flow over a weir that falls into a receiving pool where the water surface elevation of the receiving pool is lower than that of the weir crest elevation. Surface flow in the receiving pool is typically in the upstream direction, downstream from the point of entry into the receiving pool. Also, see the definition for streaming flow in this chapter.

Porosity **–** the percent open area of a mesh, screen, rack, or other flow area relative to the entire gross area.

Positive exclusion **–** a means of excluding fish by providing a barrier the fish cannot physically pass through.

Preliminary design **–** an initial design concept based on the site conditions and biological needs of the species intended for passage. This is also sometimes referred to as a functional design or conceptual design. Also, see the definition for conceptual design in this chapter.

Ramping rates **–** the rate at which the water surface level at a specific point in a river is artificially altered (either increased or decreased) over a specific time period as a result of changes in the regulation of flow upstream. The rate is typically measured and stated as the change in vertical inches per hour.

Rating curve **–** graphed data depicting the relationship between water surface elevation and streamflow.

Redd **–** the nest a female salmonid excavates, deposits embryos into, and immediately buries with gravel substrate. Redds can be located in streams, rivers, or lake beaches. The locations selected vary with populations and species (Quinn 2005).

Rotary drum fish screen **–** a horizontally oriented cylinder (drum) constructed of fish screen material. Rotary drum screens include an active cleaning method and at least one fish bypass route. The drum rotates on its horizontal axis during each cleaning cycle. Debris deposited on the upstream surface of the drum is lifted by the rotating drum and washed off the downstream surface of the drum by the flow passing through the drum. Fish are guided to a bypass entrance upstream of one end of the screen array.

Screen material **–** the material that provides physical exclusion to reduce the probability of entraining fish into diverted flow. Examples of screen material include perforated plate, bar screen, and woven wire mesh.

Scour **–** erosion of streambed material resulting in the temporary or permanent lowering of the streambed profile.

Soffit **–** the inside top of culvert or underside of a bridge.

Smolt **–** a juvenile salmonid that has completed its freshwater rearing cycle and initiated a downstream migration to reach a marine environment. To prepare for seawater, the freshwater life stage (parr) undergoes a physiological and osmoregulatory transition and begins its downstream migration. Fish in this transitional stage between fresh water and marine rearing that are actively migrating downstream are termed smolts (Quinn 2005).

Streaming flow **–** flow over a weir that falls into a receiving pool and where the water surface elevation of the receiving pool is above the weir crest elevation. In these situations, surface flow in the receiving pool is typically in the downstream direction and away from the point where flow enters the receiving pool.

Sweeping velocity **–** the vector component of water particle speed that is measured parallel to, and immediately upstream of, the screen surface.

Tailrace **–** the portion of the water channel below a dam that conveys turbine and spillway discharge downstream from the dam.

Tailwater **–** the body of water immediately downstream of a dam or other in-stream structure.

Total project head **–** the difference in water surface elevation from upstream to downstream (or from the headwater to the tailwater) of a barrier such as a dam or weir. Normally, total project head encompasses a range of values based on streamflow and the operation of flow control devices.

Thalweg **–** the streamflow path following the deepest parts (i.e., the lowest elevation) of a stream channel.

Tide gate **–** a mechanical device that allows flow to pass in one direction but not in the opposite direction. Tide gates are often used as part of a levee or dike system to allow streamflow into a bay or estuary during ebb tides and prevent the flow of saltwater to pass in the opposite direction and enter the area upstream of the levee or dike during flood tides.

Training wall **–** a physical structure designed to direct flow to a specific location or in a specific direction.

Transport channel **–** a hydraulic conveyance designed to allow fish to swim between different sections of a fish passage facility.

Transport velocity **–** the velocity of the flow within a transport channel of a fishway.

Trap and haul **–** the collection, loading, and transportation of adult fish from a collection site at or below a barrier to a release point located upstream from the barrier or at another location, and juvenile fish from a collection site at or above a barrier to a release point located downstream from the barrier or at another location.

Trash rack **–** a rack of vertical bars with spacing designed to catch debris and preclude it from entering the fishway or other hydraulic structure but allows fish to pass through the openings between bars. Trash racks are also referred to as a grizzly.

Trash rack, coarse **–** a rack of widely spaced vertical bars designed to catch large debris and preclude it from entering a fishway, while providing sufficient openings between the bars to allow adult fish to exit the fishway.

Trash rack, fine **–** a rack of narrowly spaced vertical bars designed to catch both small and large debris and reduce or eliminate the entry of fish into the intake of an AWS.

Turbine intake screens **–** partial flow screens positioned within the upper portion of a turbine intake that guide fish entering the turbine into a collection system for transport or bypass back to the river. Turbine intake screens are installed at most mainstem Columbia and Snake River dams operated by the U.S. Army Corps of Engineers (USACE; Appendix G).

Upstream fish passage – fish passage relating to the upstream migration of adult and juvenile fish.

Upstream passage facility – a fishway system designed to pass fish upstream of a passage impediment, either by volitional passage (i.e., under their own swimming capability) or non-volitional passage (i.e., via a lift or transport vehicle).

Vee screens – a pair of vertically oriented juvenile fish screens installed in a vee configuration (i.e., positioned symmetrically about a centerline), and where the bypass entrance is located at the apex of the two screens. Vee screens are also referred to as chevron screens.

Velocity head, h_v – the kinetic energy per unit weight of fluid due to its velocity; h_v has the units of length (usually in feet or meters) and is calculated as shown in the following equation:

$$h_v = v^2/2g$$

where:

v = velocity of the fluid (feet per second, meters per second)
g = acceleration due to gravity (32.2 feet per second^2, 9.81 meters per second^2)

Vertical barrier screens – screens located between the bulkhead (upstream) and operating (downstream) gate slots at mainstem dams on the Columbia and Snake rivers operated by the USACE. The screens keep fish diverted into the bulkhead slot by turbine intake screens from passing back into the turbine through the operating slot. Fish retained in the bulkhead gate slot by the vertical barrier screen enter a specially designed juvenile fish bypass system through orifices. (Figure G-4 in Appendix G.)

Volitional passage – fish passage whereby fish transit a passage facility under their own swimming capability, using timing and behavior they choose, and under all naturally passable flows. Volitional passage means fish can enter, traverse, and exit a passage facility under their own power, instinct, and swimming capability. The fish pass through the facility without the aid of any apparatus, structure, or device (i.e., they are not trapped, mechanically lifted or pumped, or transported).

Wasteway – a conveyance that returns excess water originally diverted from an upstream location back to the stream or channel from which it was diverted.

Weir – a low wall or dam built across the width of a river that pools water behind it while allowing water to flow steadily over the top of the structure.

3 Design Development

3.1 Introduction

Chapter 3 describes the general process NMFS follows and the types of information required during project design. Fish passage project designs subject to NMFS engineering review are typically developed in two major phases. The major phases are the preliminary design (Section 3.2.1), also referred to as the functional or conceptual design, and the final design (Section 3.2.2), which results in the development of detailed plans and specifications.

A review by NMFS of an applicant's fish passage facility designs will be conducted in the context of whether they meet the recommended criteria and technical assistance listed in this document.

Fish passage facilities refer to physical structures, facilities, or devices used to provide safe, timely, and effective passage for all life stages of fish as identified in Section 1.1 of this document. During its review, NMFS will consider site-specific information, including site limitations, biological information, and operations and maintenance (O&M) information provided by the applicant. Although the submittal of all information discussed in Chapter 3 may not be required in writing, the applicant should be prepared to describe how the biological and site information was included in the development of the project design.

3.2 Design Process

Both the preliminary and final designs should be developed in cooperation and interaction with WCR biological staff from effected Branch and engineering staff from the Environmental Services Branch.

To facilitate an iterative, interactive, and cooperative process, project applicants are encouraged to initiate coordination with NMFS early in the development of the preliminary design. Early and frequent interactions can aid in a smooth review process. NMFS' preference is to work with applicants in developing alternatives that comply with ESA. In general, NMFS cannot complete a project review of design plans that are submitted without the supporting information (listed in Section 3.3).

Project applicants should consult with NMFS on all phases of a design. Section 3.2.2 provides the minimum information needed for NMFS review. Large, complex projects will likely have multiple iterations within each of the two major design phases. As multiple design iterations are developed, each iteration should be made available to NMFS for review.

3.2.1 Preliminary Design

Depending on the size and complexity of the project, NMFS typically requests that it be allowed to review and provide comments on the 30%, 60%, and 90% design iterations of the preliminary design. Due to the nature of the review process, such as applications for a FERC license and ESA consultation, a preliminary design should be developed in cooperation and interaction with biological and engineering staff from the NMFS WCR. The preliminary design should be complete and to allow the application or engineering review to move forward.

The preliminary design establishes a preferred alternative based on comprehensive evaluations of the key elements of the design. This first phase in the design of a fish passage facility includes the following steps. Project proponents should:

1. Engage with project stakeholders and ascertain their operational requirements.
2. Identify and prioritize project objectives and the associated functional requirements.
3. Assemble the design criteria of the federal, state, and tribal fish resource agencies.
4. Collect pertinent biological, hydrological, and engineering information.
5. Develop appropriately scoped geomorphic assessments for the project.
6. Define project reliability and backup or contingency parameters.
7. Develop a process for evaluating and ranking alternative designs and operations.
8. Generate alternative designs and select the preferred alternative.
9. Develop initial layout drawings and models as needed to describe the facility.
10. Describe the operational requirements of the major facility sub-components

The preliminary design results in a facilities layout that includes section drawings and the identification of component sizes and water flow rates for the primary project features. Cost estimates are also included in the preliminary design. Completion of the preliminary design commonly results in a document that may be used for budgetary and planning purposes and for soliciting (and subsequently collating) design review comments provided by other reviewing entities. The preliminary design is usually considered to be at the 20% to 30% completion stage of the design process. The preliminary design may include the following sub-phases of design work:

- Reconnaissance study: Typically, this study investigates the optimal design and construction specific to each site. The study usually occurs early in the preliminary design process.
- Conceptual alternatives study: This study lists the types of facilities that may be appropriate for accomplishing the fish passage objectives at a selected site. It does not entail much on-site investigation. Its purpose is to develop a narrowed list of alternatives that merit additional assessment.
- Feasibility study: This study includes an incrementally greater amount of development of each design concept (including a preliminary cost estimate) than does the conceptual alternatives study. It enables the most-preferred alternative to be identified.

3.2.2 Detailed or Final Design

The final design should be based on the preliminary design that NMFS reviewed. Any significant deviation from the accepted preliminary design will trigger a new review. Once the detailed design process commences, NMFS should have the opportunity to review and provide *comments on the designs developed at the 30%, 60%, 90%, and 100% stages, or near each of these stages.*

The details of the final design phase uses the preliminary design as a springboard for beginning the final design and specifications in preparation for the bid solicitation (or negotiation) process. NMFS reviews usually provide refinements in the detailed design that will lead to O&M and fish safety benefits. Electronic drawings are the preferred review medium, though NMFS may request scaled 11-by-17-inch paper drawings in addition to electronic media.

3.2.3 Smaller Projects

For smaller projects where the review process may involve only one or two steps, each submittal to NMFS should include enough information about the project to ensure that the reviewing engineer is able to discern the goals of the project, any biological and physical constraints of the project, and how the proposed design intends to meet the goals of the project given constraints that were identified.

3.2.4 Review Timelines

NMFS should be allowed at least 30 days to review and comment on each stage of the design process (30%, 60%, 90%, and 100%).

Although NMFS may waive or voluntarily shorten a review period for a specific stage, project applicants should develop their design schedules using the standard 30-day review period for each stage of the design.

3.3 Information Requirements

The design of all fish passage facilities should be developed based on a synthesis of the required site and biological information listed below, with a clear understanding of how the facility will be operated and maintained. The following project information is needed for, and should be provided with, the preliminary design. In some cases, NMFS may need additional information not listed herein.

3.3.1 Functional Requirements

The project design should describe the functional requirements of the proposed fish passage facilities as related to all anticipated project operations and streamflows. The design should describe the expected median, maximum, and minimum monthly diverted flow rates and any special operations (e.g., the use of flash boards) that modify forebay or tailrace water surface elevations.

3.3.2 Site and Physical Information

The following physical information should be provided and used in developing the project design.

3.3.2.1 Plans

Design submittals should include visual representations of various project features. These plans may include any or all of the following:

- Site plan drawings: Showing the location and layout of the proposed fish passage facility relative to existing project facility features
- Surveys: Topographic and bathymetric surveys, particularly where they might influence locating fishway entrances and exits and personnel access to the site
- Additional drawings: Drawings of existing facilities illustrating longitudinal profile, elevations, and plan views, including details showing the intake configuration, location, and capacity of the project's hydraulic features
- Project Location Map including nearby town and north arrow along with Latitude and Longitude
- Temporary passage facility drawings: Drawings demonstrating plans for temporary or interim passage during construction of the primary facility. These temporary facilities should provide passage at a level no worse than existed prior to commencing construction on primary facility.

3.3.2.2 Hydrology

Design submittals should include information on the hydrology of the basin—including daily and monthly streamflow data and flow duration exceedance curves at the proposed site for a fish passage facility—based on the entire period of available records, which may be modified based upon site specific issues as approved by NMFS staff.

If stream gage data are unavailable for a proposed facility location (or if records exist for only a brief period of time), flow records may be generated using synthetic methods to develop the necessary basin hydrology information, which is used to develop the high and low fish passage design flows for the project (Chapter 4).

3.3.2.3 Project operations and basic information

Information on project operations that may affect fish migration should be provided.

Project information is key to understanding basic design parameters for fish passage (both for baseline conditions and for future fish passage changes). This could include information on powerhouse flow capacity, periods of powerhouse operation, turbine sequencing, debris management, flashboard or crest gate operation, flood or waster gate operation staffing levels, planned outages, pulse flows, project forebay and tailwater rating curves that encompass the entire operational range of the project, water temperature etc.

3.3.2.4 Morphology

Information on the stream or river channel at the site of the fish passage project should be provided, and includes but is not limited to the following:

- *Determine the potential for channel degradation, aggregation/subsidence, or channel migration, which may alter stream channel geometry and compromise fishway performance (if the fish passage facility is proposed at a new or modified diversion).*
- *Describe whether the stream channel is stable, conditionally stable, or unstable.*
- *Identify the overall geomorphology of the channel (e.g., straight, meandering, or braided).*
- *Provide the rate of lateral channel migration and change in stream gradient that has occurred during the last decade if migration is evident or likely to occur in the future using aerial photography, anecdotal information, or physical monitoring.*
- *Describe the effect the proposed fish passage facility may have on the existing stream alignment and gradient.*
- *Describe the potential for future channel modification to occur; this could be from construction of the facility or natural channel processes (i.e., instability).*
- *Describe the substrate of the channel and provide the D50.*

3.3.2.5 Sediment and debris

Any sediment and debris conditions that may influence the design of the fish passage facility or present potentially significant problems should be described.

3.3.3 Biological Information

Section 3.3.3 outlines miscellaneous information that should be provided and used in developing the project design. Contact the NMFS biologist in your area to determine which of the following is needed for the project.

3.3.3.1 Salmonid biological information

The following biological information should be provided for site specific conditions:

- Salmonid species present in the basin that are affected by the project, or are expected to be in the basin in the future
- Approximate abundance of each salmonid species and run (e.g., winter, spring, summer, fall, and late fall)
- Various life stages present, or expected to be present, in the future and their migration timing (fish passage season)
- Location and timing of spawning in the basin
- Location and timing of juvenile downstream migration

3.3.3.2 Non-salmonid passage

Information on any non-salmonid species (and life stages) present at the proposed fish passage site should be provided to address passage requirements for these species.

3.3.3.3 Predation risk

Information on predatory species that may be present at the proposed site should be provided along with information on conditions that favor or help to prevent their preying on salmonids. Information should include, but is not limited to, species type, life stage, spawning ground, and location of predator habitat.

3.3.3.4 Fish behavior characteristics

Any known fish behavioral traits of salmonid or non-salmonid passage that might affect the design of the facility should be provided.[1]

3.3.3.5 Additional research needs

Any uncertainty associated with how migrating fish approach the site where a new facility is being considered should be identified through directed studies, including routes fish may use when approaching the site. For more information related to large projects, see Appendix G.

3.3.3.6 Streamflow requirements

The minimum streamflow required to allow migration around the impediment during low water periods (See Design Flow Range in Chapter 4).

3.3.3.7 Poaching risk

The degree of poaching or illegal trespass activity in the immediate area of the proposed facility should be identified, along with any security measures needed to reduce or eliminate illegal activity.

3.3.3.8 Water quality

Water quality factors that may affect fish passage at the site should be described. For example, fish may not migrate if water temperature and quality are marginal and may instead seek coldwater refugia (e.g., deep pools fed by groundwater) or holding zones where dissolved oxygen levels are higher than surrounding reaches until water quality conditions improve. Water temperature issues are important considerations that can effect design. Therefore, it is also important to document other temperature issues (eg. reservoir stratification, or effluent releases in the project area, among other issues).

3.3.4 Operations and Maintenance Information

In order to provide a degree of certainty that necessary maintenance will be funded and performed, the following O&M information should be provided for in development of the preliminary design.

Historically, many fish passage facilities have been built and have subsequently fallen into disrepair due to improper operations or lack of maintenance or funding. New project designs

[1] For example, most salmonid species pass readily over a fishway weir with either plunging or streaming flow. However, pink and chum salmon have a strong preference for streaming flow conditions and may reject plunging flow. Therefore, if pink or chum salmon are in the basin, this needs to be identified. Similarly, American shad prefer streaming flow conditions and generally reject both plunging flow and orifice passage.

should consider the need for proper operations and long-term maintenance. Start up, daily, and yearly maintenance procedures, daily logs, and annual reports should be considered in the design development and included as part of the O&M plan.

3.3.4.1 Maintenance funding

The O&M plan should identify the party responsible for funding the O&M of the proposed facility.

3.3.4.2 Operating and maintaining entity

The O&M plan should identify the party responsible for operating the facility and carrying out maintenance actions.

3.3.4.3 Facility shutdown

The O&M plan should describe maintenance actions that will require the facility to be taken out of service and the timeline for these actions.

3.3.4.4 Schedule of operations

The O&M plan should identify the proposed schedule of operations for intermittently operated facilities, such as weirs or traps, and the accompanying plans for salvaging fish from these facilities after they are operational. This should include plans for how the facility will be dewatered and how salvaged fish will be returned to the stream or river.

4 Design Flow Range

Prior to determining the fish passage design flows, the steps in the 2022 NOAA Fisheries WCR Guidance to Improve the Resilience of Fish Passage Facilities to Climate Change should be followed to determine what if any climate impacts should be considered and included in the design. The guidance in Chapter 4 applies to projects located in Washington, Oregon, and Idaho over the range of anadromous salmonid habitat. Due to significantly different hydrologic conditions in California, project proponents should work with NMFS engineering staff to determine the appropriate design flows for site conditions.

4.1 Introduction

A fishway design and facility must allow for the safe, timely, and efficient passage of fish within a specific range of streamflow. The design streamflow range is bracketed by the designated fish passage design low flow and high flow described in Sections 4.2 and 4.3.

Within the design streamflow range, a fish passage facility should operate within its specific design criteria. Outside of the design streamflow range, fish should either not be present, not be actively migrating, or should be able to pass safely without need of a fish passage facility.

Site-specific information is critical to determining the design time period and river flows for the passage facility—local hydrology may require that the design streamflow range be modified for a particular site.

4.2 Design Low Flow for Fish Passage

Design low flow for fishways is the average daily streamflow that is exceeded 95% of the time during periods when migrating fish are normally present at the site.

This is determined by summarizing the previous 25 years of mean daily streamflow occurring during the fish passage season, or by an appropriate artificial streamflow duration methodology (if streamflow records are not available). Shorter data sets of streamflow records may be useable if they encompass a broad range of flow conditions. The fish passage design low flow is the lowest streamflow for which migrants are expected to be present, migrating, and dependent on the proposed facility for safe passage.

4.3 Design High Flow for Fish Passage

Design high flow for fishways is the average daily streamflow that is exceeded 5% of the time during periods when migrating fish are normally present at the site.

This is determined by summarizing the previous 25 years of mean daily streamflow occurring during the fish passage season, or by an appropriate artificial streamflow duration methodology (if streamflow records are not available). Shorter data sets of streamflow records may be used if they encompass a broad range of flow conditions. The fish passage design high flow is the highest streamflow for which migrants are expected to be present, migrating, and dependent on the proposed facility for safe passage.

4.4 Fish Passage Design for Flood Flows

The general fishway design should have sufficient river freeboard to minimize overtopping by 50-year flood flows.

Above a 50-year flow event, fishway operations may include shutdown of the facility to allow the facility to quickly return to proper operation when the river drops to within the range of fish passage design flows. Other mechanisms to protect fishway operations after floods will be considered on a case-by-case basis. A fishway should never be inoperable due to high river flows for a period greater than 7 days during the migration period for any anadromous salmonid species. In addition, the fish passage facility should be of sufficient structural integrity to withstand the maximum expected flow. It is beyond the scope of this document to specify structural criteria for this purpose. If the fish passage facility cannot be maintained, the diversion structure should not operate, and the impediment should be removed.

5 Upstream Adult Fish Passage Systems

5.1 Introduction

Chapter 5 provides criteria and guidelines for designing upstream adult fish passage facilities as well as selecting appropriate ladder types for specific site conditions. These criteria and guidelines apply to adult upstream fish passage facilities in moderately sized streams. Where applicable, supplementary criteria for facilities located in small streams will be noted. Chapter 5 does not address fish passage systems, such as fish locks and mechanical lifts, which may provide passage over barriers or be used as part of a trap and haul system. Fish lifting devices are covered in Section 7.6.

Chapter 5 also discusses upstream passage impediments, which are artificial or natural structural features or project operations that cause adult or juvenile fish to be injured, killed, blocked, or delayed in their upstream migration to a greater degree than in an unobstructed river setting. These impediments can present total or partial fish passage blockages. Artificial upstream passage impediments require approved structural and operational measures to mitigate, to the maximum extent practicable, for adverse impacts to upstream fish passage. These impediments require a fish passage design based on conservative criteria because the natural complexity of streams and rivers that usually provide passage opportunities has been substantially altered. The criteria in this chapter also apply to natural barriers, when passage over the barrier is desired and consistent with watershed, subbasin, or recovery plans.

Examples of passage impediments include, but are not limited to, the following:

- Permanent or intermittent dams
- Hydraulic drops over artificial instream structures[2] in excess of 1.5 feet
- Weirs, aprons, hydraulic jumps, or other hydraulic features that produce depths of less than 10 inches, or flow velocity greater than 12 feet per second (ft/s) for more than 90% of the stream channel cross section
- Conditions that create false attraction, including the following:
  - Project operations or features that lead upstream migrants into impassable routes
  - Discharges that may be detected and entered by fish with no certain means of continuing their migration (e.g., poorly designed spillways, cross-basin water transfers, canal wasteways, or unscreened diversions) or have the potential to result in mortality or injury (e.g., turbine draft tubes, shallow aprons, and flow discharges)
- Insufficient flow, which includes the following:
  - Diffused or braided flow that impedes approach to the impediment

[2] This is based on the *Fisheries Handbook of Engineering Requirements and Biological Criteria* (Bell 1991), which recommends using fishways for head differences as low as 2 feet.

- Insufficient flow in a bypass reach, such that fish cannot enter or are not stimulated to enter the reach and move upstream; bypass reaches are commonly located adjacent to a powerhouse or wasteway return
- Water diversions that reduce instream flow

- Poorly designed headcut control or bank stabilization measures that create poor upstream passage conditions such as those listed above
- Degraded water quality in a bypass reach, relative to the water quality downstream of the confluence of bypass reach and flow return discharges (e.g., at the confluence of a hydroelectric project tailrace and bypass reach)
- Ramping rates in streams or in bypass reaches that delay or strand fish
- Upstream passage facilities that do not satisfy the criteria and guidelines described in Chapter 5

The typical components of an upstream adult fish passage system are shown in Figure 5-1.

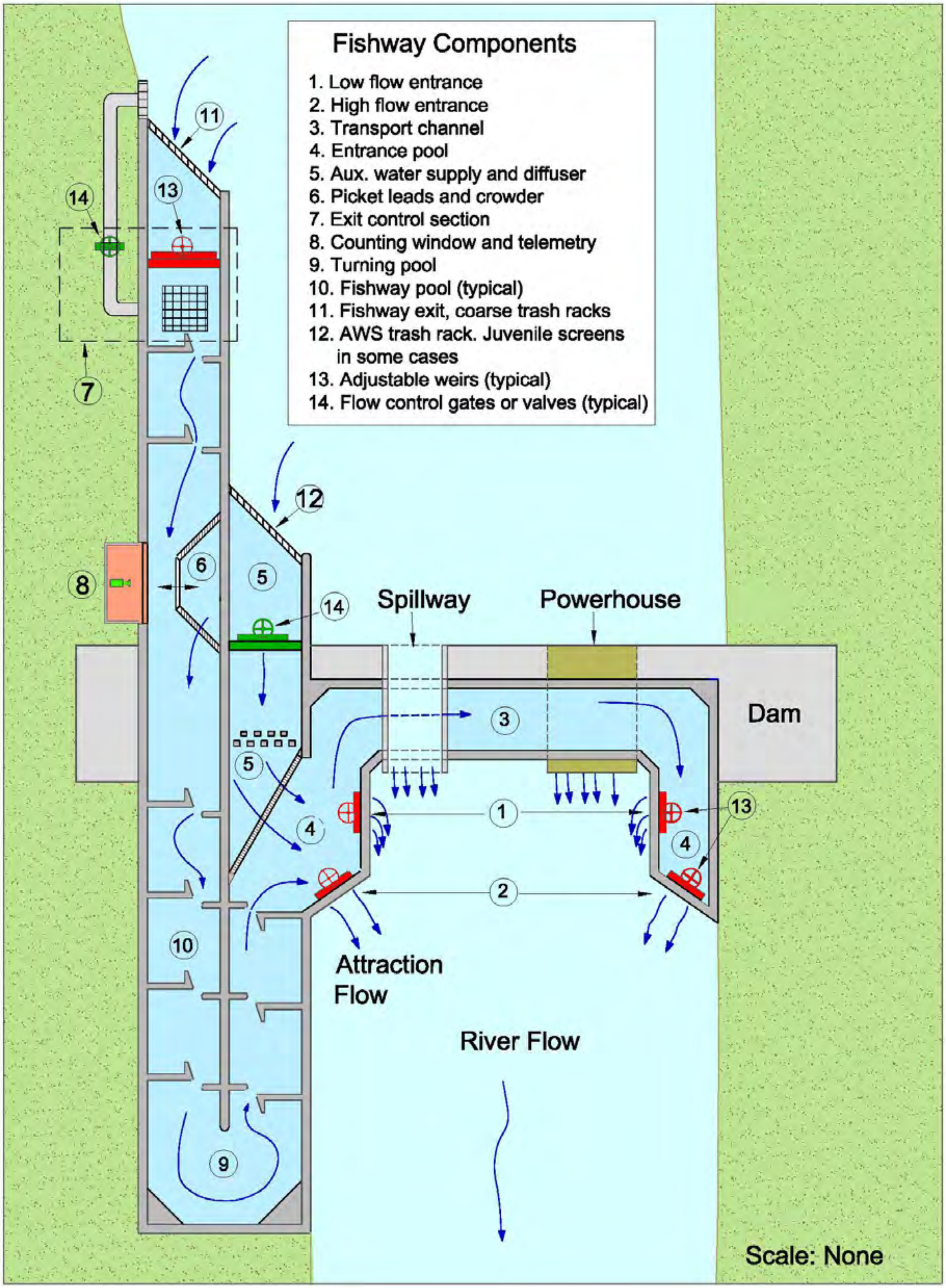


Figure 5-1. Components of vertical slot fishway for upstream passage

5.1.1 Passage Alternatives: Volitional and Non-volitional

Volitional passage is preferred for passage facilities over non-volitional passage. Non-volitional systems may be considered where volitional passage facilities are not feasible due to significant engineering constraints or biological limiting conditions.

NMFS typically prefers volitional fish passage as these systems afford passage opportunities for migrating fish at all times, and fish can transit a passage facility under their own swimming capability, using timing and behavior they choose, and under all naturally passable flows. Volitional passage means fish can enter, traverse, and exit a passage facility under their own power, instinct, and swimming capability. The fish migrate through a volitional passage facility without the aid of any mechanical apparatus, structure, or device.

Volitional passage systems at dams usually consist of hydraulically engineered fish ladders that use one of the designs described in this manual. Under certain site conditions, a volitional passage system for a dam of low or moderate height may be designed as a nature-like channel; or it may be a hybrid design that incorporates features of both nature-like and traditional designs. Volitional systems for applications other than dams generally seek to emulate nature-like conditions with stream simulation techniques.

There are some situations where a volitional passage system is infeasible due to biological factors, engineering constraints, fish management objectives, or other project-specific limitations. In these instances~~,~~ non-volitional systems may be appropriately considered to meet fisheries management goals and objectives, provided they are designed, constructed, and operated following the guidance in chapter 7 of this Manual.

Non-volitional systems, due to long term operations and maintenance requirements, can have higher total life-cycle costs when compared to fish ladders. Project proponents should carefully weigh the pros and cons of the different alternative modes of passage to select the most appropriate design that will consistently accomplish the project's fish passage goals. There may be instances where the inability of a project proponent to consistently and correctly operate and maintain a proposed collection and transport system represents an unacceptable risk to the managed fish species.

Although site specific challenges exist, non-volitional designs can be a viable management tool that provides Pacific salmonids access to some historic habitats, including cold-water sites that will be increasingly important given climate projections.

5.1.2 Passage of Other Species

Where appropriate, upstream adult fish passage systems should incorporate passage requirements for other species (e.g., shad, sturgeon, Pacific lamprey, and suckers) that may use the system, provided that the changes do not compromise the passage of target species (salmonids).

Failure to account for the passage requirements of other species may create a biological blockage in the ladder that could delay or compromise the passage of the target species. For example, if American shad (*Alosa sapidissima*) cannot pass a fishway, the numbers of shad in the fishway may build up to the point where other fish do not enter or move through the fishway.

5.1.3 Temperature Considerations

In certain cases, water temperature control may be a critical factor for fish ladder designs, particularly at high head dams. Some reservoirs or head ponds may become thermally-stratified at some point during the fish passage season, resulting in a potential temperature mismatch between the fish ladder's discharge and the dam's other tailwater or tailrace discharges. Also, during summer seasons, water temperature may increase as water passes through long fish ladders whose exterior concrete surfaces are exposed to solar energy for a considerable period of time. Such temperature mismatch situations may cause salmonids (or other species) to reject the fish passage route. To the degree these conditions exist, artificial temperature modulation at fishways and ladders may be necessary (Caudill et al. 2013).

5.2 Fishway Entrance

5.2.1 Description and Purpose

A fishway entrance is a gate or slot through which fishway attraction flow is discharged in a manner that encourages and allows adult fish to enter the upstream passage facility. The fishway entrance is often the most difficult (Bates 1992)—yet most critical—component to design for an upstream passage system, particularly at dams (Clay 1995). Fishway entrances should be placed to ensure that fish are attracted to and enter the best passage routes past the passage impediment throughout the entire design flow range. The most important aspects of fishway entrance design are as follows:

- Location of the entrance
- Pattern and amount of flow from the entrance
- Approach channel immediately downstream of the entrance
- Flexibility in adjusting entrance flow to accommodate variations in tailrace elevation, stream or river flow, and project operations

5.2.2 Specific Criteria and Guidelines – Fishway Entrance

5.2.2.1 Configuration and operation

Unless otherwise approved by NMFS, at sites where the entrances are located in deeper water, fishway entrances should be equipped with downward-opening slide gates or adjustable weir gates that rise and fall with the tailwater elevation. At locations where the tailwater is not deep, orifice entrances or downward-closing slide gates (which create an orifice entrance) may be used. The entrance gate should be able to completely close off the entrance when not in use. Gate stems or other adjustment mechanisms should not be placed in any fish migration pathway. Fishway entrance gates operating in an orifice configuration should not be closed to an opening height less than 12-inches except when fully closed.

The fishway entrance gate configuration and its operation may vary based on site-specific project operations and streamflow characteristics. Entrance gates are usually operated in either a fully open or fully closed position, with the operation of the entrance being dependent on tailrace flow characteristics. Sites with limited tailwater fluctuation may not require an entrance gate to regulate the entrance head, while other sites may maintain proper entrance head by regulating auxiliary water flow through a fixed-geometry entrance gate.

5.2.2.2 Location

Fishway entrances should be located at points where fish can easily locate the attraction flow and enter the fishway. When choosing an entrance location, high-velocity and turbulent zones in a powerhouse or spillway tailrace should be avoided in favor of relatively tranquil zones adjacent to these areas. A site-specific assessment must be conducted to determine entrance location and entrance jet orientation. A physical hydraulic model is often the best tool for determining this information (Bell 1991).

The fishway entrance should be located as far upstream as possible since fish will seek the farthest upstream point (Bell 1991). This is especially the case with low flow entrances. This guideline is subject to adjustment by NMFS based on site-specific constraints that include the configuration of the project, flow level, and flow patterns associated with powerhouse or facility operations and spill discharge in relation to site conditions.

Some fishway entrances at a project should be located on the shoreline (Bell 1991). This is because fish orient to shorelines when migrating upstream. Locating an entrance on the shoreline takes advantage of this behavior, where the shoreline serves to lead fish to the entrance.

One of the most significant design decisions for a fishway entrance is its location (WDFW 2000). Turbulence can be a barrier to fish passage because velocities, turbulence, upwells, reverse currents, and aeration can affect attraction and access to fishways (WDFW 2000). At locations where the tailrace is wide, shallow, and turbulent, excavation to create a deeper, less-turbulent holding zone adjacent to the fishway entrance(s) may be necessary. Therefore, it is important to fully characterize and understand flow patterns when locating a fishway entrance at a site.

5.2.2.3 Additional entrances

If the site has multiple zones where fish accumulate, each zone should have a minimum of one fishway entrance. For long powerhouses or dams, additional entrances may be required. Multiple entrances are usually required at sites where the high and low design flows create different tailwater conditions. All entrances should meet the requirements of Section 5.2.

Since tailrace hydraulic conditions usually change with project operations and hydrologic events, it is often necessary to provide two or more fishway entrances to accommodate the differences between high- and low-flow river conditions (often referred to as high- and low-flow entrances). When switching between high- and low-flow conditions, it is often necessary to close some entrances that are operating poorly or those the fish can no longer access, and open others where fish are congregating and holding. These features should be designed so that entrance changes can be performed simply, swiftly, and easily.

5.2.2.4 Attraction flow

Additional attraction flow from the fishway entrance is needed to extend the area of intensity of velocity of the outflow (from the entrance) to increase fish attraction into the entrance (Clay 1995). Attraction flow from the fishway entrance should be between 5% and 10% of the fish passage high design flow (Chapter 4). For smaller streams, NMFS may conclude that attraction flows up to 100% of streamflow may be required.

Larinier et al. (2002) conclude that a major cause of poor fishway performance is a lack of adequate attraction flow. At dams, the entrance flow for fish attraction should be sufficient to compete with spillway or powerhouse discharge flow (Bates 1992). Generally speaking, the higher the percentages of total river flow used for attraction into the fishway, the more effective the facility will be in providing upstream passage. The proportion of attraction flow needed is based on extensive research and results of laboratory studies.[3] The proportion selected should be sufficient to allow fish to both find and want to enter fishway entrances.

Under conditions where ladder entrances are optimally situated near the impediment and fish are naturally led to an entrance, an attraction flow of 5% of the fish passage design flow is used. However, some situations may require that more than 10% of the passage high design flow be used. For example, if a site features obscure approach routes to the passage facility or if entrances are located in a less than optimal location, a higher proportion of the design flow is needed as attraction flow. Additionally, facilities with multiple entrances may require more attraction flow (not to exceed a total of 10% of the fish passage design flow).

Powerhouse and spillway flows are not considered part of the proportion of project flow used for fishway attraction. Powerhouse and spillway flows should be shaped, and turbine unit and spill gate operation prioritized, to create tailrace conditions that naturally lead to and allow fish to rapidly locate the fishway entrances (Bell 1991).

5.2.2.5 Hydraulic drop

The fishway entrance hydraulic drop (also called entrance head) should be maintained between 1 and 1.5 feet, depending on the species present at the site, and designed to operate from 0.5 to 2 feet of hydraulic drop (USFWS 1960; Junge and Carnegie 1972).

A range of 1 to 1.5 feet is considered a normal operating range that helps establish streaming flow conditions (Bates 1992). Gauley et al. (1966) found in laboratory studies that Chinook salmon and steelhead made significantly faster ascents up an experimental ladder with orifice flow and flow over a weir when head on the weir was increased from 0.95 to 1.2 feet.

The hydraulic drop criterion is based in part on results of laboratory studies where an increasing number of Chinook and sockeye salmon and steelhead failed to enter all entrances tested when head was increased from 2 to 3 feet. Pink and chum salmon have more specific

[3] For example, Weaver (1963) conducted a study wherein he provided salmon and steelhead with a choice of entering adjacent channels of the same width but different velocities; a higher proportion chose to enter the channel with higher velocity.

requirements. Fish from these species can easily swim through an entrance with 1.5 feet or more of head differential, but they will not jump even a portion of that height (Bates 1992).

5.2.2.6 Dimensions

For larger streams, the minimum fishway entrance width should be 4 feet, and the entrance depth should be at least 6 feet, although the shape of the entrance is dependent on attraction flow requirements and should be shaped to accommodate site conditions.

For smaller streams, the ladder entrances should be as large as possible, consistent with available fishway entrance flow, to maximize fish attraction and minimize plugging by debris. The minimum size for an orifice-style entrance should be 1.5 feet by 1.5 feet. The minimum width for a vertical slot-style entrance should be 1.25 feet if large Chinook salmon are present and 1 foot otherwise, and the depth (i.e., bottom of the slot to the tailwater level) should be at least 2 times the slot width.

In general, the dimensions of the fishway entrance should create a compact, strong attraction flow jet that projects out of the entrance a significant distance into the tailrace.

For identical water velocities, attraction jets created by entrances that are small, narrow, and deep, or are wide and shallow, do not project as far into the tailrace as does a compact entrance (Section 5.2.2.8; also, see requirements for mainstem Columbia and Snake rivers in Appendix G). The entrance width criterion is based partly on results of laboratory studies where Chinook salmon and steelhead preferred 3.9-foot-wide entrances over 1.5-foot-wide entrances under a constant velocity condition of 8 ft/s and lighted conditions. However, under dark conditions, all of these species preferred the wider opening, and coho salmon preferred the wider opening under both lighted and dark conditions (Weaver et al. 1976).

For ladder entrances at facilities located in small streams, orifice size is based on the minimum orifice size for an Ice Harbor-style ladder (Section 5.5.3.3). For a slot-style entrance at a facility in a small stream, the slot width is based on the minimum slot widths for vertical slot ladders (Section 5.5.2.1.1), and the minimum depth is based on the square area of a 1.5-foot by 1.5-foot orifice. For example, the criterion above states that slot depth (the depth from the bottom of the vertical slot-style entrance to the tailwater water surface elevation) should be double the slot width, and the minimum width should be 1.25 feet if large Chinook salmon are present and 1 foot otherwise. Therefore, when sizing a 1-foot-wide slot, the design should submerge the slot 2 feet, which is close to the 2.25 square foot (ft^2) open area of a 1.5-feet by 1.5-feet orifice.

5.2.2.7 Types of entrances

Fishway entrances may be adjustable submerged weirs, vertical slots, orifices, or other shapes, provided that the requirements specified in Section 5.2.2 are achieved.

Care should be taken to select a fishway entrance that generates a good attraction jet and is passable by all species of interest (Junge and Carnegie 1972). For example, American shad typically refuse to pass through orifices. Therefore, at sites where American shad are present, orifice entrances should be avoided, and surface routes in fishways are required (Larinier et al. 2002). This is true of all species in the genus *Alosa*. Also, American shad orient to walls when migrating through fishways and can be trapped in corners if no surface-oriented route is available (Junge and Carnegie 1972; Bell 1991; WDFW 2000).

5.2.2.8 Flow conditions

The fishway entrance should create either streaming flow or hydraulic conditions similar to a submerged jet.

The desired flow condition for entrance weir and slot discharge jet hydraulics is streaming flow (WDFW 2000). A streaming flow is an intact plume of water moving almost horizontal near the water surface or at the elevation of an orifice entrance. In contrast, plunging flow drops vertically over an entrance sill or weir and then upwells downstream a few feet from an entrance. Plunging flow sets up a hydraulic roll where surface flow is moving in an upstream direction toward the entrance (Figure 5-2). This induces fish to jump at the flow, which may cause injuries, and it presents hydraulic conditions that some species may not be able to pass or may refuse to pass. This includes American shad and pink and chum salmon. Plunging flow also directs the attraction jet downward toward the stream bottom rather than across the tailrace. Streaming flow may be accomplished by placing the entrance weir (or invert of the slot) elevation such that flow over the weir falls into a receiving pool with a water surface elevation above the weir crest elevation (Katopodis 1992).

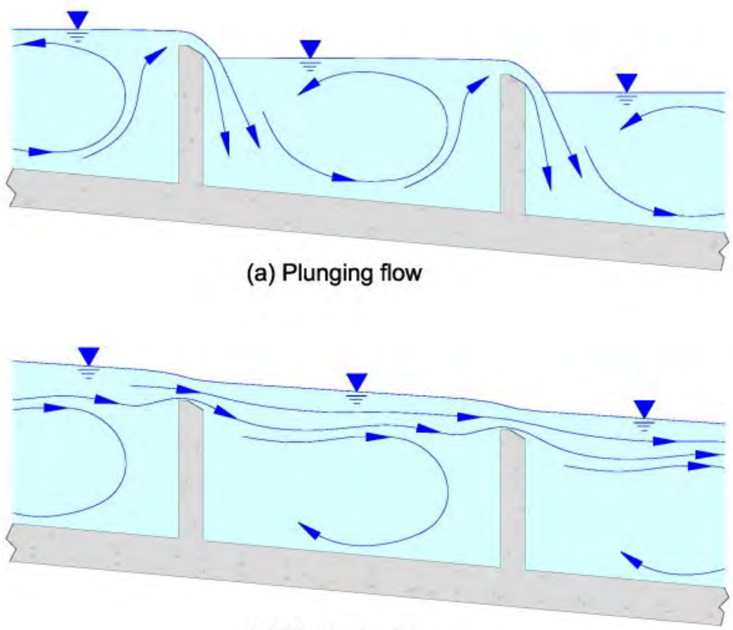


Figure 5-2. Plunging (a) and streaming (b) flows in pool and weir style of fishways

5.2.2.9 Orientation

Generally, low-flow entrances should be oriented nearly perpendicular to the streamflow (Figure 5-1; Bates 1992). High-flow entrances should be oriented to be more parallel to streamflow or at an angle away from the shoreline (Figure 5-1). A site-specific assessment should be conducted to determine entrance location and entrance jet orientation.

Low-flow entrances are designed to be used by fish during periods when flow conditions approach the low design flow. They are generally the entrances furthest upstream and closest to the passage barrier. High-flow entrances are designed for use during periods when flow conditions approach the high design flow. Bates (1992) suggests that high-flow entrances be placed at a 30-degree angle to the high-flow streamline, ideally along the edge of a high-flow hydraulic barrier. In general, high-flow entrances are located slightly downstream from the barrier at a point in the tailrace where the turbulence from the barrier under high flow conditions has just dissipated. A physical hydraulic model is often the best tool for determining this information; this model is used to test various design alternatives that favor fish passage (Bell 1991).

5.2.2.10 Staff gages

The fishway entrance design should include staff gages to allow for a simple determination of whether the entrance head criterion (Section 5.2.2.5) is met. Staff gages should be located in the entrance pool and in the tailwater just outside of the fishway entrance in an area visible from an easy point of access. Gages should be readily accessible to facilitate in-season cleaning.

Staff gages are important tools for determining whether a fish ladder entrance is meeting criteria. Care should be taken when locating staff gages to avoid placement in turbulent areas and locations where flow is accelerating toward a fishway entrance.

5.2.2.11 Entrance pools

The fishway entrance pool should be designed to combine ladder flow with auxiliary water system (AWS; also known as auxiliary water supply system) flow in a manner that encourages fish to move from the entrances in an upstream direction and optimizes the attraction of fish to lower fishway weirs.

The fishway entrance pool is at the lowest elevation of the upstream passage system. It discharges flow into the tailrace through the entrance gates to attract upstream migrants. In many fish ladder systems, the entrance pool is the largest and most important pool in terms of providing proper guidance of fish from the entrance to the ladder section of the upstream passage facility. Ladder flow and AWS flow through diffuser gratings are combined in the pool to form the entrance attraction flow (Section 5.3, Figure 5-1).

Attraction to the lower fishway weirs may be optimized by the following:

- Shaping the entrance pool to create a natural funnel leading fish to the ladder weirs
- Angling vertical AWS diffusers toward the ladder weirs
- Locating the jet from the ladder weir adjacent to the upstream terminus of the vertical AWS diffusers

The pool geometry will normally influence the location of attraction flow diffusers.

5.2.2.12 Transport velocity

Transport velocities between the fishway entrance and first fishway weir, fishway channels, and over-submerged fishway weirs should be consistent with the guidance found in section 5.4.2.1.

Gauley et al. (1966) reported that Chinook and sockeye salmon and steelhead passage times did not differ significantly between water velocities of 1 and 4 ft/s in an experimental 270-foot-long transportation channel. However, Weaver (1963) reported that Chinook salmon moved progressively slower in a test flume as velocities increased from 2 to 8 ft/s.

Note that as tailwater level rises and the lower fishway weirs become submerged, it becomes necessary to increase the flow in this area of the ladder to meet the transport velocity criterion (Bell 1991).

An AWS can be used to supply additional water through wall or floor diffusers. Care should be taken to design the fishway weirs that will be submerged to accommodate the additional flow in the ladder so that other fish passage (or hydraulic) criteria are not exceeded. The transport channel velocity guidelines do not apply to individual ladder pools since these are governed by design criteria specific to these pools.

5.3 Auxiliary Water Systems

5.3.1 Description and Purpose

An AWS should be used to supply additional water to the fishway when the required attraction flow (as specified in Section 5.2.2.4) is greater than ladder flow.

Auxiliary water is often required at fishways to provide additional attraction flow from the entrance pool to fishway entrances (Bell 1991). Adding AWS flow is based on the concept that fish migrating upstream are attracted by flow velocity of certain magnitudes, which the fish swim against to continue their migration upstream (Clay 1995). Auxiliary water can also be supplied through an AWS to areas between fishway weirs that are partially submerged by high tailwater elevations and fail to meet the flow velocity criterion, as discussed in Section 5.2.2.12. In addition, an AWS can be used to provide additional flows to various transition pools in the ladder such as bifurcation or trifurcation pools, multiple entrances, pools in fish trapping facilities, exit control sections, and counting station pools.

5.3.1.1 AWS supply source

The source of water for the AWS flow should be of the same quality (e.g., temperature, turbidity, and water chemistry) as the flow in the ladder (i.e., the receiving water).

The AWS flow is usually routed from the forebay to the ladder via gravity, but water quality may vary from the ladder flow depending on the location of the AWS intake. The AWS flow can also be pumped from the tailrace or delivered via a combination of gravity and pumped sources. Differences in the water sources could cause fish to reject the ladder.

5.3.2 Specific Criteria and Guidelines – AWS Fine Trash Racks

5.3.2.1 Bar spacing

A fine trash rack should be provided at the AWS intake with clear space between the vertical flat bars of 0.875 inch or less.

The purpose of an AWS fine trash rack is to stop debris from entering the AWS, which might plug the upstream side of the diffuser panel. Since the normal, clear opening between bars on the diffuser panels is 1 inch (Section 5.3.7), the AWS fine trash rack should be 0.875 inch or less. At sites where Pacific lamprey may be present and diffusers with 0.75-inch clear openings are used (Section 5.3.7), the AWS fine trash rack should have a maximum clear opening of 0.625 inch or less.

5.3.2.2 Velocity

Maximum velocity through the AWS fine trash rack should be less than 1 ft/s, as calculated by dividing the maximum flow by the submerged area of the fine trash rack.

5.3.2.3 Cleaning consideration

The support structure for the fine trash rack should not interfere with cleaning requirements and should provide access for debris raking and removal.

5.3.2.4 Slope

The fine trash rack should be installed at a 1H:5V (horizontal:vertical) or flatter slope for ease of cleaning. The fine trash rack design should accommodate maintenance requirements by considering access for personnel, travel clearances for manual or automated raking, and removal of debris.

5.3.2.5 Staff gages and head differential

Staff gages should be installed to indicate head differential across the AWS intake fine trash rack and should be located to facilitate observation and in-season cleaning. Head differential across the AWS intake fine trash rack should not exceed 0.3 foot in order to facilitate cleaning, minimize velocity hot spots, and maintain hydraulic efficiency in gravity and pumped systems.

Staff gages are used for determining whether the head across a trash rack is within criteria or not. Care should be taken when locating staff gages so that they can be easily read by personnel.

5.3.2.6 Structural integrity

AWS intake fine trash racks should be of sufficient structural integrity to avoid the permanent deformation associated with maximum occlusion.

5.3.3 Specific Criteria and Guidelines – AWS Screens

In instances where the AWS poses a risk to the passage of juvenile salmonids because of its design involving high head and convoluted flow paths, the AWS intake should be screened to the standards specified in Chapter 8 to prevent juvenile salmonids from entering the AWS.

Trip gates, pressure relief valves, or other alternate intakes to the AWS may be included in the design to ensure that AWS flow targets are achieved if screen reliability is uncertain under high river flow conditions. Debris and sediment issues may preclude the use of juvenile fish screen criteria for AWS intakes at certain sites. Passage risk through an AWS will be assessed by NMFS on a site-specific basis to determine whether screening of the AWS is warranted and how to provide the highest reliability possible.

5.3.4 Specific Criteria and Guidelines – AWS Flow Control

The AWS should have a flow control device located sufficiently far away from the AWS intake to ensure the flow at the AWS fine trash rack or screen is uniformly distributed. To facilitate cleaning, the flow control system should allow flow to be easily shut off for maintenance and then restarted (and reset) to proper operating conditions.

The flow control device may consist of a control gate, pump control, turbine intake flow control, or other flow control systems located sufficiently far away from the AWS intake to ensure uniform flow distribution at the AWS fine trash rack for all AWS flows. Flow control is necessary to ensure that the correct quantity of AWS flow is discharged at the appropriate location during a full range of forebay and tailwater levels.

5.3.5 Specific Criteria and Guidelines – AWS Excess Energy Dissipation

Excess energy should be dissipated from AWS flow prior to passage through diffusers.

Dissipation of excess energy is necessary to minimize surging and induce relatively uniform velocity distribution at the diffusers because surging and non-uniform velocities may cause adult fish jumping and associated injuries or excess migration delay. The introduction of highly turbulent or aerated water will discourage fish from entering or passing through a fishway and possibly result in fish delay or injury (Clay 1995). Examples of methods to dissipate excess AWS flow energy include the following:

- Routing flow into a fishway pool with adequate volume (Section 5.3.6.2)
- Passing AWS flow through a turbine
- Passing AWS flow through a series of valves, weirs, or orifices
- Passing AWS flow through a pipeline with concentric rings or other hydraulic transitions designed to induce head loss

All of these dissipation systems require that AWS flow passes through a baffle system that has a porosity of less than 40% to reduce surging through fishway entrance pool diffusers. Adjustable baffles may be required in some systems to properly balance flow across the diffuser.

Figure 5-3 provides a schematic of a fishway AWS diffuser system showing the components needed, and their shape and arrangement, to control water flow rate and convert high-velocity, high-pressure, non-uniform flow into low-energy uniform flow.

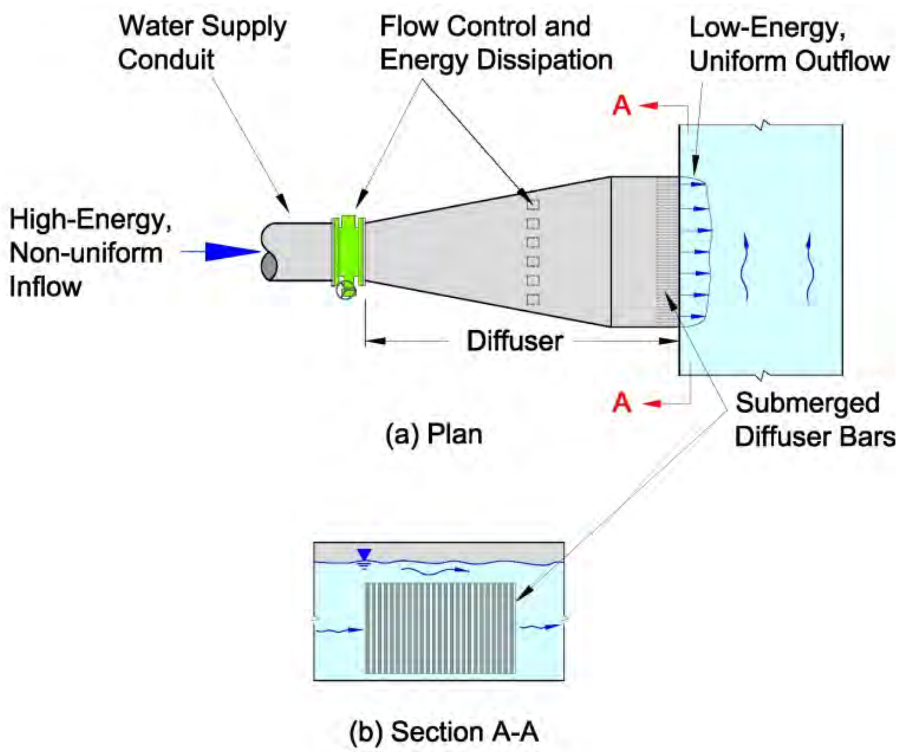


Figure 5-2. Schematic of a fishway AWS diffuser system in plan (a) and section (b) views

5.3.5.1 Energy dissipation pool volume

An energy dissipation pool in an AWS should have a minimum water volume established by the formula shown in Equation 5-1.

$$V = \frac{(\gamma)(Q)(H)}{16\ ft\text{-}lb\ /ft^3/s} \tag{5-1}$$

where:

V = pool volume in cubic feet (ft^3)
γ = specific weight of water, 64.2 pounds (lb) per ft^3
Q = AWS flow, in ft^3/s
H = energy head of pool-to-pool flow, in feet drop into the AWS pool

Note that the pool volumes required for AWS pools are smaller than those required for fishway pools. This is due to the need to provide resting areas in fishway pools and because AWS systems require additional elements (e.g., diffusers and valves) to dissipate energy and are not pathways for upstream fish passage.

5.3.6 Specific Criteria and Guidelines – AWS Diffusers

The spaces between bars of a diffuser should be sized to prevent fish passage and injury (Bell 1991; Bates 1992). For adult salmonid passage, the maximum clear spacing between bars is 1 inch between diffusers bars. At sites where adult Pacific lamprey may be present, diffusers should have a maximum 0.75-inch clear spacing between bars.

Wall diffusers should consist of non-corrosive, vertically oriented diffuser panels of vertically oriented flat bar stock. Similarly, floor diffusers should consist of non-corrosive, horizontally oriented diffuser panels of horizontally oriented flat bar stock. Orientation of flat bar stock should maximize the open area of the diffuser panel. If a smaller species or life stage of fish is present, smaller clear spacing between bar stock may be required.

5.3.6.1 Material

The bars and picket panels used as part of AWS diffuser systems should be made of aluminum, stainless steel, or epoxy-coated carbon steel. The use of submerged galvanized steel should be minimized or eliminated, especially when used in close proximately to fish (i.e., fishways).

Galvanized steel is coated with zinc, a metal that can be toxic to fish.

5.3.6.2 Velocity and orientation

The maximum AWS diffuser velocity should be less than 1 ft/s for wall diffusers and 0.5 ft/s for floor diffusers based on the total submerged diffuser panel area (Bell 1991). Wall diffusers should only be used when the orientation can be designed to assist with guiding fish within the fishway. Diffuser velocities should be nearly uniform, which may require the use of porosity control panels (Section 5.3.6.3). The face of the diffuser panels (i.e., the surface exposed to the fish) should be flush with the wall or floor.

These criteria are based on *Design of Fishways and Other Fish Facilities* (Clay 1995), which states that 1 ft/s "has been adopted as the best compromise between practicality and efficiency," These criteria are also based on the results of laboratory studies where spring- and fall-run Chinook salmon and steelhead passage times increased when diffuser flows were added and were progressively longer as floor diffuser velocity increased from 0.25 to 1.25 ft/s (Gauley et al. 1966).

An example of wall diffusers being used to assist in guiding fish is when the diffusers in the entrance pool of a fishway are situated such that fish are naturally lead upstream to the first ladder pool.

When wall diffusers are used in conjunction with a half Ice Harbor-style ladder, the diffuser should be located on the same side as the overflow weir, and the diffuser bars should be oriented horizontally.

5.3.6.3 Porosity control baffles

Similar to juvenile fish screens, diffusers should include a system of porosity control baffles located just upstream of the diffuser pickets to ensure that average velocities at the face of the diffuser are uniform and can meet criteria (Section 5.3.6.2).

The purpose of the porosity control panels is to control the amount of flow through the diffuser pickets and create a uniform flow condition at the face of the pickets.

5.3.6.4 Debris removal

The AWS design should include access for personnel to remove debris from each diffuser unless the AWS intake is required per the criteria listed in Section 5.3.4 to be equipped with a juvenile fish screen (Chapter 8).

5.3.6.5 Edges

All flat bar diffuser edges and surfaces exposed to fish should be rounded or ground smooth to the touch, with all edges aligning in a single smooth plane to reduce the potential for contact injury.

5.3.6.6 Lamprey passage

At sites where Pacific lamprey are present, horizontal diffusers should not extend the complete width of the floor of the fishway or entrance pool. A solid surface, approximately 1.5 feet wide, should be located along the floor between the lateral sides of the diffuser panels and the base of either wall.

5.3.6.7 Elevation

Wall AWS diffusers should be submerged throughout the range of operation (i.e., the top elevation of the wall diffuser should be below the lowest water surface elevation that will occur based on the fishway design).

This is to prevent water from cascading through the diffuser, which can induce fish to leap at the surface disturbance.

5.3.7 Specific Criteria and Guidelines – Bedload Removal Devices

At locations where bedload may cause accumulations at the AWS intake, sluice gates or other simple bedload removal devices should be included in the design.

5.4 Transport Channels

5.4.1 Description and Purpose

A transport channel conveys flows between different sectors of the upstream passage facility, providing a route for fish to pass.

5.4.2 Specific Criteria and Guidelines – Transport Channels

5.4.2.1 Velocity range

The transport channel velocities should be between 1.5 and 4 ft/s (Gauley et al. 1966; Bates 1992), including flow velocity over or between fishway weirs inundated by high tailwater (Bell 1991).

Gauley et al. (1966) reported that Chinook and sockeye salmon and steelhead passage times did not differ significantly between water velocities of 1 and 4 ft/s in an experimental 270-foot-long transportation channel. However, Weaver (1963) reported that Chinook salmon moved progressively slower in a test flume as velocities increased from 2 to 8 ft/s.

5.4.2.2 Dimensions

The transport channels should be a minimum of 5 feet deep and 4 feet wide.

This is based on providing the narrowest, shallowest flow path that adult fish are known to move through readily while also displaying the least amount of fallback behavior and delay. In addition, this size of channel relates to the goal of keeping water velocities in the transport channel low.

5.4.2.3 Lighting

Ambient natural lighting should be provided in all transport channels, if possible. If ambient (natural) lighting is not available, acceptable artificial lighting should be used.

In laboratory tests, fish were presented with the choice of a large entrance (3.9 feet by 3.9 feet) that was dark or a smaller entrance (1.5 feet by 2 feet) that was lighted. Study results corroborate the understanding that fish prefer lighted entrances and channels: 80% of Chinook salmon, 90% of coho salmon, 69% of steelhead, and 86% of sockeye salmon chose the lighted entrance (Bates 1992).

5.4.2.4 Design (general)

Based on the literature and experiences of fish biologists at many facilities located in the WCR, the following features should be included in the design of transport channels:

- *The transport channels should be of open channel design (Bell 1991).*
- *Designs should avoid hydraulic transitions or lighting transitions (USFWS 1960; Bell 1991).*
- *Transport channels should not expose fish to any moving parts.*
- *Transport channels should be designed so that there is no standing water in the channel when the system is dewatered.*
- *Transport channels should be free of exposed edges that protrude from channel walls.*

5.5 Fish Ladder Design

5.5.1 Description and Purpose

The purpose of a fish ladder is to convert total project head at the passage barrier into passable increments and provide suitable conditions for fish to hold, rest, and ultimately pass upstream. Nearly all of the energy from the upstream ladder pool is dissipated in the downstream ladder pool volume, resulting in a series of relatively calm pools that migrating fish may use to rest and stage before ascending upstream. The criteria provided in this section have been developed to provide conditions to pass all anadromous salmonid species upstream with minimal delay and injury.

5.5.2 Common Types of Fish Ladders

Fish ladders or fishways, in one form or another, have been around for more than 300 years (Clay 1995). Over time, ladder designs have developed and evolved and have been adapted to meet site-specific conditions. For the purpose of this document, fish ladders are divided into the following two categories:

- Pool-style ladders, including:
  - Vertical slot
  - Pool and weir
  - Weir and orifice
  - Pool and chute
- Roughened (Baffled) chute-style ladders, including:
  - Denil steeppass
  - Alaska steeppass (ASP)

The following sections present brief discussions of criteria and guidelines for the more common styles of fish ladders.

5.5.2.1 Vertical slot ladder

The vertical slot configuration is a pool-style of fish ladder (Figures 5-3 through 5-5; Table 5-1). The vertical slot ladder is suitable for passage impediments that have tailrace and forebay water surface elevations that fluctuate within large ranges. The maximum head differential—typically associated with the lowest river flows—establishes the design water surface profile, which usually parallels the fishway floor gradient.

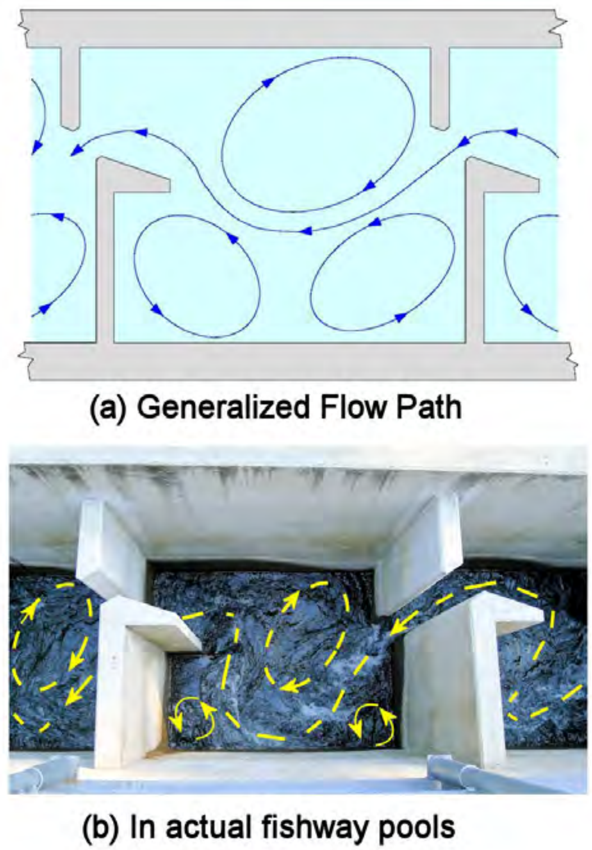


Figure 5-3. Plan view of a vertical slot ladder showing generalized flow paths

Figure 5-4. Oblique view of a vertical slot ladder baffle when dewatered

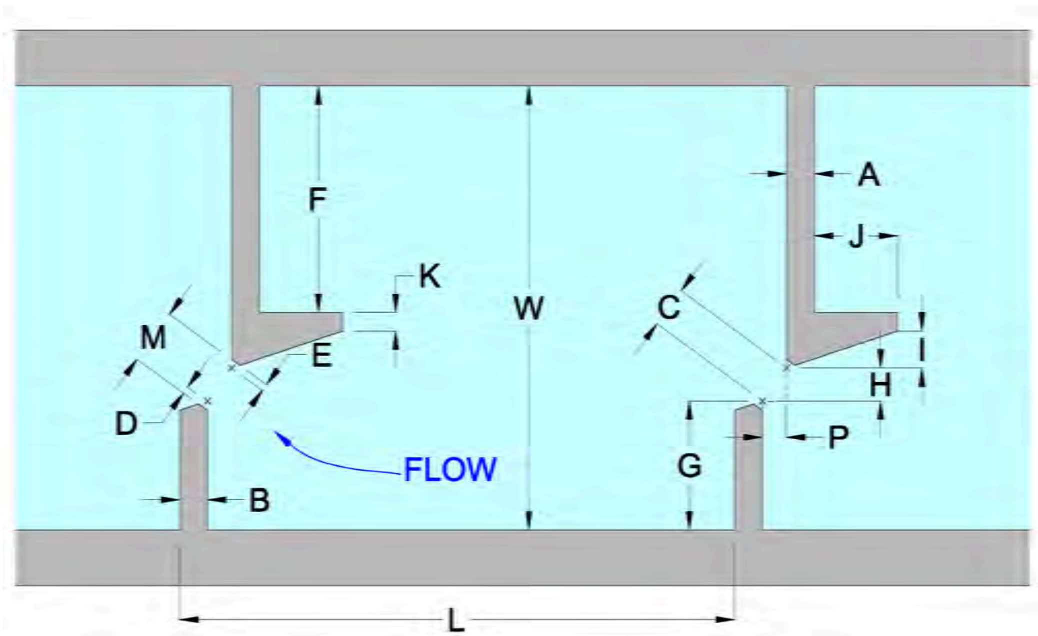


Figure 5-5. Dimensions of a typical vertical slot ladder pool

(Note that information for Figure 5-6 is provided in Table 5-1. “D” is the dimension of the layout points used during ladder design and construction (i.e., the framing and the form work for the concrete pours); it determines the chamfer for the slot and the width of the slot; and knowing “D” allows the designer to layout the complex angles used during construction.)

Table 5-1. Dimensions for vertical slot ladder components measured in feet.

Symbol		Dimension Nomenclature (Refer to Figure 5-6)			
L		Pool length	10’0”	10’0”	10’0”
W		Pool width	6’0”	8’0”	8’0”
A		Long baffle width[A]	0’6”	0’6”	0’6”
B		Short baffle width[A]	0’6”	0’6”	0’6”
M		Slot width	1’0”	1’0”	1’3”
C		Slot width layout points	0’9”	0’9”	0’9”
D, E		Dimension “C” layout points (separation from baffles)	0’1½”	0’1½”	0’3”
F		Long baffle wall length	3’1”	4’1”	4’1”
G		Short baffle wall length (wall to layout point)	1’3¾”	2’3¾”	2’3¾”
I		Flow deflector width change	0’7”	0’8”	0’7”
J		Flow deflector length	1’3”	1’6”	1’3”
K		Flow deflector upstream width	0’5”	0’4”	0’5”

Note:
A: Short baffle and long baffle widths may need to be increased in certain instances for structural integrity in large fishway installations.

The full-depth vertical slots allow fish passage at any depth (Clay 1995). Fish are assumed to be able to move directly from slot to slot in a straight path, although this has not been verified (Clay 1995). However, hydraulic studies have verified that velocity through the slot is constant throughout the vertical profile (Katopodis 1992). The vertical slot may not be well suited for species that require overflow weirs for passage or that tend to orient to walls such as American shad.

5.5.2.1.1 *Vertical slot width and depth*

For adult anadromous salmonids, slots should never be less than 1 foot in width. If larger Chinook salmon are expected to pass, the minimum slot width is 1.25 feet (Clay 1995). Bell (1991) recommends a minimum slot depth of 3 feet, although they are typically on the order of 5- to 6-feet deep to match the required pool depth.

The passage corridor typically consists of 1- to 1.25-foot-wide vertical slots between fishway pools. However, narrower slots have been recommended (Clay 1995) and used in applications for other fish species that are smaller than salmon or steelhead. In some situations, wider slots (or two slots per ladder weir) are used if AWS flow is not being added to the ladder.

Vertical slot ladders tend to require more water to operate properly compared with other styles of fishways because of the width and depth of the slot and the head differential between pools. Low sills can be added to the bottom of each slot to reduce the overall amount of flow in the ladder that is required. However, these sills may block the passage of species that prefer or need to travel along the floor of a ladder.

5.5.2.1.2 *Vertical slot geometry (pool size)*

Standard, proven design dimensions should be adhered to unless it can be proven through physical hydraulic modeling that changes do not affect the function of the ladder.

Vertical slot ladders are sensitive to changes in pool geometry (e.g., pool width, length, slope, and slot width; Clay 1995), and initial construction costs are higher than other types of ladders because of the more complex design and concrete placement.

5.5.2.2 Pool and weir ladder

The simplest style of fish ladder is the pool and weir ladder (Bell 1991); it is also one of the oldest styles of fish ladder. The pool and weir fish ladder passes the entire, almost constant, fishway flow through successive pools separated by overflow weirs that break the total project head into passable increments (Figure 5-6). This design allows fish to ascend to higher elevations by passing over weirs, and it provides resting zones within each pool. When passing this style of ladder, fish must leap or swim over the weir flow. Pools are sized to allow flow energy to be nearly fully dissipated through turbulence within each receiving pool (Clay 1995).

Figure 5-6. Examples of pool and weir ladders

(Note that the orifices in the weir wall on the left-side photo are to drain each of the pools and are not meant for fish passage.)

In contrast to vertical slot ladders, pool and weir ladders require nearly constant water surface elevations in the forebay pool to function properly (Bell 1991; Clay 1995). When the water surface elevation fluctuates outside of the design elevation, too much or too little flow enters the fishway. This flow fluctuation may affect upstream passage by causing fishway pools to be excessively turbulent or providing insufficient flow. To accommodate forebay fluctuations and maintain a consistent flow in the ladder, pool and weir ladders are often designed with an AWS (Section 5.3) and fishway exit control section (Section 5.7; Bell 1991). To accommodate tailwater fluctuations, pool and weir ladder designs may include an adjustable fishway entrance (i.e., adjustable geometry and attraction flow) and an AWS to provide additional flow to meet the channel velocity criterion (Section 5.4.2.1; Bell 1991).

5.5.2.3 Weir and orifice ladder

The weir and orifice fish ladder passes flow from the forebay through successive fishway pools connected by overflow weirs and submerged orifices, which divide the total project head into passable increments (Figures 5-7 and 5-8, Table 5-2; Clay 1995). Weir and orifice ladders are similar to pool and weir ladders in the following ways:

- Weir and orifice ladders require nearly constant water surface elevations in the forebay pool (unless adjustable components are included to accommodate the varying forebay level); water surface elevations outside of the design elevation result in too much or too little flow entering the fishway, which may affect fish passage due to turbulence or insufficient flow.
- Weir and orifice ladders are often designed with an AWS and fishway exit control section (Section 5.7), an adjustable fishway entrance (i.e., adjustable geometry and attraction flow), and an AWS to provide additional low diffusers to meet the transport channel velocity criterion (Section 5.4.2.1).

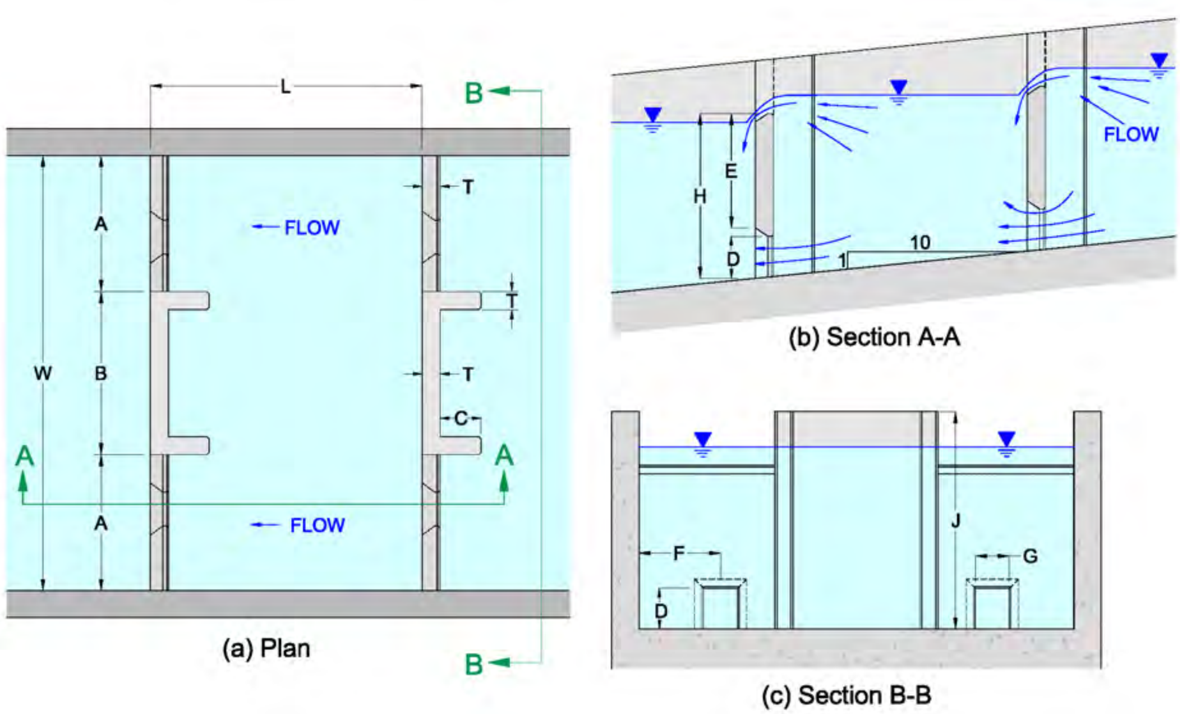


Figure 5-7. Ice Harbor-style weir and orifice ladder (adapted from Gauley et al. 1966

(Note that information for Figure 5-7 is provided in Table 5-2.)

(a) Looking downstream (b) Looking upstream

Figure 5-8. Overhead views of Ice Harbor-style weir and orifice fish ladders

Table 5-2. Dimensions for Ice Harbor fishways measured in feet

Symbol	Dimension Nomenclature (Refer to Figure 5-8)	Bell 1991	Gauley et al. 1966
L	Pool length	8–20	10
W	Pool width	6–20	16
A	Weir length	1.5–5	5
B	Center baffle width	W/2*	6
C	Flow stabilizer length	NA	1’6”
D	Orifice height	1’6”	1’6”
E	Baffle height above orifice	4’3”	4’6”
F	Wall to orifice center line	NA	3
G	Orifice width	1’3”	1’6”
H	Weir height	6	6
J	Wing baffle height	8	8
T	Weir and baffle thickness	NA	NA

Notes:
* See “W” in panel (a) of Figure 5-8.
Dimensions listed under Bell (1991) are taken from https://www.fs.fed.us/biology/nsaec/fishxing/fplibrary/Bell_1991_Fisheries_handbook_of_engineering_requirements_and.pdf.
Dimensions listed under Gauley et al. 1966 are taken from the report located here: https://www.nwfsc.noaa.gov/assets/26/7778_08132014_135336_Gauley.et.al.1966.pdf.
NA: not available

When passing this style of ladder, fish have the choice of leaping or swimming over the weir or swimming through the orifice, and it is NMFS' experience that most salmonids prefer to swim through the orifice. The Ice Harbor ladder is an example of a weir and orifice fish ladder. This ladder design was developed in the 1960s for use at Ice Harbor Dam on the Snake River in Washington by the Bureau of Commercial Fisheries at USACE Fisheries-Engineering Research Laboratory (FERL), which was located at the Bonneville Dam on the Columbia River in Oregon (Figure G-1 in Appendix G). Fish passage research was conducted at FERL from 1955 until it was decommissioned in the 1980s (see Appendix I for a listing of reports of research conducted at the FERL). The research provided basic knowledge of the behavior, abilities, and requirements of fish in fish passage situations (Collins 1976).

Development and testing at FERL resulted in the design of the l-on-10 slope ladder for Ice Harbor Dam, which was studied in a full-scale section of the ladder consisting of six ladder pools. A prototype ladder was tested during its first year of operation at Ice Harbor Dam. The design is a pool and weir ladder with submerged orifices, flow stabilizers, and a non-overflow section in the middle of each weir (Figures 5-7 and 5-8). See Table 5-2 for typical dimension of this type of fishway. There is a 1-foot rise between pools, and the average water depth under normal operating conditions is 6.5 feet (Gauley et al. 1966). The Ice Harbor-style of ladder includes two rectangular orifices centered on and located directly below each overflow weir. The position and depth of the orifices were found to have a significant effect on the passage of fish through rectangular submerged orifices (Thompson et al. 1967). The orifice and weir combinations are located on each side of the longitudinal centerline of the ladder. Between the two weirs is a slightly higher non-overflow wall with an upstream-projecting flow baffle located at each end. An adaptation for lower flow designs is the half Ice Harbor ladder design, which consists of a weir, an orifice, and a non-overflow wall between fishway pools.

5.5.2.4 Pool and chute ladder

A pool and chute ladder is a hybrid that operates under varying river flow conditions. This ladder is designed to operate as a pool and weir ladder at low river flows and as a roughened chute-style fishway at higher river flows (Figure 5-9). This ladder is an alternative style of ladder for sites with a low hydraulic drop that must pass a wide range of streamflows with a minimum of flow control features. Placement of stoplogs—a cumbersome and potentially hazardous operation—is required to optimize operation of this ladder. However, once suitable flow regimes are established, the need for additional stoplog placement may not be required. Criteria for this type of ladder design are still evolving, and design proposals will be assessed by NMFS on a site-specific basis. Bates (1992) provides specific criteria and guidelines for this style of ladder where fish have the option of swimming over, or leaping the overflow weir, or swimming through the orifice. The lateral slope of the weirs presents fish with flow conditions that range from plunging flow near the edges to streaming flow towards the center of the ladder.

Figure 5-9. Pool and chute ladder dewatered (at left) and watered (at right)

5.5.2.5 Half Ice Harbor and half-pool and chute ladders

The flow rate available to pass through a fishway at small projects is often too low to take advantage of the benefits of the standard Ice Harbor or pool and chute ladder designs. In these situations, it is possible to design and construct weirs shaped as one-half of an Ice Harbor-style weir and orifice ladder or one-half of a pool and chute-style ladder (Figure 5-10). These designs share the same advantages and disadvantages as their full-sized counterparts and should meet all of the design criteria for each type of full-sized ladder. The hydraulic design process used for half-ladders is analogous to the design process used for full-sized ladders.

Figure 5-10. Half ladder designs for projects with reduced available fishway flows

(Note: panel on left is a half-Ice Harbor ladder weir and orifice design; panel on right is a half-pool and chute ladder with weir design.)

5.5.3 Specific Criteria and Guidelines – Fish Ladder Design

5.5.3.1 Hydraulic drop

The maximum hydraulic drop between fish ladder pools should be 1 foot or less (Bell 1991; Clay 1995). Where pink or chum salmon are present, the maximum hydraulic drop between pools should be 0.75 foot or less (Bates 1992; Clay 1995).

5.5.3.2 Flow depth

Fishway overflow weirs should be designed to provide at least 1 foot (± 0.1 foot) of flow depth over the weir crest (Clay 1995; WDFW 2000).

The depth should be indicated by locating a single staff gage in an observable, hydraulically stable location that is representative of flow depth throughout the fishway. The zero reading of the gage should be at the overflow weir crest elevation.

5.5.3.2.1 *Streaming flow*

Some fish species will not leap or are poor leapers and will refuse to pass or become delayed by plunging flow conditions in a ladder. They may also refuse to pass through the orifices in a ladder (e.g., all shad species). For those species, streaming flow should be created *between ladder pools to provide acceptable passage conditions. When pink or chum salmon are present, the upstream weir crest should be submerged by at least 0.5 foot by the downstream water surface level (Bates 1992). Where American shad are present, the upstream weir crest should be submerged by at least 0.3 foot by the downstream water surface level.*

Streaming flow occurs when the weir is backwatered by the downstream weir (Bates 1992; Katapodis 1992). The transition between plunging flow and streaming flow is hydraulically unstable and should be avoided according to Bell (1991) and Bates (1992) because passage can be delayed when flow is in this transition. Hydraulic instability occurs in the transition regime between the upper range of plunging flow and the lower range of streaming flow. The instability can also cause large oscillations that are transmitted throughout the fishway because energy is not dissipated in each pool of the fishway, which makes the streaming flow jet difficult to manage. For these reasons, streaming flow in a fishway should be used cautiously (Bates 1992).

Submerging the upstream weir crest by 0.3 foot is based on experience with adjusting ladder flows at Columbia River dams to pass American shad. In addition, Larinier and Travade (2002) state that a head of around 1.3 feet and streaming flow in an Ice Harbor-style ladder are needed for shad passage. Rideout et al. (1985) report substantial improvements in American shad passage at the Turners Falls dam fishway in Massachusetts when flow over weir crests was changed from plunging to streaming.

5.5.3.3 Pool dimensions

In general, pool dimensions should be a minimum of 8 feet long (upstream to downstream), 6 feet wide, and 5 feet deep. However, specific ladder designs may require pool dimensions that are different from the minimums specified in this criterion, depending on site conditions and ladder flows (see Clay 1995).

For small stream ladders, Bell (1991) provides minimum dimensions for some pool and weir fishway designs. The minimum pool should not be less than 6 feet long, 3 feet deep, and 4 feet wide. It is recommended that the fishway slope not exceed 1:8. For pools less than 8 feet in length, the drop between pools should be reduced proportionally. To allow for the proper dissipation of the orifice flow, the pool dimensions for a pool and orifice-style ladder should not be reduced (Clay 1995).

Ladder pools should be designed so that there is no standing water in the pools when the system is dewatered. The floors of the ladder should be sloped from the sides to the floor orifice to encourage fish to move downstream during salvage operations conducted when a ladder is dewatered for maintenance.

5.5.3.4 Turning pools

Turning pools (i.e., pools where the fishway direction changes more than 90 degrees) should be at least double the length of a standard fishway pool, as measured along the centerline of the fishway flow path. The orientation of the upstream weir to the downstream weir should be such that energy from flow over the upstream weir does not affect the hydraulic conditions at the downstream weir.

5.5.3.5 Pool volume

The pool volume within the fishway should provide sufficient volume (i.e., hydraulic capacity) to absorb and dissipate the pool-to-pool energy and accommodate the maximum daily run of fish (i.e., fish capacity; Appendix H).

Generally, the volume required to provide adequate hydraulic capacity governs pool sizing (Bell 1991; Bates 1992). To provide adequate hydraulic capacity, the fishway pools should be a minimum volume (of water) based on Equation 5-2.

$$V = \frac{(\gamma)(Q)(H)}{4\ ft{-}lb\ /ft^3/s} \qquad (5\text{-}2)$$

where:

V = pool volume in ft^3
γ = specific weight of water, 64.2 lb per ft^3
Q = specific weight flow, in ft^3/s
H = energy head of pool-to-pool flow, in feet

This pool volume should be provided under every expected design flow condition, with the entire pool volume having active flow and contributing to energy dissipation.

If large numbers of fish are expected to pass the fish ladder in a relatively short amount of time, overcrowding can occur, leading to delay. Delay in passage is minimized by providing ample volume to accommodate the peak of the run without overcrowding (Clay 1995). Therefore, it may be necessary to increase the individual pool volume to accommodate the peak run of fish. See Appendix H for sizing a fish ladder based upon run size.

5.5.3.6 Freeboard

The freeboard of the ladder pools should be at least 3 feet at high design flow.

5.5.3.7 Orifice dimensions

At sites where large salmonids are expected, the minimum dimensions of the orifice should be 18 inches high by 15 inches wide (Bell 1991), based on the Ice Harbor ladder design dimensions (Section 5.5.3.3).

The minimum dimensions of orifices where large salmonids are not expected should be at least 15 inches high by 12 inches wide.

The top and sides of the orifice should be chamfered 0.75 inch on the upstream side and chamfered 1.5 inches on the downstream side of the orifice to provide the most stable flow (Bates 1992).

For sites where Pacific lamprey are present, the floor of the fishway should provide a continuous, uninterrupted surface through the orifice. USACE (Portland District) has developed and installed an orifice with rounded edges to facilitate Pacific lamprey passage.

The primary concern with smaller orifices is the increased risk of plugging by debris (WDFW 2000).

5.5.3.8 Lighting

Ambient lighting should be provided throughout the fishway, and abrupt lighting changes should be avoided (Bell 1991). In enclosed systems, such as transport tunnels, provisions for artificial lighting should be included. In cases where artificial lighting is required, lighting in the blue-green spectral range should be provided. Artificial lighting should be designed to operate under all environmental conditions at the installation.

These lighting criteria are based in part on laboratory studies where a majority of Chinook and sockeye salmon and steelhead entered the lighted orifice when given a choice between a dark experimental orifice and a lighted control orifice where head was equal between the two orifices (Weaver et al. 1976).

5.5.3.9 Change in flow direction

At locations where the flow changes direction more than 60 degrees, 45-degree vertical miters (minimum 20 inches wide) or a 2-foot minimum, vertical radius of curvature should be included in the design of the outside corners of fishway pools (Bell 1991).

Bell reports that "Fish accumulate when pool hydraulic patterns are altered. If the design includes turn pools, fish will accumulate at that point. Square corners, particularly in turn pools, should be avoided as fish jump at the upwelling so created" (1991). Depending upon the pool configuration, size of the turning pool, and amount and velocity of the flow in the ladder, larger radii of curvatures may be necessary.

5.6 Counting Stations and Windows

5.6.1 Description and Purpose

Counting stations provide a location and facility to observe and enumerate fish utilizing the fish passage facility. Although not always required, a typical counting station includes a video camera or fish counting technician, crowder, and counting window (Bell 1991). Counting stations are often included in a fish ladder design to allow fishery managers to assess fish population status, observe fish size and condition, and conduct scientific research.

5.6.1.1 Operation

Counting stations should not interfere with the normal operation of the ladder and should not create excessive fish passage delay.

A decision to include a counting station as part of the ladder design should be carefully considered. Regardless of how well the counting station is designed, oftentimes fish hold and delay at counting stations because of conditions that change the facility such as crowding, lighting, and hydraulics. Instead of a counting station, other means of enumeration may be acceptable, including the use of submerged cameras and their associated lighting, adult PIT-tag detectors, and orifice counting tubes.

5.6.2 Specific Criteria and Guidelines – Counting Stations

5.6.2.1 Location

Counting stations should be located in a hydraulically stable, low velocity (i.e., around 1.5 ft/s), and accessible area of the upstream passage facility.

5.6.2.2 Downstream and upstream pools

The pool downstream of the counting station should extend at least two standard fishway pool lengths from the downstream end of the picket leads. The pool upstream of the counting station should extend at least one standard fishway pool length from the upstream end of the picket leads. Both pools should be straight and in line with the counting station (Bell 1991).

5.6.3 Specific Criteria and Guidelines – Counting Windows

5.6.3.1 Design and material

The counting window should be designed such that cleaning of the window can be accomplished completely, conveniently, and at a frequency that ensures window visibility will be maintained and accurate counting can be accomplished. The counting window material should be abrasion-resistant to accommodate frequent cleaning.

5.6.3.2 Orientation

Counting windows should be vertically oriented.

5.6.3.3 Sill

The counting window sill should be positioned to allow full viewing of the fish passage slot (from floor to water surface).

5.6.3.4 Lighting

The counting window design should include sufficient indirect, artificial lighting to provide satisfactory fish identification at all hours of operation and without causing passage delay.

5.6.3.5 Dimensions

The minimum observable length of the counting window in the upstream-to-downstream flow direction should be 5 feet, and the minimum height (depth) should be full water depth.

5.6.3.6 Counting window slot width

The width of the counting station slot (the area between the counting window and the vertical surface at the back of the slot) should be at least 18 inches. The design should include an adjustable crowder to move fish closer to the counting window (but not closer than 18 inches) to allow fish counting under turbid water conditions. The counting window slot width should be maximized as water clarity allows and when not actively counting fish.

5.6.3.7 Picket lead

A downstream picket lead should be included in the design to guide fish into the counting window slot, and it should be oriented at a deflection angle of 45 degrees relative to the direction of fishway flow. An upstream picket lead oriented at a deflection angle of 45 degrees to the flow direction should also be provided. Picket orientation, picket clearance, and maximum allowable velocity should conform to specifications for diffusers (Section 5.3.7).

Combined maximum head differential through both sets of pickets should be less than 0.3 foot. Both upstream and downstream picket leads should be equipped with witness marks to verify correct position when picket leads are installed in the fishway. A 1-foot-square opening should be provided in the upstream picket lead to allow smaller fish that pass through the downstream picket lead to escape the area between the two picket leads.

Picket leads may comprise flat stock bars oriented parallel to flow or other cross-sectional shapes, if approved by NMFS.

5.6.3.8 Transition ramps

If the counting window requires a false floor to force fish to swim higher in the water column to be more easily identified, then transition ramps should be included in a counting station design. The ramps should smoothly transition from the floor of the counting station pool to the false floor at the counting window and then back to the counting station floor.

These ramps provide gradual transitions between walls, floors, and the false floor in the counting window slot. The purpose is to minimize flow separations created by head loss that may impede fish passage and induce fallback behavior at the counting window. In situations where space is available, the transitions should be more gradual than 1:8, and where space is confined, a 1:4 transition should be used.

5.6.3.9 Water surface through the counting slot

A free water surface should exist over the length of the counting window.

5.7 Fishway Exit Control

5.7.1 Description and Purpose

This section describes and provides criteria for a ladder exit control channel for fish to egress the fishway and enter the forebay of a dam to continue upstream migration. The exit control channel may include the following features: add-in auxiliary water valves and diffusers, exit pools with varied flow, exit channels, a coarse trash rack that keeps large debris out of the ladder but allows fish to pass through the trash rack and exit the ladder, and fine trash racks and control gates on AWS systems. The exit control section of the ladder also attenuates fluctuations in forebay water surface elevation, thus maintaining hydraulic conditions suitable for fish passage in the ladder pools. Other functions that should be incorporated into the design of the exit control section include minimizing the entrainment of debris and sediment into the fish ladder. Different types of ladder designs (Section 5.5) require specific fish ladder exit design details unique to each type of ladder.

5.7.2 Specific Criteria and Guidelines – Fishway Exit Control

5.7.2.1 Hydraulic drop

The exit control section hydraulic drop per pool should range from 0.25 to 1 foot.

5.7.2.2 Length

The length of the exit channel upstream of the exit control section should be a minimum of two standard ladder pools.

5.7.2.3 Design requirements

Exit section design should utilize the requirements for AWS diffusers, channel geometry, and energy dissipation as specified in Sections 5.3, 5.4, and 5.5.

5.7.2.4 Closure gates

Any closure gate that is incorporated into the exit control section should be operated either in the fully opened or closed position (i.e., the gates cannot be partially open to regulate flow).

5.7.2.5 Location

In most cases, the ladder exit should be located along a shoreline, in a velocity zone of less than 4 ft/s, and sufficiently far enough upstream of a spillway, sluiceway, or powerhouse to minimize the risk of fish non-volitionally falling back through these routes (Clay 1995).

The distance the exit needs to be upstream of these hazards depends on bathymetry near the dam spillway or crest and associated longitudinal river velocities (Bell 1991).

5.7.2.6 Public access

Public access near the ladder exit should be prohibited.

5.8 Fishway Exit Sediment and Debris Management

5.8.1 Description and Purpose

As stated in Section 5.7.1, the design of the ladder exit should strive to minimize the entrainment of debris and sediment into the fish ladder. Floating and submerged debris can become lodged in ladder orifices or on weir crests, alter hydraulic conditions in these fish passage routes, and impact fish behavior and passage rates. Similarly, sediment transported into the fishway can deposit in low-velocity areas, alter hydraulic conditions, and impact fish passage. Removing debris and sediment from ladders can be difficult and costly. Therefore, preventing debris and sediment from entering the ladder from the forebay should be a goal of the ladder exit design.

5.8.1.1 Coarse trash rack

For facilities where maintenance is frequently required and provided, coarse trash racks should be included at the fishway exit to minimize the entrainment of debris into the fishway (Figure 5-9; Bell 1991).

5.8.2 Specific Criteria and Guidelines – Coarse Trash Rack

5.8.2.1 Velocity

The velocity through the gross area of a clean coarse trash rack should be less than 1.5 ft/s to reduce debris accumulation and thus facilitate cleaning of the racks regularly (Bates 1992).

Bell (1991) indicated there is no evidence of fish refusing to pass through trash racks at velocities normal to the trash rack of 2 ft/s or less.

5.8.2.2 Depth

The depth of flow through a coarse trash rack should be equal to the pool depth in the ladder exit channel.

5.8.2.3 Maintenance

At locations where manual cleaning is anticipated, the coarse trash rack should be installed at 1:5 slope (or flatter) for ease of cleaning (Bates 1992). The coarse trash rack design should allow for easy maintenance and provide access for personnel, travel clearances for manual or automated trash raking, and the removal of debris.

5.8.2.4 Bar spacing

The coarse trash rack on the ladder exit should have a minimum clear space between vertical flat bars of 10 inches if Chinook salmon are present, and 8 inches for all other species and instances. Lateral support bar spacing should be a minimum of 24 inches and should be sufficiently set back from the face of the coarse trash rack to allow trash rake tines to fully *penetrate the rack for effective debris removal. Coarse trash racks should extend to the appropriate elevation above water to allow debris raked from the trash racks to be easily removed.*

Bell (1991) recommends that the clear openings of a trash rack be adapted to the width of the largest fish to be passed, which is usually 12 inches for large salmon. Figure 5-11 shows an example of a sloping coarse trash rack on the exit channel of a small fishway.

Figure 5-11.Sloping coarse trash rack on a fishway exit channel

5.8.2.5 Orientation

The fishway exit coarse trash rack should be oriented at a deflection angle greater than 45 degrees relative to the direction of river flow.

5.8.3 Specific Criteria and Guidelines – Debris and Sediment

5.8.3.1 Coarse floating debris

Debris booms, curtain walls, or other provisions should be included in the design of a fishway if coarse floating debris is expected.

5.8.3.2 Debris accumulation

If debris accumulation is expected to be high, the fishway design should include an automated mechanical debris removal system. If debris accumulation potential is unknown, the *design should anticipate the need for debris removal in the future and include features to allow an automated mechanical debris removal system to be retrofitted to the design.*

5.8.3.3 Sediment entrainment and accumulation

The fishway exit should be designed to minimize sediment entrainment into the fishway and sediment and debris accumulation at the exit under normal operations.

5.9 Roughened (Baffled) Chute Fishways

5.9.1 Description and Purpose

This section discusses the baffled chute, which is another general type of fish passage system. It consists of a hydraulically roughened flume that has nearly continuous energy dissipation throughout its length.

5.9.2 Specific Criteria and Guidelines – Baffled Chutes

The baffled chute fishway utilizes a relatively steep, narrow flume with internal roughness elements that generate lower water velocities that allow the fish to swim through the fishway. Denil and ASP fishways are examples of baffled chute fishways that share a similar design philosophy. Baffled chute fishways are designed to operate with less flow and at steeper slopes than traditional ladders.

5.9.2.1 Uses

Denil and ASP fishways should not be used as the primary route of passage at permanent fishway installations in the WCR.

Baffle chute fishways are not considered a substitute for a permanent style of ladder (e.g., a pool and weir ladder) because of their tendency to collect debris and their limited operating range. Denil and ASP fishways are primarily used at sites where the fishway can be closely monitored and inspected daily. This includes off-ladder fish traps, temporary fishways used during construction of permanent passage facilities, and fishways operated temporarily each year to collect hatchery broodstock. Baffle chute fishways should not be used at locations or in situations where the downstream passage of adults or juvenile salmonids occurs.

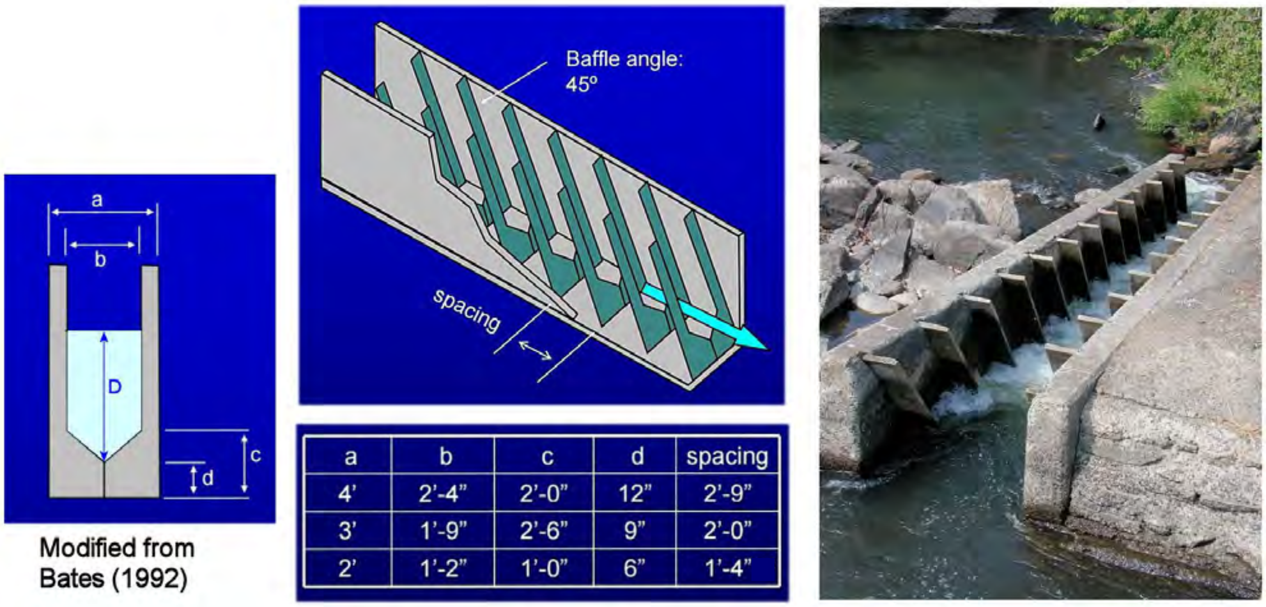
5.9.2.2 Debris

Denil and ASP fishways should not be used in areas where even minor amounts of debris are expected (Bell 1991).

Debris accumulation in any fishway, in combination with turbulent flow, may injure fish or render the fishway impassable. Because of their internal baffle geometry and narrow flow paths, baffle chute fishways are especially susceptible to debris accumulation, creating a blockage to passage.

5.9.2.3 Design

Denil and ASP fishways are designed with a sloped channel that has a constant discharge for a given normal depth, chute gradient, and baffle configuration (Figure 5-12). Energy is dissipated consistently throughout the length of the fishway via channel roughness and results in an average velocity compatible with the swimming ability of adult salmonids. The passage corridor consists of a chute flow between and through the baffles. A wide range of flows are possible for Denil fishways depending on fishway size, slope, and water depth (Bates 1992).



a	b	c	d	spacing
4'	2'-4"	2'-0"	12"	2'-9"
3'	1'-9"	2'-6"	9"	2'-0"
2'	1'-2"	1'-0"	6"	1'-4"

Figure 5-12. Drawings, dimensions, and a photo of a Denil fishway

5.9.2.3.1 *Specific design information – Denil fishways*

The standard dimensions shown in Figure 5-12 and the following design information for Denil fishways is taken from Bates (1992):

- *NMFS recommends a maximum slope of 20%.*
  - The normal slope for a Denil-style fishway is 17% (Bell 1991), though they have been used at slopes up to 25% (Bates 1992).
- *Discharge through Denil fishways can be calculated using Equation 5-3 (Bates 1992).*

$$Q = 5.73D^2\sqrt{bS} \qquad (5\text{-}3)$$

where:

Q = ladder flow, in ft^3/s
D = depth (feet) of flow above the vee baffle
b = clear opening in the baffle (feet)
S = slope (feet/feet)

- *The average chute design velocity should be less than 5 ft/s (Bell 1991).*
    - The most common size of Denil fishway used is the 4-foot-wide flume (Bates 1992).
- *Flow control is important though not as critical for a Denil fishway as for a weir and pool ladder. The forebay should be maintained within several feet to maintain good passage conditions in a Denil fishway.*
    - According to the velocity profiles developed by Rajaratnam and Katopodis (1984), centerline velocities increase towards the water surface in Denil fishways where the ratio of flow depth to width (D/b in Figure 5-13) is more than 3. The height of the Denil fishway is not limited; additional height adds attraction flow and operating range without additional passage capacity because of the higher velocities in the upper part of the fishway (Bates 1992).
- *Minimum depth in a Denil fishway should be 2 feet, and depth should be consistent throughout the fishway for all flows.*
    - Bates (1992) reports that Denil fishways are typically constructed with depths from 4 to 8 feet.
- *The standard length is 30 feet (Bell 1991).*
- *Denil fishways can be constructed out of plywood, steel, or concrete with steel or plywood baffles.*

5.9.2.3.2 *Specific design information – Alaska steeppass fishways*

The ASP fishway is a specially designed baffle chute fishway developed for use in a variety of locations in Alaska (Figure 5-14; Ziemer 1962). It is typically constructed in sections that can be bolted together on site, making the system portable.

(a) Downstream end. (b) Upstream end. (c) In operation.

Figure 5-13. Examples of ASP fishways

The following design information for ASP fishways is taken from Rajaratnam and Katopodis (1984):

- *Discharge through the ASP fishway can be calculated as shown in Equation 5-4:*

$$Q = 1.12S^{0.5}\, D^{1.55}\, g^{0.5} \tag{5-4}$$

where:

Q = flow (ft^3/s)
S = slope (ft/ft)
D = depth (feet) of flow above the floor vane
g = gravitational acceleration (32.2 ft/s^2)

Most of the following design information on ASP fishways is taken from Bates (1992), and standard ASP fishway dimensions are shown in Figure 5-14.

- *NMFS recommends a maximum slope of 28%.*
  - The normal slope is about 25%, but ASP fishways have been tested and used up to a slope of 33% (Bates 1992).
- *The average chute design velocity should be less than 5 ft/s.*
- *Flow control is very important for properly functioning ASP fishways. The forebay water surface cannot vary more than 1 foot without creating passage difficulties, and the tailwater should be maintained within this same range to prevent a plunging flow or backwatered condition from forming. Backwatering the entrance results in reduced entrance velocity and fish attraction (Bates 1992).*
  - For example, Slatick (1975) found that the median passage time for salmon increased fourfold, and 25% fewer salmon entered the fishway when the downstream end was submerged by 2.5 feet.
- *Minimum depth in an ASP fishway is 1.2 feet.*
- *The standard length of each unit is 10 feet. Individual units can be bolted together to create lengths of 20 to 30 feet.*
- *ASP fishways are usually constructed of heavy gauge aluminum.*

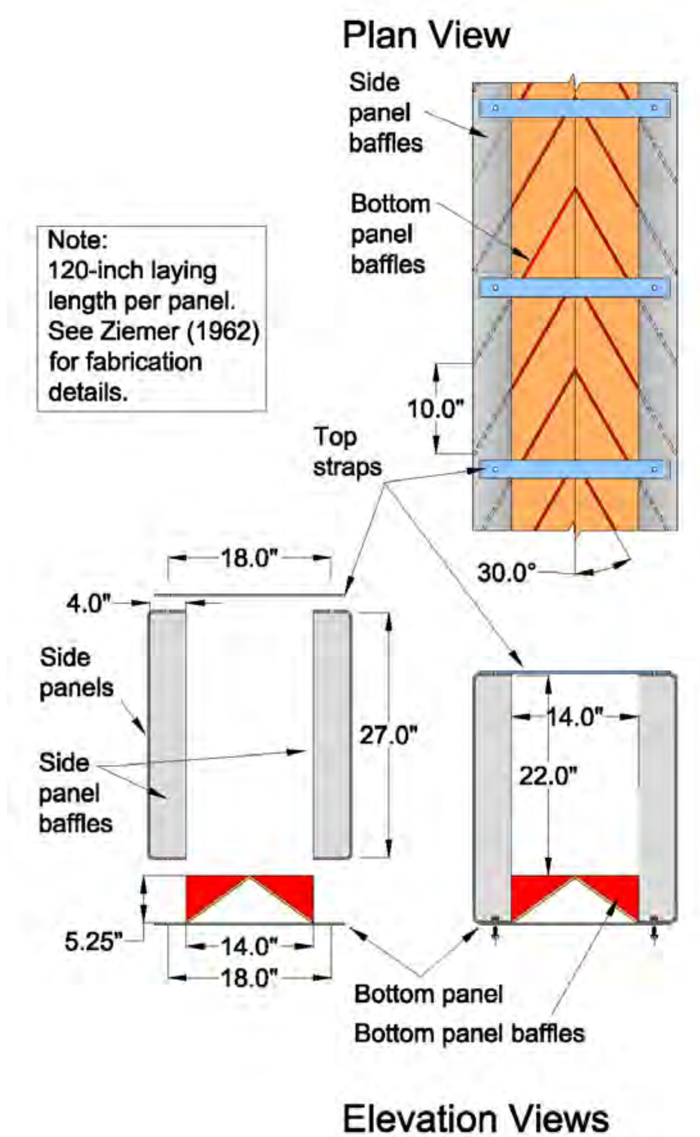


Figure 5-14. Plan and elevation views of a typical ASP fishway

5.9.2.3.3 *Special considerations for Denil and Alaska steeppass fishways*

The following unique aspects of Denil or ASP fishways must be carefully considered: intermediate resting pools, minimum resting pool volume, and exit locations.

- Intermediate resting pools:

If the Denil or ASP fishway is long, intermediate resting pools should be included in the design. Resting pools (where water velocities are less than 1 ft/s) should be provided for Denil fishways longer than 30 feet in length (Bell 1991); resting pool size should be based on minimum pool size or EDF (energy dissipation factor) calculations. These guidelines also apply to ASP fishways longer than 30 feet in length.

Typically, there are no resting locations within a given length of Denil or ASP fishway. Once a fish starts to ascend a length of an ASP or Denil fishway, it must pass all the way upstream and exit the fishway or risk injury when falling back downstream. Therefore, if the Denil or ASP fishway is long, intermediate resting pools should be included in the design. Clay (1995) recommends that resting pools be provided for every 12 feet of height ascended and that average velocity in the resting pool should not exceed 1 ft/s. NMFS recommends that the designer size the resting pool based on the minimum pool size necessary to achieve either an average velocity of 1 ft/s or an adequate pool size based on the expected run size, if known (Appendix H), or on the EDF formula for pool volume (Equation 5-5), whichever is larger.

- Minimum resting pool volume:

The minimum volume of the resting pool is calculated as shown in Equation 5-5, which is similar to Equation 5-2 in Section 5.5.3.5 except that the volume required is increased by a factor of 2 since this equation is for a resting pool.

$$V = (\gamma)(Q)\left(\frac{v^2}{2g}\right)/\left\{\left(2ft\ \frac{lbs}{s}\right)/ft^3\right\} \tag{5-5}$$

where:

V = *volume, in* ft^3
γ = *specific weight of water, 62.4 lb per* ft^3
Q = *Denil or ASP flow, in* ft^3/s
v = *velocity of pool-to-pool flow, in ft/s*
g = *gravitational acceleration (32.2* ft/s^2*)*

Blackett (1987) conducted experimental modifications to an ASP fishway at a 10-meter-high falls to improve sockeye salmon entry and passage. Sockeye salmon passage was equivalent between an ASP fishway of approximately 200 feet in length with no resting pools and an adjoining ASP fishway where three resting pools were incorporated into the design—although significant year-to-year differences in passage occurred amongst each ASP fishway. However, resting pools were beneficial for holding slower or descending salmon without blocking the passage of other salmon. Also, sockeye salmon passage was greater in the original ASP fishway with three resting pools than in another ASP fishway tested that contained a single resting pool.

- Exit locations:

Denil and ASP fishway exits should be located to minimize the potential for fish to fallback over the barrier.

5.10 Nature-Like Fishways

The nature-like fishway is a fishway type characterized by its use of natural materials (such as rocks and boulders) and incorporation of natural riverine characteristics in its construction and design (Katopodis et al. 2001; Wildman et al. 2003). Nature-like fishway design simulates the hydraulic conditions of natural channels, natural passage windows, and migration timing for target fish species. The resulting project should provide natural hydraulic conditions for target species (mimicking the geomorphic form and complexity found in natural channels the target species inhabit).

Nature-like fishways are thought to facilitate the passage of a wide assemblage of fish and aquatic species, sometimes purported to provide better passage than traditional methods (fish ladders). However, Castro-Santos (2011) concluded that nature-like fishway designs evaluated in his study were not superior to traditional fish ladders for the 23 fish species from the northeastern United States (of those that were evaluated). More recently, Landsman et al. (2018) compared the passage of salmonid and non-salmonid species at nature-like fishway and pool-and-weir fishways in eastern Canada and reported similar results. Nature-like fishways have been observed to pass anadromous and resident salmonids with varying degrees of success at projects of varying hydraulic complexity (Aarestrup et al. 2003; Calles and Greenberg 2005, 2009; Dodd et al. 2017).

At the project-scale, design variables related to nature-like fishways are nearly synonymous with more traditional fish ladder designs typically used at these same locations (such as a vertical slot or ice harbor). The main difference being that nature-like fishways are constructed using natural materials, not concrete. Like any other fishway, if the design variables between the tailrace and the forebay are improperly designed, the result may be adverse passage effects to the project. All project-scale passage variables should be properly analyzed, accounted for, and work together to provide safe, timely, and effective upstream passage for salmonids and other target species (the same expectation as had for any other style of fishway).

5.10.1 Experimental Applications

Nature-like concepts and methods are sometimes used in conjunction with more traditional fishway designs. When combining nature-like methods with traditional methods many of the passage assumptions and anticipated hydraulic conditions associated with traditional fishways do not hold, or are hard to predict. Combined designs are classified by NMFS as experimental. Experimental designs are addressed in Section 1.5 and should be vetted using the guidelines contained in Appendix C.

5.10.2 Design Methods

Nature-like fishways are intended to simulate passage conditions of a natural channel. Like natural channels, there is a high degree of hydraulic variability within the fishway. This high variability makes recommending a universal design approach challenging. The following guidelines will help designers better understand critical components of nature-like fishway design, regardless of the engineering methods and approaches implemented.

Nature-like fishway designs may simulate the form and roughness of a reference reach selected as a design template from a natural channel, or the design may rely on hydraulic analysis and physical modeling, or both. The following sources provide additional information on the hydraulic and geomorphic concepts and potential design methods used in nature-like fishway design: Acharya et al. 2000; Keils et al. 2000; Katopodis et al. 2001; Courtice et al. 2016.

5.10.3 Specific Criteria and Guidelines

The criteria contained in this section apply primarily to fish passage projects where the fishway is designed to provide passage around a dam or diversion.

5.10.3.1 Maximum average channel velocity

Maximum average channel velocity at the 5% exceedance flow should be no greater than 5 ft/s, regardless of channel slope. The relationship between channel roughness and channel slope should be carefully engineered to ensure this criterion is not exceeded.

Barnard (2013) indicates that at the 10% exceedance flow, high gradient streams in Washington State exhibit similar average channel velocities, regardless of channel slope, on the order of 4 ft/s. The velocity criterion in the section is presented to help designers express a more realistic relationship between channel slope and roughness in nature-like fishway designs. When channel slope and roughness have the proper relationship to maintain a 5 ft/s average channel velocity at the 5% exceedance flow, energy dissipation and turbulence are much more likely to be within the range observed in natural high gradient streams of similar slope and roughness. This criterion also simplifies and improves design and monitoring by providing a simple value to compare against hydraulic models and field measurements. An in-depth discussion on turbulence in higher gradient natural channels in contained in CH 6 of Barnard (2013).

The origin of the 4ft/s criterion used the 10% exceedance flow to back calculate EDF in high gradient natural channels. When using a 5% exceedance flow it seems reasonable to increase the maximum average channel velocity to 5 ft/s. When using a 1% exceedance flow, it seems reasonable to use a maximum average channel velocity of 6 ft/s. These assumptions are supported by data from Castro and Jackson (2001) which indicates the average bankfull channel velocity in the Pacific Northwest can be well represented as an average of 6 ft/s. Work by Love and Lang (2014) reported that annual exceedance values associated with a discharge equal to 50% of the 2-year return interval ranged between 0.2% and 1.8%. Annual exceedance flows between 10% and 1% exceedance are likely well represented by a range of average channel velocities between 4ft/s and 6ft/s.

5.10.3.2 Pool depth

If drop structures are used in the fishway, minimum pool depth should be 4 feet in the receiving pool of each drop structure.

5.10.3.3 Maximum hydraulic drop

Maximum hydraulic drop is 1 foot for adult salmonids and 0.5 foot for juvenile salmonids.

5.10.3.4 Maximum fishway slope

Maximum fishway slope is 5% for all salmonid species.

5.10.3.5 Channel stability

Beds and banks should be designed to be immobile at all anticipated fishway discharges.

5.10.3.6 Channel roughness

Simulated or modeled roughness values should be physically expressed in the post-construction roughness of the channel design. Actual fishway roughness should produce a maximum 5 ft/s average velocity at the high fish passage design flow. Designers should provide a summary discussion of how modeled roughness will be translated and transformed into actual project roughness.

Modeling requires the use of roughness values to estimate the effects of boundary roughness on water depth and velocity in channel design. NMFS has observed there can be large discrepancies between modeled roughness values and the actual roughness physical expressed in the design post-construction. These discrepancies are typical expressed as higher velocities, increased turbulence, unanticipated scour and erosion, and a fewer holding and resting areas than were expected. Individually and in aggregate these issues can adversely affect fish passage. It is expected that documentation of the methods, assumptions, and specifications used to detail and explain the roughness design process will result in fewer projects failing to meet passage requirements.

Channel roughness providing the bulk of fish passage benefits are best described and specified comparing the size of the elements to the depth of water at the high fish passage design flow. Large roughness elements will possess an exposed dimension above the thalwag that is analogous to the high fish passage design depth. Meaning once stable, the element should have a portion exposed to the air, or nearly exposed, at the high fish passage design flow. This relationship between water depth and roughness size is critical to providing the necessary energy dissipation and velocity reduction for fish to rest and move in higher gradient channels. Channels with low relative roughness (uniformly sized bed and bank material), are characterized as hydraulically smooth. Hydraulically smooth channels at high gradients provide little to no resting or holding areas for fish. Hydraulically smooth channels commonly fail to meet fish passage velocity criteria.

The above discussion was developed based on the relationship between natural D84 and D90 class material and bankfull depth for streams in Washington State with slopes greater than 2% (Barnard et al. 2013). Barnard et al. measured stream discharge and bed roughness, observing that the rock providing the bulk of velocity reduction and hydraulic diversity were those elements which had a dimension analogous to the bankfull depth of the channel. Over a diverse range of project sizes, NMFS has also observed that velocity conditions are most often passable when somewhere in the range of 20%-40% of the project surface area is occupied by roughness elements extending significantly into the water column at the bankfull discharge.

5.10.3.7 Technical components

The technical components, and their associated criteria, used in nature-like fishway project remain consistent with more traditional fish ladder designs and include the following:

Section 5.2, Fishway Entrance

Section 5.3, Auxiliary Water Systems

Section 5.6, Counting Stations

Section 5.7, Fishway Exit Control

Section 5.8, Fishway Exit Sediment and Debris Management

Section 5.11, Miscellaneous Considerations

Appendix H: Sizing Fish Ladder Pools Based on Energy Dissipation and Fish Run Size

5.10.4 Monitoring and Maintenance

A monitoring and maintenance plan for nature-like fishways is required. The frequency of monitoring and maintenance needed will be determined in consultation with NMFS. The plans should address how morphology and fish passage hydraulics will be monitored and modified, as needed, by developing an adaptive management approach that identifies triggers for when additional actions are to be implemented that address changes in nature-like fishway channel morphology and hydraulic conditions.

5.10.4.1 Passage assessment

Depending on project-specific considerations, monitoring may include an assessment of passage efficiency via fish tagging or fish counts. This monitoring criterion will be identified by NMFS on a project-by-project basis.

5.10.4.2 Channel stability

The loss or displacement of bed and bank material after a high-flow event does not necessarily equate with a failure of the nature-like fishway to maintain passage conditions. Any resulting loss or displacement of bed and bank material should be evaluated to determine the effects, if any, on passage criteria. Needed modification or repairs to bring the fishway into criteria should be discussed with NMFS and implemented by the facility owner. Proposed actions to bring the design into compliance with velocity criteria should be approved by NMFS.

5.10.4.3 Channel velocity

Channel velocity should be verified through post construction monitoring. When average channel velocity exceeds 5 ft/s at the high fish passage design flow needed modifications or repairs to bring the fishway into criteria should be identified be discussed with NMFS and *implemented by the facility owner. Proposed actions to bring the design into compliance with velocity criteria should be reviewed by NMFS.*

Two methods of measuring average velocity are used. First, longitudinal, or reach average velocity is measured. This is defined as the travel time of a particle beginning at the fishway exit and ending at the entrance, divided by the fishway length, and reported in ft/s. The velocity. Second, cross section average velocity is measured. Cross section velocity is measured at discrete sections of the fishway not associated with a hydraulic drop. Cross sections are measured every 40 feet of fishway beginning immediately upstream of the fishway entrance.

5.11 Miscellaneous Considerations

5.11.1 Security

Fishway facilities and areas should be secured to discourage vandalism, preclude poaching opportunity, and provide for public safety.

Security fencing around the facility and grating over the fishway may be required.

5.11.2 Access

Access for personnel to all areas of the fishway should be provided to facilitate operational and maintenance requirements. Walkway grating should allow as much ambient lighting into the fishway as possible. Consideration should be given to providing access for personnel to each pool of the ladder to support fish salvage operations.

5.11.3 Edge and Surface Finishes

All metal edges in the flow path used for fish migration should be ground smooth and rounded to minimize risk of lacerations. Concrete surfaces should be finished to ensure smooth surfaces, with 1-inch-wide, 45-degree corner chamfers.

5.11.4 Protrusions

Protrusions that fish could contact, such as valve stems, bolts, gate operators, pipe flanges, and permanent ladders rungs, should not extend into the flow path of the fishway.

5.11.5 Exposed Control Gates

All control gates exposed to fish (e.g., entrances in the fully open position) should have a shroud or be recessed to minimize or eliminate fish contact.

5.11.6 Maintenance Activities

To ensure fish safety during in-season fishway maintenance activities, all fish ladders should be designed to provide a safe egress route or safe holding areas for fish prior to any temporary (i.e., less than 24 hours) dewatering. Longer periods of fishway dewatering for *scheduled ladder maintenance should occur outside of the passage season and with procedures in place that allow fish to be evacuated in a safe manner.*

5.12 Operations and Maintenance Considerations

5.12.1 Activity Near the Ladder

There should be no construction or heavy activity within 100 feet of a ladder entrance or exit or within 50 feet of any other portion of the ladder, but this can be reviewed on a case by case basis.

5.12.2 Maximum Outage Period

A fishway should never be inoperable due to mechanical or operational issues for more than 48 hours during the fish passage season of any anadromous species.

6 Exclusion Barriers

6.1 Introduction

Upstream-migrating salmonids are often attracted to areas of a river where flow is concentrated or velocities are high such as the discharge from a hydroelectric powerhouse. This behavior may cause fish to attempt to ascend a barrier at locations where passage is poor or blocked, which could result in the following:

- Injuries (e.g., lacerations, abrasions) caused by
  - Brushing against rocks or structures while swimming in turbulent areas
  - Jumping and striking rocks or structural projections
- Direct or delayed mortality due to injuries
- Migration delays

Exclusion barriers are structures or devices that are designed and used to halt the upstream migration of fish (BOR 2006). These barriers can guide fish to an area where upstream migration is allowed or to holding, sorting, evaluation, and transportation facilities. They are also used to prevent fish from entering an area where no upstream egress or suitable spawning habitat exists. For example, exclusion barriers could be required to protect upstream-migrating salmon and steelhead from injuries or mortality caused by ascending powerhouse turbine draft tubes or tunnels. Exclusion barriers can also be used for the following:

- Preventing fish from entering return flow from an irrigation ditch; tailrace of a power plant; channels subject to sudden flow changes; and channels with poor spawning gravels, poor water quality, or insufficient water quantity
- Guiding fish to counting facilities as well as trap facilities for upstream transport, research, or broodstock collection

6.1.1 Fish Safety

Exclusion barriers should be designed to minimize both the potential for fish injury and mortality and migration delays.

Fish may be physically injured (e.g., lacerations, abrasions) when attempting to pass exclusion barriers in migration pathways (FERC 1995). Therefore, barrier design and operation should consider and eliminate sources of injury due to shallow depths, exposed components, and rough surfaces. Barriers that are poorly designed can cause fish to delay migration while undertaking multiple attempts to pass the barrier.

6.1.2 Barriers Used to Collect Information

Installing exclusion barriers solely for the purpose of collecting information needed for fisheries management will be discouraged, especially if ESA-listed fish are present in the watershed.

6.1.3 Other Species

Installing an exclusion barrier in river systems with multiple species of migratory fish should be carefully considered because some designs may inadvertently block the upstream and downstream movement of non-target species.

Conversely, exclusion barriers may also be used to restrict the movement of undesirable species into upstream habitat (Clay 1995) such as sea lamprey in the Great Lakes (McLaughlin et al. 2007).

6.1.4 Flow Range

All barriers should be designed to function safely over the expected design range of flow conditions for the site when target fish are present (BOR 2006).

6.2 Types of Exclusion Barriers

Barriers to upstream fish passage are either physical or behavioral (e.g., acoustic, chemical, thermal, or lighting). They can be natural or fabricated. Natural barriers consist mainly of waterfalls and debris jams, whereas fabricated barriers consist mainly of dams, culverts, and log jams (Powers and Orsborn 1985). This chapter focuses on fabricated physical barriers, which present fish with structures or conditions that block farther upstream migration.

Fabricated physical barriers are classified into three categories: diffusers, weirs, and drop structures (Figure 6-1). Picket and weir barriers rely on bars racks, pickets, porous rigid panels, screens, or fences to physically exclude fish from entering an area. Fixed bar racks and picket barriers have similar meanings and purposes, and fish passage designers often use these terms interchangeably. However, the term ‘picket barrier’ carries an added nuance—these barrier panels tend to guide fish in some preferred direction—in addition to blocking farther upstream passage. Figure 6-2 is a schematic illustration of a temporary fish weir that uses pickets to guide fish to a trap at the riverbank.

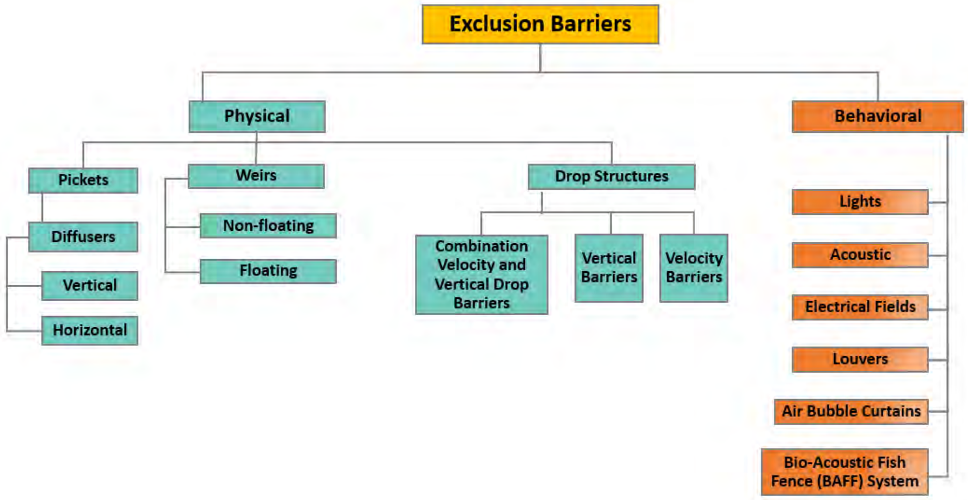


Figure 6-1. Classifications of exclusion barriers

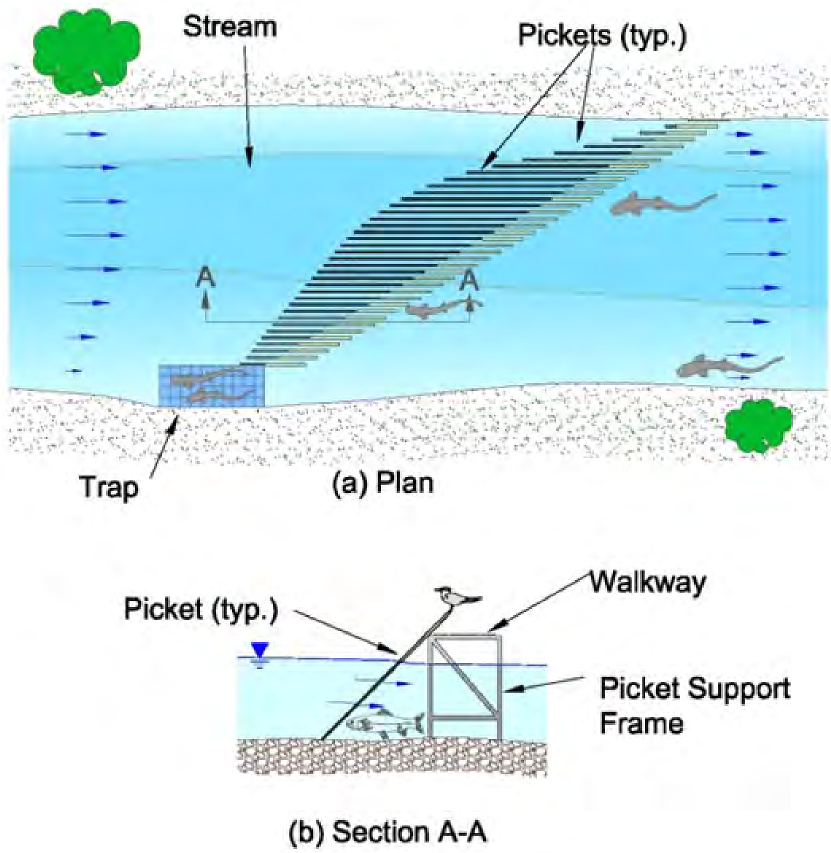


Figure 6-2. Fish weir constructed with pickets in plan (a) and section (b) views

Advantages of pickets and weir barriers include the following:

- They induce a small loss of head under clean and partially plugged conditions.
- They can function over a wide range of river flow stages.
- They can be designed to be removable.

Disadvantages of pickets and weir barriers include the following:

- Bar spacing that is too wide will not function effectively as a barrier, and bar spacing that is too narrow can collect debris more quickly than it can be removed. Striking a balance between the competing design objectives of excluding fish while not collecting more debris than can be managed may be difficult or impossible, depending on the river system and target fish species being excluded.
- Downstream juvenile and adult fish that need to pass the barrier can be excessively delayed and, in some designs, injured or killed. It is important to recognize that this type of barrier can cause injury and mortality to downstream migrants.
- Barrier components require periodic cleaning and are subject to rapid plugging (BOR 2006).

Drop structure barriers involve a combination of local hydraulic conditions downstream of a barrier and the swimming capabilities of the species and life stage to block migration (Powers and Orsborn 1985). They create hydraulic conditions that exceed the swimming or leaping capabilities of the fish to overcome the hydraulic condition. Examples include velocity barriers, vertical drop barriers, and velocity drop barriers. Hydraulic conditions at a specific site function as a barrier when one or more of the following conditions are present:

- Water velocity downstream from a barrier exceeds the swimming speed of fish.
- A standing wave develops downstream of the barrier that fish cannot pass through, or it forms too far downstream to allow the fish to rest before bursting upstream.
- A downstream plunge pool is too shallow to allow fish to jump the barrier.
- Barrier height exceeds jumping ability of fish.

Advantages of drop structure barriers include the following:

- These have lower maintenance requirements compared to picket and weir barriers.
- Debris passes over the barrier with flow (instead of plugging the barrier, which can be the case with structural barriers).
- All species and life stages of fish whose swimming capabilities are weaker than the species the barrier was designed to address are excluded.
- The passage of downstream migrants over drop barriers is usually safer than through picket and weir barriers.

Disadvantages of drop structure barriers include the following:

- They require a significant head to function properly.
- Their performance depends on maintaining a minimum head differential across the barrier.
- The pool upstream of the barrier structure may increase sediment deposition, which reduces channel capacity (BOR 2006).
- Drop structures may create a serious hazard to boaters and swimmers and precautions to protect boaters and swimmers should be included in the design.

Several reports contain additional information on the topic of exclusion barriers and fish swimming performance. Bell (1991) provides information on the swimming and jumping capabilities of various salmonid species. Powers and Orsborn (1985) provide equations for calculating maximum swim distances and estimating leap height and distance. Katopodis (1992) provides endurance curves for fish of various lengths for the two main modes of fish locomotion and a formula for calculating swimming distance. The two main modes of locomotion are anguilliform body shapes (e.g., lamprey and Burbot) and subcarangiform body shapes (e.g., anadromous salmonids and various freshwater species such as bass, suckers, and chub).

6.3 Picket and Weir Barriers

Physical barriers typically rely on a combination of low-velocity flow discharged through bar racks, pickets, diffusers, screens, or fences to physically block fish from entering an area. Picket and weir barriers include fixed bar racks, picket panels (Figure 6-3), diffusers (a specialized form of picket barrier usually used in AWS in fishways), horizontal outlet diffusers, and a variety of hinged, floating weir designs and framework-supported (rigid) weir designs. The clear opening between bars in bar rack panels or pickets in picket panels should be sufficiently narrow to create a barrier to the smallest-sized migrant fish being excluded from farther passage upstream. Depending on the design and site conditions, weir barriers may need to be removed during high-flow events to prevent structural damage, which potentially reduces the barrier's ability to prevent target fish from passing into undesirable areas.

Figure 6-3. Picket barrier panels under construction at the Slide Creek tailrace barrier located on the North Umpqua River, Oregon

Because both debris and downstream-migrating fish must pass through physical barriers, sites should be selected based on the following design objectives:

- Minimizing the entrainment of debris
- Maximizing the ability to remove debris
- Preventing the entrainment and delay of downstream-migrating fish and adult fish that fall back across the barrier
- Maximizing the ability to rapidly remove and bypass any fish that are entrained on the barrier
- Allowing the most advantageous orientation of the barrier (typically angled to guide fish to a collection point)

6.3.1 Risk of Fish Impingement

If adult fish are exposed to the upstream side of physical barriers, they have a high likelihood of being impinged. Therefore, these types of barriers cannot be used in waters containing species listed under the ESA unless they are continually monitored by personnel on site and have an approved operational plan and a facility design that allows impinged or stranded fish to be removed in a timely manner and prior to becoming injured. Also, these types of barriers should not be used at sites where adult fish are actively migrating downstream or may inadvertently pass over a nearby dam or weir in a downstream direction prior to reorienting again to continue their upstream migration.

In addition to blocking the upstream passage of adult fish, physical barriers can effectively block or injure fish migrating downstream (e.g., steelhead kelts, adult salmon that passed a dam and subsequently migrated back downstream, juvenile salmonids, and resident fish). This can impact population productivity and should be fully considered during the planning process.

6.3.2 Debris

Physical barriers should be continually monitored for debris accumulations, and debris should be removed before it concentrates flow and results in the velocity and head differential criteria being exceeded (Sections 6.3.3.2 and 6.3.3.3). Additionally, excessive debris loading could cause permanent damage to weir structures.

Allowing debris to accumulate on components of physical barriers results in increased water velocity through the remaining open areas. As debris accumulates, the potential for impinging downstream migrants increases progressively and can reach unacceptable levels that result in mortality and injury. Concentrating flow through the remaining open areas of the barrier (e.g., the open picket area) will also attract upstream migrants to these areas. This can increase the potential for injury due to adult fish jumping into structural components and for fish accessing unwanted areas because they jumped and landed over the barrier.

6.3.3 Picket Barriers and Fixed Bar Racks

Picket barriers and fixed bar racks create a uniform, low-velocity flow that is discharged through a series of bars or screens that cover the entire exclusion area.

The following specific criteria or guidelines apply to picket barriers and fixed bar racks.

6.3.3.1 Openings

The spaces between bars of a diffuser should be sized to prevent fish passage and injury (Bates 1992). The clear opening between bars in bar rack panels, between pickets in picket panels, and between panels and abutments should be less than or equal to 1 inch to exclude anadromous salmonids and less than or equal to 0.75 inch to exclude Pacific lamprey. Smaller openings may be required if resident species are also present that need to be excluded by the facility.

Openings larger than 1 inch may allow the heads of small salmon and steelhead to pass through the picket opening. This can lead to salmonids and other species becoming caught on the picket by their operculum that covers and protects the gills. Fish caught in this manner—between bars or pickets and gaps between panels or panels and abutments—often die because they are unable to extricate themselves off the picket.

6.3.3.2 Design velocity

The average velocity through pickets should be less than 1 ft/s for all design flows (Clay 1995). The maximum velocity through the pickets should be less than 1.25 ft/s, or one-half the velocity of adjacent passage route flows, whichever is lower. When river velocities exceed these criteria, such as due to increasing flows or debris accumulations, the picket barrier should be removed.

The average design velocity is calculated by dividing streamflow by the total submerged picket area over the design range of streamflows (Gauley et al. 1966). As discussed in Section 6.3.2, non-uniform or excessive velocities through the structure can create false attraction conditions that delay fish and induce upstream migrants to attempt to jump over the barrier, potentially injuring the fish.

6.3.3.3 Head differential

The maximum head differential under fouled conditions should not exceed 0.3 foot above the normal head differential across the pickets that occurs under clean picket conditions. If this differential is exceeded, the pickets should be cleaned as soon as possible.

Excessive head differential (head loss) through the structure can cause a cascading effect of water through the pickets, which increases the likelihood of upstream migrating fish leaping at the structure. Clay (1995) and DOI (1987) provide formulas to calculate head loss through picket barriers and trash racks.

6.3.3.4 Debris and sediment

A debris and sediment removal plan should be considered in the design of the barrier that anticipates the entire range of conditions expected at the site. Debris should be removed before accumulations develop that violate the average design river velocity and head differential criteria (Sections 6.3.3.2 and 6.3.3.3, respectively).

6.3.3.5 Orientation of physical barrier

Physical barriers should be designed to lead fish to a safe passage route.

Leading fish to a safe passage route can be achieved by angling the structural barrier toward the route, providing nearly uniform velocities across the entire horizontal length of the structural barrier, and providing a sufficient level of attraction flow that leads fish to the route and minimizes the potential for fish being falsely attracted to flow coming through the picket barrier.

6.3.3.6 Picket freeboard

Depending on the angle of the pickets (from vertical), the pickets should be designed such that they extend out of the water and at least 2 vertical feet above the water surface at the upper design flow level.

The purpose of the picket freeboard is to prevent fish from leaping over the barrier. Note that if the angle of the pickets is relatively steep, a freeboard of 2 feet may be insufficient to block stronger fish from leaping over the pickets, depending on site-specific conditions.

6.3.3.7 Submerged depth

The minimum depth at the picket barrier at low design flow should be 2 feet for at least 10% of the river cross section at the barrier. Picket barriers should be sited where there is a relatively constant depth over the entire stream width.

6.3.3.8 Picket porosity

The picket array should have a minimum of 40% open area.

Picket barriers with insufficient porosity may generate excessive head loss for the given river velocity. This head loss is exhibited as a cascade of water as it passes through the pickets, which may induce fish to jump and increase the potential for injury at the barrier.

6.3.3.9 Picket construction and material

Pickets should comprise flat bars where the narrow edge of the bar is aligned with flow or round columns of steel, aluminum, or durable plastic. Other shapes may be approved by NMFS, but should not increase the risk of fish impingement.

Picket panels should be of sufficient structural integrity to withstand high streamflows and some debris loading without deforming (i.e., without exceeding the clear opening criteria cited in Section 6.3.3.1, compromising the cleaning system, or permanently changing the shape of the picket panel). Pickets that become permanently deformed should be repaired or replaced as soon as possible. Pickets that deform or bend to a point where the clear opening criteria cited in Section 6.3.3.1 is no longer met under the design flow and debris loading conditions incorporated into the design can create openings that allow fish to pass the barrier or become injured as they try to force their way through the pickets.

6.3.3.10 Sill

A uniform concrete sill, or an alternative approved by NMFS, should be provided to form a foundation for the pickets and ensure that fish cannot pass under the picket barrier.

6.3.4 Diffusers

Diffusers are a specialized type of picket barriers or fixed bar racks where a flow control or hydraulic baffling structure is incorporated into the design to regulate flow through the barrier or bar rack. Wall-oriented (i.e., vertical) and floor-oriented (i.e., horizontal) diffusers are most commonly used as part of the AWS in adult ladders to prevent adult fish from entering the AWS system or delaying their migration due to being attracted to AWS flow entering the ladder. Wall diffusers are also used as tailrace barriers to prevent fish from entering tailraces downstream of hydroelectric dams, while encouraging fish to continue to move upstream through another stream, river route, or channel.

The following specific criteria or guidelines apply to diffusers.

6.3.4.1 Openings

The spaces between bars of a diffuser should be sized to prevent fish from passing through the bars or becoming injured (Bates 1992). The clear opening between pickets and between pickets and abutments should be less than or equal to 1 inch to block anadromous salmonids. These clear openings should be less than or equal to 0.75 inch to block Pacific lamprey. Smaller openings may be required if resident species are also present that need to be excluded by the facility.

Wall diffusers consist of vertically oriented diffuser panels of flat bar stock using non-corrosive materials. The orientation of flat bar stock should be designed to maximize the open area of the diffuser panel. If smaller fish species or life stages are present, smaller clear openings between the bars may be required.

6.3.4.2 Design velocity and orientation

The average velocity through a wall diffuser should be less than 1 ft/s for all design flows based on total submerged diffuser area. The maximum velocity at any point on the diffuser should be less than 1.25 ft/s, or one-half the velocity of flow in an adjacent passage route, whichever is lower. Diffuser velocities should be nearly uniform. The orientation of the diffuser should be selected that assists in guiding fish towards the safe passage route. The face of the diffuser panels (the surface exposed to the fish) should be flush with the wall or floor.

These criteria are based on results of laboratory studies where passage times of spring- and fall-run Chinook salmon and steelhead increased progressively with increased diffuser flows and where diffuser velocities increased from 0.25 to 1.25 ft/s (Gauley et al. 1966).

6.3.4.3 Porosity control baffles

Similar to juvenile fish screens, a *diffuser should include a system of porosity control baffles located just upstream of the diffuser pickets to ensure the average velocities at the face of the diffuser can meet criteria.*

Porosity control panels control the amount of flow and velocities through the diffuser pickets and create a uniform flow condition at the face of the pickets.

6.3.4.4 Debris removal

The diffuser design should include access for personnel to be able to remove debris from each diffuser. This criterion is not required when the intake to the diffuser water supply is equipped with a juvenile fish screen (Chapter 8).

The dewatering screen system also removes debris from water being supplied to the diffuser.

6.3.4.5 Edges

The edges of all diffuser surfaces exposed to fish should be rounded or ground smooth to the touch, with all edges aligning in a single smooth plane.

Rounding and grinding smooth surfaces that fish can contact and making all diffuser surfaces flush reduces the potential for fish injury.

6.3.4.6 Elevation

Wall-style diffusers should be submerged throughout the range of operation (i.e., the top elevation of the wall diffuser should be below the water surface elevation associated with the low flow selected for the design).

Maintaining a submerged wall-style diffuser prevents water from cascading through the diffuser, which can induce adult fish to leap at the surface disturbance and become injured when contacting the diffuser material and wall and delay their migration up the ladder.

6.3.5 Horizontal Outlet Diffusers

A horizontal outlet diffuser is a device that can be used to prevent fish from entering a drain or discharge pipe. They can also be used below a powerhouse at the turbine draft tube outlet to prevent adult fish from ascending up the draft tube discharge during unit start up or shut down or during normal operations if draft tube velocity is low (typically less than 16 ft/s; Figure 6-4). This type of diffuser also prevents fish from entering the draft tube and contacting the turbine runners, which may result in injury or mortality. If the turbine draft tubes are located in close proximity to the entrance of an upstream passage system (e.g., a fishway), a horizontal outlet diffuser system may be the appropriate choice for an exclusion system.

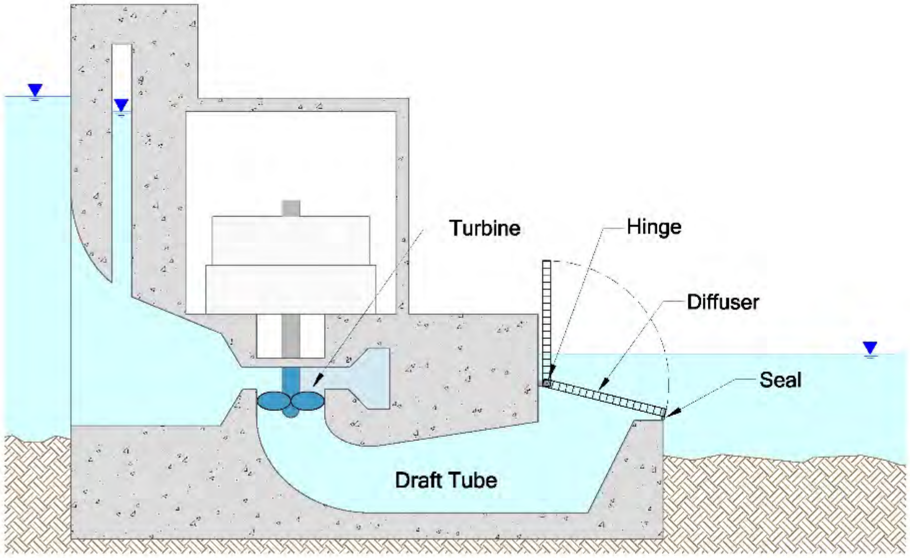


Figure 6-4. Layout of a horizontal outlet diffuser covering the entrance to a turbine draft tube

6.3.5.1 Design velocity

Average flow velocity exiting the horizontal outlet diffuser grating should be less than 1.25 ft/s and be distributed as uniformly as possible. The maximum point velocity should not exceed 2 ft/s.

6.3.5.2 Porosity control baffles

Similar to juvenile fish screens, diffusers should include a system of porosity control baffles located just upstream of the diffuser pickets to ensure the average velocities at the face of the diffusers can meet criteria.

Porosity control panels control the amount of flow and velocities through the diffuser pickets and create a uniform flow condition at the face of the pickets.

6.3.5.3 Openings

The spaces between bars of a diffuser should be sized to prevent fish passage and injury (Bates 1992). The clear opening between bars, and between bars and abutments, should be less than or equal to 1 inch to exclude anadromous salmonids and less than or equal to 0.75 inch to prevent Pacific lamprey from entering the chamber behind the diffuser. Smaller openings may be required if resident species are also present that need to be excluded by the facility.

Horizontal outlet diffuser panels consist of non-corrosive, horizontally oriented flat bar stock. The orientation of flat bar stock should be designed to maximize the open area of the diffuser panel.

6.3.5.4 Edges

The edges of all diffuser surfaces exposed to fish should be rounded or ground smooth to the touch, with all edges aligning in a single smooth plane.

Rounding and grinding smooth surfaces that fish can contact and making all diffuser surfaces flush reduces the potential for fish injury.

6.3.5.5 Debris removal

The diffuser design should include access for personnel to be able to remove debris from each diffuser. This criterion is not required when the intake to the diffuser water supply is equipped with a juvenile fish screen (Chapter 8).

Trash (bar) racks installed at the intake to the diffuser system and a juvenile fish screen (if installed) remove debris from water being supplied to the diffuser.

6.3.5.6 Submergence

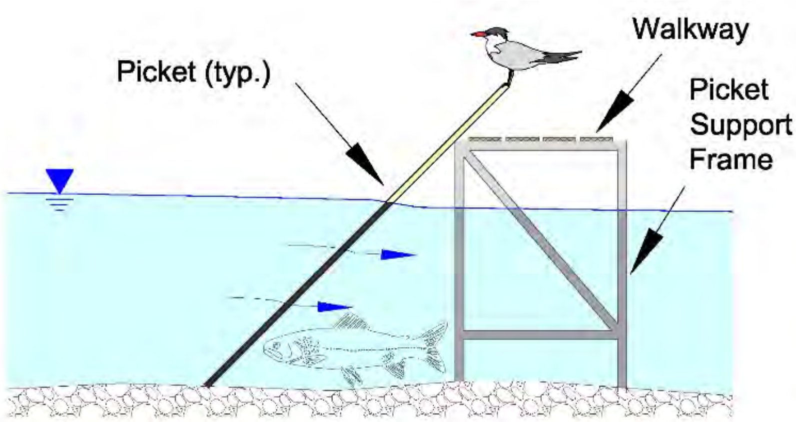
Horizontal outlet diffusers should be submerged a minimum of 2 feet for all tailwater elevations.

6.3.6 Fish Weirs

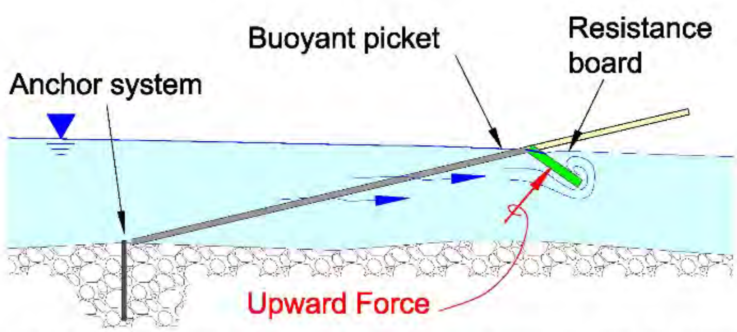
Fish weirs are physical barrier systems that are constructed across a stream (Figure 6-2). The purpose of fish weirs is to prevent fish from passing upstream of the weir and guide upstream-migrating fish to a trap. The weirs are constructed of panels of metal or plastic pickets that extend from the bottom of the stream to an elevation several feet above the water surface. The clear spacing between the pickets is selected based upon the size of the target species being trapped. When viewed from above, weirs are usually placed at angles greater than 90 degrees from the main thread of the current (Figure 6-2). The trap is placed at the most upstream area of the weir. The angle between the direction of stream or river flow and the weir results in the weir being longer than if it was positioned perpendicular to the bank and reduces water velocity through the pickets.

6.3.6.1 Types of fish weirs

The two most commonly used types of weirs in the WCR are rigid (frame-supported) weirs and floating resistance board picket weirs (Figure 6-5). Weirs can be temporary or permanent.



(a) Cross section through rigid (frame-supported) picket weir.



(b) Cross section through floating resistance board picket weir.

Figure 6-5. Cross sections of rigid and floating picket weirs

The pickets in rigid weirs are placed at an angle greater than 45 degrees above the water surface. Clean pickets in a floating weir have a very small angle above the water surface, and increased flow velocity and debris loading can further reduce the angle and can eventually submerge the floating weir panels.

Rigid weirs use panels of solid metal rods or hollow conduits that are supported by rigid frameworks (Figure 6-6). The supporting structures for temporary weirs can be light metal trusses or frames that are installed at the start of the fish passage season and are removed at the end of the trapping season. Permanent installations consist of foundations, frameworks, and abutments that stay in the river. However, the pickets at permanent installations are removed from the weir during periods when fish are not being trapped and during winter at locations that experience icing.

Figure 6-6. Elk Creek Dam picket weir (Elk Creek, Oregon)

The main advantage of rigid weirs is that the pickets are supported both along the river bottom and above the water surface, which may provide greater lateral stability and help to maintain constant spacing between the pickets. The main disadvantage of rigid weirs is that they are more susceptible to damage with increased debris loads experienced during high flows. High flows and debris can create sufficient force on the face of the panels such that the entire structure can be washed away. Some trap operators remove the pickets from the weir when they anticipate the occurrence of high flows.

Floating resistance board weirs are constructed using panels of hollow plastic piping or conduits that are capped at both ends to provide buoyancy. A resistance board at the downstream end of the pickets directs the local flow downwards, which creates an uplift force and a drag force on the pickets (Tobin 1994). In situations where the resistance board does not provide enough uplift (i.e., under conditions of low stream velocities), the board can be replaced with a long, linear float to support the picket panels. The pickets extend downstream and above the water surface to prevent fish from jumping over. The Alaska Department of Fish and Game has developed a user’s manual for installing, operating, removing, and storing resistance board weirs used to count adult salmon migrating upstream based on direct experience, providing considerable information on this type of picket barrier (Stewart 2003).

The advantage of floating weirs is that they are less prone to damage over a wider range of flows and debris loads. High flows can also submerge the panels, which also tends to move debris off the panels and reduce the downstream pressure on the panels. The main disadvantages of floating weirs include the following:

- Debris can easily be trapped on top of the pickets due to the low angle of the panels.
- Fish can pass over the pickets when the pickets are submerged during high flows.
- The pickets may be more susceptible to lateral current forces because the pickets are supported only by the bottom of the river.
- In situations where adult fish are upstream of the weir and they fall back downstream, or they are migrating downstream, the fish can easily become stranded on the pickets and die due to

the low approach angle and force of the flow that tends to push the fish up onto the dry part of the pickets.

6.3.6.2 Site selection

Weirs should be constructed at sites that have the following characteristics (Zimmerman and Zabkar 2007):

- *Construction, operation, and maintenance activities can be conducted safely.*
- *The river should be wide and shallow (about 3 feet maximum depth at normal flows) with uniform flow distribution.*
- *The substrate should consist of gravel and small cobbles and be without boulders in the weir alignment.*
- *Traps should have sufficient flow depth during minimum expected river flow stages and be accessible during flood flows. More than one trap location may be required.*

The site should be low gradient and straight, with uniform depth and width, and have areas of sufficient depth for adult holding pools upstream and downstream of the weir (Hevlin and Rainey 1993).

6.3.6.3 Velocity

Water velocity at the river channel cross section of the weir location should be a maximum of 2 ft/s at low flows if a concrete apron is used (Hevlin and Rainey 1993), and velocity and depth should allow for safe access to the weir under normal flows (Zimmerman and Zabkar 2007)

6.3.6.4 Picket spacing and freeboard

The clear spacing between the pickets and the freeboard has the same requirements as those for other structural barriers (Sections 6.3.3.1, 6.3.4.1, and 6.3.5.2). The clear opening between bars in bar rack panels, between pickets in picket panels, and between panels and abutments should be less than or equal to 1 inch to exclude anadromous salmonids and less than or equal to 0.75 inch to exclude Pacific lamprey.

6.3.6.5 Suitability at sites with downstream migrants and monitoring

Fish weirs are not suitable for sites with downstream-migrating adult fish (e.g., steelhead kelts, salmon that pass the structure but migrate downstream [i.e., fallback], and resident fish). If deployed in these situations, weir operators should provide around-the-clock monitoring and fish salvage efforts for as long as these barriers are in place (Section 6.3.1).

While blocking the upstream passage of fish, fish weirs can also block the migration of, or injure, fish migrating downstream (e.g., steelhead kelts, adult salmon, juvenile life stages, and resident fish) and prevent them from completing their life cycle. When weir pickets are at a low angle with respect to the water surface (i.e., floating weirs), downstream-migrating adult fish can become stranded as they are pushed downstream along the pickets and the water becomes shallow. Juvenile passage openings or structures should be provided as part of the design, or these weirs should be removed during the juvenile salmonid outmigration season. When rigid weirs are properly designed and sited, adult and juvenile fish that are migrating downstream are guided along the face of the weirs to the downstream apex of the weir and the shoreline where they can be trapped or released downstream.

6.4 Drop Structure Barriers

Drop structure barriers create conditions that target species are incapable of overcoming based on their swimming abilities or behavioral traits. A condition affecting swimming ability is the creation of a shallow, high-velocity flow for a significant distance, which most salmonids cannot pass. Hydraulic conditions can also interact with fish behaviors, including the reluctance of American shad to pass through a submerged orifice in a ladder or leap a ladder weir under plunging flow conditions. Both are examples of incorporating knowledge about the swimming ability and behavior of target species into facility designs so that the facility becomes a migration barrier. Note: Drop structures may create a serious hazard to boaters and swimmers, and precautions to protect boaters and swimmers should be included in the design.

6.4.1 Orientation of Drop Structure Barriers

As with physical barriers, drop structure barriers should be designed to lead fish to a safe passage route.

This can be achieved by angling the barrier toward a safe passage route and by providing the following:

- Nearly uniform velocities across the entire horizontal length of the barrier
- Sufficient attraction flow that leads fish into the safe passage route and minimizes the potential for false attraction

6.4.2 Upstream Impacts

Since this type of barrier creates an upstream impoundment, the designer should consider backwater effects upstream of the barrier that may induce loss of power generation, inundation of property, and sediment deposition in the impoundment.

6.4.3 Combination Velocity and Vertical Drop Barriers

6.4.3.1 Description and purpose

A combination velocity and drop barrier consists of a weir and concrete apron (Figure 6-7). Upstream passage is prevented by a shallow, high-velocity flow on the apron with an impassable vertical jump over the weir upstream of the apron. A fish that negotiates the apron and reaches the base of the weir is unable to pass the weir due to insufficient water depth needed to reorient its position and the lack of a pool needed to accelerate to leap over the weir sill (Wagner 1967; Weaver et al. 1976).

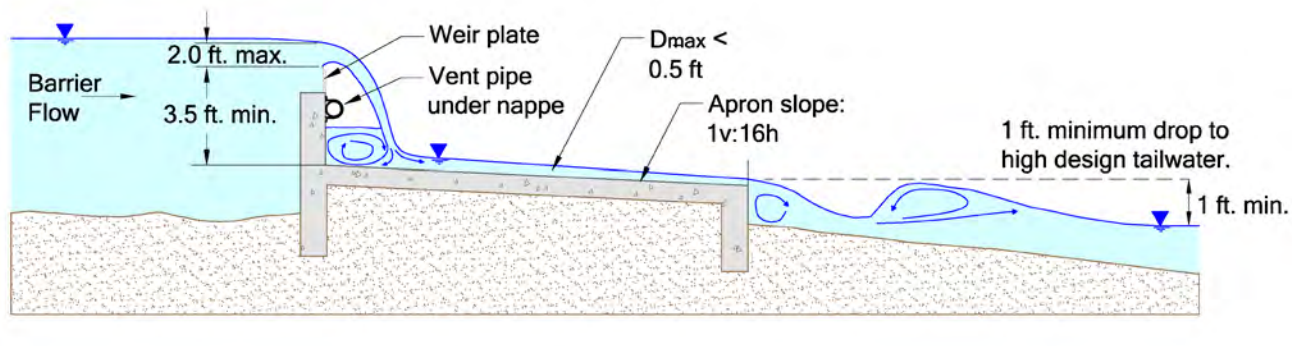


Figure 6-7. Cross section of a combination velocity and vertical drop barrier

6.4.3.2 Specific criteria and guidelines

6.4.3.2.1 *Weir height*

The minimum weir height relative to the maximum apron elevation is 3.5 feet (Wagner 1967).

This design assumes a straight, uniform, linear weir crest that will create uniform flow conditions on the apron. Labyrinth-style weirs are not allowed since they concentrate flow on the apron and create non-uniform flow conditions downstream.

6.4.3.2.2 *Apron length*

The minimum apron length (extending downstream from the base of a weir) is 16 feet.

This criterion is based, in part, on results of laboratory studies where adult Chinook salmon and steelhead were blocked by a velocity barrier dam with a 15-foot-long apron under two test conditions: 1) a vertical dam height of 3 feet with 1 foot of head; and 2) a vertical dam height of 4 feet with 2 feet of head (Slatick and Wagner 1989).

6.4.3.2.3 *Apron slope*

The minimum apron slope in a downstream direction is 1:16 (vertical:horizontal).

6.4.3.2.4 *Weir head*

The maximum head over the weir crest is 2 feet.

Other combinations of weir height and weir crest head may be approved by NMFS on a site-specific basis.

6.4.3.2.5 *Apron elevation*

The elevation of the downstream end of the apron should be greater than the tailrace water surface elevation corresponding to the high design flow (BOR 2006). There should be at *least 1 foot of elevation difference between the water surface elevation at the downstream end of the apron and the high design tailwater elevation.*

6.4.3.2.6 *Flow venting*

The flow over the weir should be fully and continuously vented along the entire weir length to allow a fully aerated flow nappe to develop between the weir crest and the apron (BOR 2006).

Full aeration of the flow nappe prevents an increase in water surface behind the nappe, reducing the opportunity for fish to stage and jump the weir.

6.4.3.2.7 *Flow depth on the apron*

Flow depth on the apron should not exceed 0.5 foot (Wagner 1967).

At sites where a maximum depth of 0.5 foot cannot be maintained, apron velocities of 20 ft/s in association with a sill height (i.e., minimum weir height relative to the maximum apron elevation) of 5.25 feet have been used successfully (Wagner 1967).[4]

6.4.3.2.8 *Minimum flow velocity over the apron*

A minimum velocity of 16 ft/s is recommended by Wagner (1967).

The recommendation by Wagner (1967) is based on Weaver (1963) who reported that Chinook salmon and steelhead could swim against a 16-ft/s velocity for a distance of at least 85 feet in a test flume.

6.4.4 Vertical Drop Barriers

6.4.4.1 Description and purpose

A vertical drop barrier functions as an exclusion barrier by providing head in excess of the leaping ability of the target fish species (Figure 6-8). Vertical drop barriers can be designed based on a concrete monolith, rubber dam, bottom-hinged leaf gate, or an alternative approved by NMFS.

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[4] Wagner (1967) does not provide any additional information on this particular barrier configuration. If it is assumed that flow on the apron is 8 inches deep at 20 ft/s, the discharge per linear foot is approximately 13.5 ft^3/s. This translates to a maximum of 2.5 feet of head over a sharp crested weir. This barrier configuration should be biologically tested before a prototype facility is constructed.

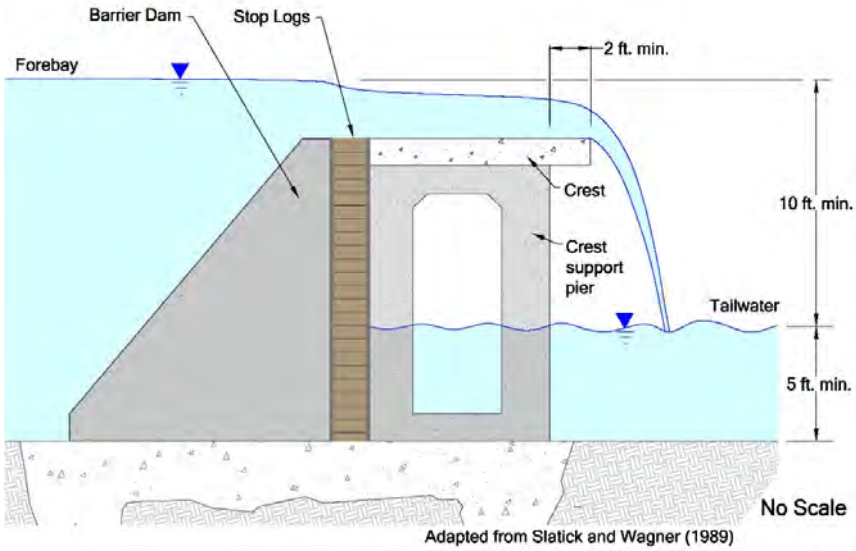

Figure 6-8. Cross section of a vertical drop barrier

6.4.4.2 Specific criteria and guidelines

6.4.4.2.1 *Minimum height*

The minimum height of a vertical drop structure should be 10 feet relative to the high design flow (Wagner 1967; Bell 1991; Clay 1995). This is measured as the water surface level of the forebay relative to the water surface level of the tailrace.

6.4.4.2.2 *Cantilever*

If the potential for injury to fish from leaping exists, the downstream crest of the barrier should extend over the tailwater at least 2 feet beyond any structural surfaces.

6.4.4.2.3 *Minimum flow depth*

Provisions should be made to ensure that fish jumping at flow over the vertical drop structure will land without contacting any solid surface and in a pool that is a minimum of 5 feet deep.

6.4.5 Velocity Barriers

Figure 6-9 shows a cross section of a velocity barrier and its main characteristics that include high water velocity and the long longitudinal length of the barrier over which the design velocity is maintained. The design approach is to provide a combination of water velocity, travel distance, and shallow depth that, taken together, exceed the swimming ability of the target fish.

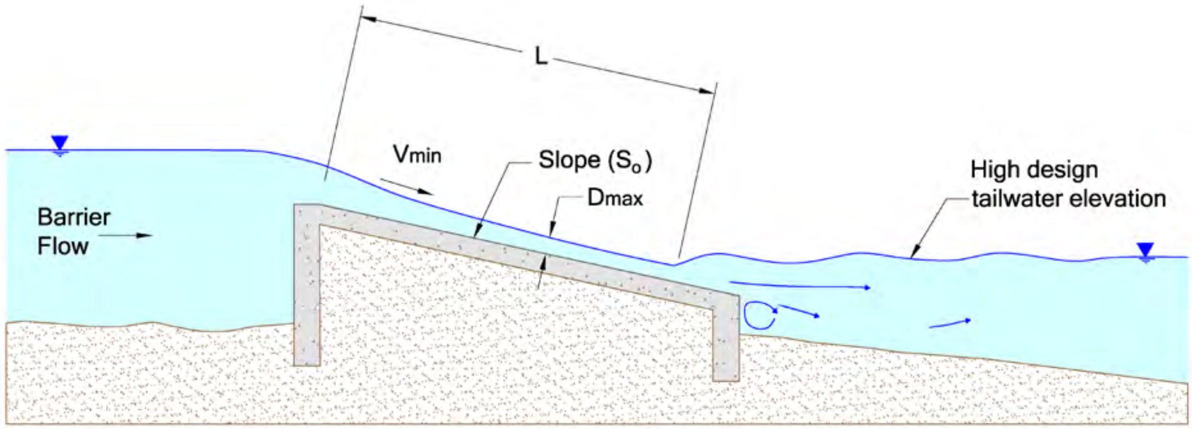

Figure 6-9. Cross section of a velocity barrier

Designing a velocity barrier to prevent the upstream migration of adult salmonids can be challenging due to their strong swimming capabilities. Experience has shown that salmonids will seek flow concentrations or discontinuities in flow (often near the edges of the flow) and use these features to find a route over this style of barrier. In addition to combining high velocity and shallow depth, the design should also create uniform flow conditions across the barrier, which can be difficult to achieve.

NMFS currently does not have criteria or guidelines for a velocity barrier.

NMFS will evaluate a proposed velocity barrier design based upon the hydraulic conditions created by the barrier and by comparing these conditions to the swimming capabilities of the target species. In general, velocity barriers are not recommended by NMFS because fish may spend a long time trying to negotiate the obstacle before seeking an alternate route, which delays the fish and may exhaust them in the process. As discussed in Section 6.3.3.5, barriers should also lead fish to a safe passage route, and NMFS will assess this when reviewing a proposed velocity barrier design.

6.5 Behavioral Barriers

Behavioral types of barriers, such as electric and acoustic fields, have had limited application and were ineffective in most cases (BOR 2006). While electric fields have been used as barriers for decades, persistent problems with early installations limited their widespread use (FERC 1995). These limitations included fish injury and mortality, safety, and effectiveness over a wide range of flow and environmental conditions (Clay 1961). Strobe lights and acoustical systems have been tested in various applications to block juvenile or adult fish from entering water intake systems. These systems were tested in the 1980s and 1990s and seemed promising at first (EPRI 1994) but were found to have limited effectiveness. Thus, electrical fields, strobe lights, acoustical systems, and other behavioral barriers are not widely used within the WCR and are considered experimental. Additional information regarding the various types of behavioral barriers and their performance and limitations may be found in Appendix C. Appendix C also provides information regarding the processes to be followed in order to use experimental devices such as behavioral barriers.

7 Adult Fish Trapping Systems

7.1 Introduction

Chapter 7 presents criteria and guidelines that address the design of new adult fish trapping systems. This chapter also includes criteria and guidelines that may apply to existing trapping programs that are being retrofitted. In both cases, traps should be designed to utilize known or observed fish behaviors to benignly route fish into a holding pool. The holding pool does not include a volitional exit, and once the fish are allowed or encouraged to exit the holding pool, they can be examined for research and management purposes and loaded into transportation tanks for transport to release locations or hatcheries.

NMFS typically prefers the use of volitional passage for upstream fish passage facilities, as opposed to non-volitional facilities and operations. Volitional passage is defined as the passage of fish under all naturally passable flows, whereby a fish can enter and exit any passage apparatus or structure under its own power, instinct, swimming ability, and migration timing. Non-volitional is defined as the collection, handling, transportation, and release of adult fish from a collection site at or below a barrier to a release point located upstream from the barrier or location.[5]

For some facilities, fish transportation is not a requirement and fish are trapped, monitored, sorted, and released from the trap to continue their upstream migration. For example, at some trapping facilities hatchery-origin fish are removed to protect wild-origin fish or collect hatchery broodstock. In the Pacific Northwest, certain areas within watersheds are designated as wild fish sanctuaries, and hatchery-origin fish should be collected and removed from traps located below these areas. Also, fish of a specific species or life stage or fish previously tagged for research purposes may also need to be collected and monitored at trap locations and then released.

The operational requirements for a trapping facility and its design are highly interdependent: management objectives for trap operation define the facility's functional design, and the objectives should be identified before trap design development can proceed. NMFS' primary objective is that a fish passage facility be designed and operated in a manner that the facility helps restore the viability of anadromous fish populations, which is why NMFS often prefers that volitional passage be used. Volitional passage facilities can operate 24 hours per day, 7 days per week, year-round.

However, there are instances where passing fish over a barrier using trap and haul techniques may be the only viable passage alternative. For example, thermal stratification can occur in

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[5] An illustration of a trap and haul operation is available at http://www.westcoast.fisheries.noaa.gov/fish_passage/about_dams_and_fish/trap_and_haul.html.

reservoirs at high head dams during summer, resulting in temperature differentials between the fishway entrance and water released below the dam. This can affect how fish utilize volitional passage facilities, and a trap and haul program would provide passage to areas above the thermally stratified reservoir.

The success of collection and transport operations relies on a high degree of engineering, technical, and operational competence. The process is generally composed of the following distinct phases: (1) Collection, (2) Handling, (3) Transportation, and (4) Release. This sequence is sometimes abbreviated by the acronym 'CHTR'. The essential idea is to engineer effective system components for each phase, and to consistently execute operations to move fish in a safe and timely manner to designated release location(s). This section provides guidance on how to collect, handle and release fish from a collection facility. For all of these steps, careful attention must be given to maintenance of aquatic conditions and water quality to keep fish in good condition. It is very important to properly acclimate fish to any changing aquatic conditions or environmental transitions. Stressors associated with the aquatic environment (as experienced by the fish) must be minimized and carefully managed. All technical details for each phase of the overall process must be properly addressed.

7.2 Types of Traps

There are two types of traps. The first type is where a trap is an integral component of the primary route of fish passage above a barrier. Examples of these traps include the following:

- Traps located directly adjacent to a barrier
- Traps at the upstream end of a fish ladder
- Traps that serve as holding box associated with broodstock collection facilities in tributary streams in conjunction with intermittent barriers

A collection and transport facility located at the upstream end of a fish ladder is the most common application of this type of trap.

The second type of trap is an off-ladder design wherein the trap is situated adjacent to a ladder such that it is not the primary route of passage and does not interfere with the normal operation of the ladder. The ladder provides volitional passage from the tailrace to the forebay of the barrier under normal conditions, but when necessary or desired, all or some fish can be diverted into the trap.

For both types of traps, once fish are in a trap they can be accessed for a variety of purposes, including the following:

- Enumeration
- Evaluation for tags and injuries
- Sampling for genetic identification
- Sorting for various management purposes
- Transportation to various locations
- Tagging to support fisheries management or research

Fish that are enumerated or evaluated can be released back into the ladder or at another location.

7.2.1 General Criteria

Fish ladders should not be designed or retrofitted with in-ladder traps or fish loading facilities. Rather, fish holding and loading facilities should be placed in an adjacent, off-ladder location in order to route fish targeted for trapping purposes.

Fishway ladder pools typically do not meet the requirements of trap holding pools. Therefore, use of fishway ladder pools to site traps can create adverse impacts to the migrating fish. These impacts include elevated stress, delay, injury, or mortality caused by turbulence, jumping at water being supplied to the holding pool, and handling. Locating the trap off-ladder allows the facility to have the operational flexibility to readily switch between volitional ladder passage and trapping modes of operation.

7.3 Design Scoping

7.3.1 Purpose

Proposals to design new facilities or complete major upgrades to existing facilities should address the following issues, or at the very least show how the following issues were considered:

- *Describe the objective of the trapping operation and identify how the fish will be counted, collected (including the expected holding densities), handled, sampled for research or management purposes, transported (how and what frequency), and released.*
- *Identify the number of fish that will be targeted and the total number potentially present. This should include the expected peak number of fish per day, seasonal and daily fish returns, future fish return expectations, expected incidental catch, etc.*
- *Identify the target species, including ESA-listed species.*
- *Identify other species likely to be present at the trap, including ESA-listed species.*
- *Describe the environmental conditions expected to occur during trap operation such as water and air temperature, flow conditions (lows and peaks), and debris load.*
- *Describe the location, duration, frequency, predicted fish numbers, and scale of the trap and haul operations by developing an operations plan for the trap.*
- *Describe the facility's security mechanisms and procedures that will be in place in the operations plan.*
- *Identify when, what and how many fish will be taken to what location and for what purpose for the entire trapping season.* (Many times different species or origins have different destinations from the trapping facility. Understanding the fish disposition for each species, run type and origin plays a huge role in the facility design (e.g. number of holding tanks and raceways).)
- *Describe the maximum duration of delay or holding within the trapping system for target and non-target species and life stages.*
- *If a Hatchery and Genetic Management Plan, ESA Section 4(d) Limit 7 Scientific Research and Take Authorization application, ESA Section 7(a)(2), or ESA Section 10(a)(1)(A) permit application exists, show how one of these documents was used as the basis for design of a*

trapping facility. At least one of these types of documents will have to be developed for most trapping facilities and will be available for designing the facility.

7.4 Fish Handling Criteria

Section 7.4 provides criteria and guidelines that are applicable to handling fish in traps.

7.4.1 Nets

The use of nets to capture or move fish should be minimized or eliminated. If individual adult fish need to be moved, then they should be placed into rubber tubes with one end sealed. The tube should be partially filled with sufficient water to keep the head and gills of the fish submerged. Avoid handling the fish by hand, unless they have been adequately sedated. All fish should be handled with extreme care.

7.4.2 Anesthetization

Fish should be anesthetized before being handled.

The method of anesthetization for ESA-listed anadromous salmonids may be specified by the appropriate ESA permit, which should be in place prior to any directed take of listed species. The type of anesthetic to be used can be selected by agreement with NMFS during the design process and prior to submittal of an ESA permit request. Determination of the method and anesthetic used should be decided early in design, since each has different infrastructure requirements.

Once the anesthesia is selected protocols should be written to guide appropriate application of the chemical to allow for safe handling while minimizing the risk of over-exposure and mortality. The protocol should include details on water temperature and adjustment of dosage based on water temperature. Finally, a water temperature maximum should be set when fish handling will not be done.

7.4.2.1 Recovery

Fish that have undergone anesthetization should be allowed to recover from the effects of the anesthetic before being released (Section 7.5.10).

Fish require time to recover from the effects of anesthesia. The amount of recovery time needed will depend on several variables including the exposure time to the anesthesia, the water temperature (and general water quality conditions), and the individual sensitivity of the fish. Warm water temperatures and prolonged exposure to anesthetic will result in extended recovery times.

Fish should be monitored to ensure they are recovering. Signs of recovery include fish that are consistently upright and oriented, display normal gilling activity, and are responsive to stimuli.

During recovery fish should be protected from risk of impingement or accidental release back to the river (see specific guidance in Section 7.5.10).

7.4.3 Non-Target Fish

New or upgraded trapping facilities should be designed such that non-target fish can bypass the anesthetic tank.

7.4.4 Frequency

Unless otherwise agreed to by NMFS, all fish (i.e., adults and juveniles of all species and sizes) should be removed from the trap holding pool and raceways at least once every 24 hours whenever the trap is in operation. When either environmental (e.g., water temperature extremes, low dissolved oxygen, or high debris load) or biological conditions (e.g., migration peaks or delay) warrant, fish should be removed more frequently to preclude overcrowding or adverse water quality conditions from developing (Section 7.5.5.2).

7.4.5 Personnel

Trap personnel that handle fish should be experienced or trained to ensure that fish are handled safely.

7.5 Trap Design Criteria

Section 7.5 provides criteria and guidelines that apply to trap design.

7.5.1 Trap Components

Trap systems should include the following components:

- *Removable diffusers or gates located within the fish ladder to block passage and guide fish into the trap*
- *A holding pool; a transition channel or port that connects the fish ladder to the holding pool; and a trapping mechanism as described in Section 7.5.4 (attraction flow is discharged via devices described in Section 7.5.4)*
- *A gate to prevent fish from entering the trap area during crowding operations*
- *A fish crowder (and brail if needed) to encourage adult fish to exit the off-ladder holding pool and enter sorting and loading facilities*
- *Separate holding pool inflow supply and outflow facilities*
- *Distribution flume used in conjunction with false weir or steeppass systems to enable fish to exit the holding pool*
- *A lock or lift (or hopper) for loading fish onto the transportation truck*
- *A flume, pipe, or ladder to return fish either to the ladder or to the dam forebay where they can continue their upstream migration (when returning fish to the ladder, fish should be allowed to volitionally enter the ladder from a resting pool)*

7.5.2 General

7.5.2.1 Location

The entrance to trap facilities should be located in a hydraulically stable, low-velocity (i.e., approximately 1.5 ft/s), accessible area of the upstream passage facility, similar to the requirements for a counting station (Section 5.6).

This location allows fish to be more easily directed toward the trap entrance without excessive turbulence.

7.5.2.2 Flow

Fish ladders should not experience any significant change in fishway flow volume during trap operations.

Fish ladders are often designed to operate within a narrow range of flows; thus, changing the flow volume during trap operations can often compromise the function of the ladder. Depending on the design, it may be necessary to add or remove flow from the ladder in order to adjust for the operation of the trap.

7.5.2.3 Edges

All trapping components exposed to fish should have all welds and sharp edges ground smooth to the touch to minimize injuries. Additional features, such a neoprene padding covered by UV stabilized rubber, may also be required to minimize fish injuries.

7.5.2.4 Fish safety

Provisions should be included in the facility design to provide guaranteed safety to the fish or a method or manner to release fish back to the river in case of emergency (e.g., power outage or loss of water supply).

Fish safety provisions may include guaranteed water supply, water level and water supply alarms, aeration systems, and backup pumps and generators.

7.5.3 Pickets

Pickets are used to prevent fish from entering a specific area (e.g., AWS) or to guide fish to a particular area (e.g., toward a counting window for enumeration or a trap entrance).

7.5.3.1 Design velocity

The average velocity through pickets should be less than 1 ft/s for all flows (Clay 1995).

The average design velocity is calculated by dividing flow by the total submerged picket area. Non-uniform or excessive velocities through the structure can create false attraction conditions that delay fish and induce upstream migrants to attempt to jump over the pickets, potentially injuring the fish.

7.5.3.2 Material

Pickets should be constructed of non-corrosive materials. Panels may consist of flat bars (where the narrow edge of the bar is aligned with flow) or round columns of steel, aluminum, or durable plastic. All surfaces exposed to fish should be rounded or ground smooth to the touch, with all edges aligning in a single smooth plane to reduce the potential for contact injury.

7.5.3.3 Bar spacing

The maximum clear spacing between picket bars is 1 inch for adult trapping facilities. At sites where lamprey may be present, pickets should have a maximum 0.75-inch clear spacing between bars.

At sites where smaller fish are present, a smaller spacing between bars may be required.

7.5.3.4 Pickets in off-ladder holding pools

Off-ladder holding pools should include intake and exit pickets designed to prevent adult fish from exiting the holding pool. These should conform to the criteria identified in Section 6.3. The design of off-ladder holding pools should also include an adjustable overflow weir located downstream of, or in conjunction with, the entrance pickets to control the water surface elevation in the holding pool.

7.5.3.5 Blocking pickets

Removable pickets installed within the ladder to block fish from ascending further and route them into an off-ladder trapping pool should be angled toward the off-ladder trap entrance and comply with the criteria listed in Sections 5.3.7 and 5.6.3.7. Pickets installed within ladders should be completely removed from the ladder when trapping activities are not occurring.

7.5.4 Trapping Mechanisms

7.5.4.1 Description and purpose

There should be a mechanism that allows fish to enter, but not volitionally exit, a holding pool. The most commonly used mechanisms include finger weirs, Vee trap fykes, or false weirs (Section 7.5.8).

The maximum velocity over finger traps is 8 ft/s. The amount of flow over the top of a finger weir is usually 2 to 6 inches but varies based upon species. The height of a finger weir varies but is usually in range of 6 to 10 inches (Bell 1991). When using finger traps, an escape area should be provided at both ends to prevent fish from being held against the fingers and killed (Bell 1991).

For a Vee trap, Bell (1991) recommends a minimum velocity of 4 ft/s. The opening at the apex is usually around 8 inches but may need to be larger or smaller depending upon the species present. Being able to adjust this opening can be very beneficial.

Figure 7-1 shows a schematic of a finger weir. Figure 7-2 shows a cutaway of a Vee trap.

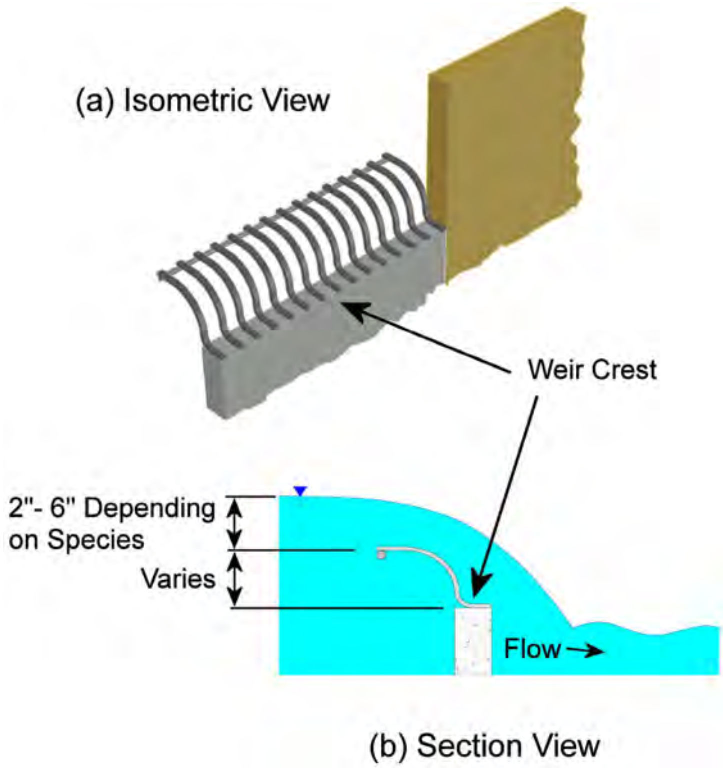

Figure 7-1. Finger weir schematic

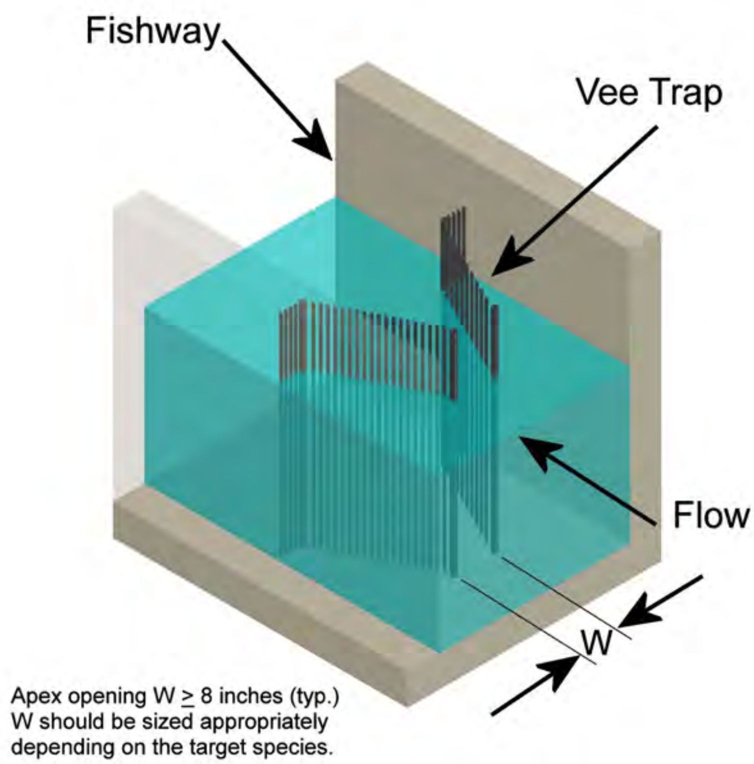

Figure 7-2. Cutaway of a Vee trap

7.5.4.2 Edges

All trapping components exposed to fish should have all welds and sharp edges ground smooth to the touch to minimize injuries. Additional features, such a neoprene padding (covered by UV stabilized rubber), may also be required to minimize fish injuries.

7.5.4.3 Materials and bar spacing

Materials and bar spacing should conform to Sections 7.5.3.2 and 7.5.3.3.

7.5.4.4 Closure

Trapping mechanisms should be able to be closed temporarily to avoid spatial conflict with brail crowding and loading operations. The trapping mechanisms should be designed to safeguard against fish gaining access to unsafe areas such as areas behind a crowder or under a floor brail.

7.5.5 Holding Pools

Holding pools and raceways are used to provide safe areas where fish can be held and accumulated until the facility operators are prepared to process them (for actions such as sorting, evaluation, or transportation).

7.5.5.1 Water quality

Holding pool water quality should be equal to or exceed that of the ambient waters from which fish are trapped.

Key water quality parameters include water temperature, oxygen content, and pH. The purpose of this criterion is to provide fish with a safe, healthy holding environment.

7.5.5.2 Trap holding pool capacity

The following criteria should be followed with regard to trap holding pool capacity:

- *Trap holding pool capacity is based on the number and poundage of fish that can be safely held in a given pool volume for a given time period as well as water quality and quantity.*
- *The number of fish is determined by the maximum daily number of fish passing through the ladder or facility, or by the number of fish expected to be trapped and held prior to being transported.*
- *Fish poundage is determined by multiplying the weight of the average fish targeted for trapping by the maximum number of fish expected to occupy the trap. Note that the poundage calculation may entail calculations for a number of different fish species.*

7.5.5.3 Short-term holding

Trap holding pools should be sized to provide a minimum volume of 0.25 ft^3/lb of fish. Trap water supply flow rate should be at least 0.67 gallon per minute (gpm) per adult fish for the predetermined adult fish trap holding capacity.

These criteria apply to conditions when water temperatures are less than 50 degrees Fahrenheit (°F), dissolved oxygen is between 6 and 7 parts per million, and fish are held less than 24 hours (Senn et al. 1984; Bell 1991; Bates 1992). For example, to hold 100 lb of fish for less than 24 hours, the holding pool would need to provide a volume of 25 ft^3 (100 lb × 0.25 ft^3/lb of fish) at 50°F. These criteria are based on the long-term holding requirements presented by Senn et al. (1984), which have been modified and adapted to short-term holding conditions. (See Section 7.5.5.5 for guidance on when water temperatures exceed 50°F.)

7.5.5.4 Long-term holding

Trap holding pool water volumes and water supply rates should be increased by a factor of 2 (0.5 ft^3/lb of fish and at least 1.34 gpm per adult fish, respectively).

For example, to hold 100 lb of fish for more than 24 hours (but less than 96 hours), the holding pool would need to provide a volume of 50 ft^3 (100 lb × 0.5 ft^3/lb of fish) at 50°F. Long-term holding should not exceed 96 hours. Trap and haul facilities are not intended for the long-term holding of adults (e.g., hatchery broodstock). However, NMFS will consider additional information or research regarding adult fish holding times and densities, if provided. (See Section 7.5.5.5 for guidance on when water temperatures exceed 50°F.)

7.5.5.5 Holding pool capacity when water temperatures are greater than 50°F

If water temperatures are greater than 50°F, the poundage of fish held should be reduced by 5% for each degree above 50°F (Senn et al. 1984). The trap capacity and average weight of targeted fish values to be used in a design are subject to approval by NMFS.

For short term holding (less than 24 hours) at 60°F, to hold 100 lb of fish, the holding pool would need to provide a volume of 50 ft^3. For long term holding (greater than 24 hours but less than 96 hours) at 60°F, the holding pool would need to provide a volume of 100 ft^3.

Extreme care should be taken when water temperatures are above 68°F during trap operations.

Table 7-1 is provided for reference.

Table 7-1. Holding Pool capacity when water temperature exceeds 50°F

Temp (°F)	Short Term Holding (0.25 lb/ft^3)	Short Term Holding (0.25 ft^3/lb)	Long Term Holding (0.5 lb/ft^3)	Long Term Holding (0.5ft^3/lb_
50	4.00	0.25	2.00	0.50
51	3.80	0.26	1.90	0.53
52	3.60	0.28	1.80	0.56
53	3.40	0.29	1.70	0.59
54	3.20	0.31	1.60	0.63
55	3.00	0.33	1.50	0.67
56	2.80	0.36	1.40	0.71

57	2.60	0.38	1.30	0.77
58	2.40	0.42	1.20	0.83
59	2.20	0.45	1.10	0.91
60	2.00	0.50	1.00	1.00
61	1.80	0.56	0.90	1.11
62	1.60	0.63	0.80	1.25
63	1.40	0.71	0.70	1.43
64	1.20	0.83	0.60	1.67
65	1.00	1.00	0.50	2.00
66	0.80	1.25	0.40	2.50
67	0.60	1.67	0.30	3.33
68	0.40	2.50	0.20	5.00
69	0.20	5.00	0.10	10.00

7.5.5.6 Trap holding pool inflow

The following criteria should be followed with regard to trap holding pool inflow:

- *Inflow should be routed through an upstream diffuser designed in accordance with the criteria identified in Section 5.3.7.*
- *The maximum average velocity through the diffuser that is acceptable is 1 ft/s for vertical diffusers and 0.5 ft/s for horizontal diffusers.*
- *Horizontal diffusers should be used when supplying water directly to fish holding pools to reduce the potential for fish jumping at the diffuser flow (Bell 1991).*
- *For both vertical and horizontal diffusers, baffling and other methods of energy dissipation should be used to prevent excessive turbulence and surging, which may induce adult jumping within the trap.*
- *Flow distribution through the diffuser should not cause fish to crowd into a particular area of the holding pool. However, when fish are being crowded for handling or routing, it is best to take advantage of their natural behavior and concentrate the water supply near the end of the pool where fish are being encouraged to move to as part of the operation.*

7.5.5.7 Shading

Consideration should be given to providing shading for holding pools and raceways.

Shading can reduce stress and jumping in adult fish and can reduce the potential for sun burn (Bell 1991).

7.5.5.8 Holding pool water depth

The minimum depth of water in the holding pool is 5 feet.

This is the same minimum depth criterion as is specified for fish ladder pools.

7.5.5.9 Adult jumping

Trap holding pool designs should include provisions that minimize adult jumping, which may result in fish injury or mortality.

Examples of provisions that reduce jumping include the following (Bell 1991):

- Incorporating a high freeboard on holding pool walls of 5 feet or more (note that Bell [1991] recommends incorporating up to 6 feet of freeboard into the facility design)
- Covering or shading the holding pool to keep fish in a darkened environment
- Providing netting over the pool that is strong enough to prevent adults from breaking through the mesh fabric
- Providing sprinklers above the holding pool water surface to break up the water surface and reduce the ability of fish to detect movement above the trap pool
- Designing the corners of the holding pools to have a minimum radius of 18 inches
- Ensuring that water from distribution flumes and pipes does not drop directly into the holding pool
- Ensuring that there are no areas of strong horizontal light nor dark areas present on the surface of the holding pool

7.5.6 Crowders

Crowders are porous panels that can be deployed into a holding pool and used to move fish horizontally to the end of the pool for collection by a hopper or lift, or to encourage the fish to leave the holding pool. Crowders can be pushed by personnel or mechanically operated.

7.5.6.1 Bar spacing

Holding pool crowders should have a maximum clear opening between bars of 0.875 inch. Gaps around the sides of crowder panels should not exceed 1 inch. The side and bottom seals of the crowder panel should allow the crowder to move without binding and should prevent fish from entering the area behind the crowder panel.

If smolt-sized juvenile salmonids or other small fish are expected to be retained in the adult holding pool, the maximum clear bar spacing of the crowder panel (and brail if present) should be reduced to 0.25 inch, and any gaps around the sides the crowder panels should not exceed 0.375 inch.

Often, smaller-sized fish find their way into and become caught in the adult trap holding pool. Provisions should be incorporated into the trap design to safely remove smaller-sized fish from the holding pool and return them to the river.

7.5.6.2 Material

Crowder panels should be constructed of non-corrosive materials. The use of galvanized material should be avoided if possible, and otherwise minimized. Panels may consist of fish screen material such as profile bar or perforated plate material, flat bars where the narrow edge *of the bar is aligned with flow, or round columns of steel, aluminum, or durable plastic. All edges and surfaces exposed to fish should be rounded or ground smooth to the touch.*

The galvanization process uses zinc, which can be toxic to fish (this is why non-corrosive materials for crowder panels should be used). During the crowding process, fish are extremely likely to come into direct contact with the crowder panels. To reduce the potential for fish to be descaled or injured when being crowded, all surfaces and edges that fish can contact need to ground smooth or rounded.

7.5.6.3 Crowding process and crowding speeds

For mechanical crowders, the beginning of the crowding process can be automated, but at the end of the process when fish densities are high the crowder should be manually controlled.

Speeds for horizontally oriented crowders are typically in the 0.5- to 1-ft/s range for pre-anesthesia, sorting, and holding pools. Maximum crowder speed should not exceed 2 ft/s and should be adjustable.

Crowders are often controlled by a variable frequency drive (VFD). VFDs allow for crowder travel speed to be slowly increased or decreased. This moves the equipment to crowd, but not stress, adult fish in the holding pool. Further, it eliminates erratic (jerking) crowder movement provided with a simple on-off switch. Crowder speeds are also sometimes controlled by a switch to toggle between fast and slow speeds. In all cases, the VFD should be programmed not to increase the crowder or brail speed beyond a maximum level.

7.5.6.4 Coverage

Crowders should be able to cover (crowd) the entire holding pool and should not leave any areas where fish may escape the crowding process.

Being able to crowd the entire holding pool ensures that all fish can be removed from the pool and that no fish spends more time than necessary in the holding pool.

7.5.6.5 Fish entering the holding pool while crowding

If the crowder cannot be removed from the holding pool, it is important that fish do not enter that portion of the holding pool located behind the crowder during crowding operations.

Fish should not be able to access the area behind the crowder where they could become trapped resulting in injury or death.

7.5.7 Brails

Brails are porous panels that can be used to move fish vertically in a holding pool or fish lock. For large holding pools, they are often used in conjunction with a crowder to encourage fish to exit the holding pool.

7.5.7.1 Floor brails

The following criteria should be followed with regard to floor brails:

- *Floor brails should be composed of screen material that is sized according to the life stage and species present to preclude injury or mortality from occurring to target and non-target fish species. Gap openings along the sides of the brail should not exceed 1 inch.*
- *For adult salmonids, brails should have a maximum clear spacing between bars of 0.875 inch. Gaps around the sides of crowder panels should not exceed 1 inch, and seals should be installed that cover all gaps. The side and bottom seals of the crowder panel should allow the crowder to move without binding and prevent fish from moving underneath the brail.*
- *If juvenile salmonids (i.e., smolt-sized fish) or other small fish are expected to be caught in the holding pool, consideration should be given to including a separator system and juvenile sanctuary area as part of the brail system. Also, the maximum clear spacing between bars of the brail should be reduced to 0.25 inch, with side tolerances of no more than 0.375-inch opening or the openings sealed with a brush material.*

7.5.7.2 Material

Brail panels should be constructed of non-corrosive material. The use of galvanized material should be avoided if possible, and otherwise be minimized. Panels may consist of fish screen material such as profile bar or perforated plate material; flat bars where the narrow edge of the bar is aligned with flow; or round columns of steel, aluminum, or durable plastic. All edges and surfaces exposed to fish should be rounded or ground smooth to the touch.

The galvanization process uses zinc, which can be toxic to fish (this is why non-corrosive materials for crowder panels should be used). During the crowding process, fish are extremely likely to come into direct contact with the crowder panels. To reduce the potential for fish to be descaled or injured when being crowded, all surfaces and edges that fish can contact need to ground smooth or rounded.

7.5.7.3 Slope

The sides and the floor of the brail should be sloped toward the holding pool egress point to encourage adult fish to move off the brail.

7.5.7.4 Lifting

The brail should not be used to lift fish out of the water.

7.5.7.5 Brail speed

Brail speeds are typically in the 0.5- to 1-ft/s range for pre-anesthesia, sorting, and holding pools. Maximum brail speed should not exceed 2 ft/s and should be adjustable. The beginning of the brailing process can be automated, but at the end of the process when fish densities are high, the brail should be manually controlled.

7.5.7.6 Fish lock brails

When floor brails are used in association with fish locks (Section 7.6.2), the floor brail hoist should be designed for both manual and automatic operation and should allow the brail to move at a maximum rate of 2.3 ft/s (both upward and downward). Also, the brail should be able to be operated at speeds that match changes in water surface elevation. Automated operation is allowed only when the water depth above the brail is 4 feet or more. At water depths less than 4 feet, operation of the brail should be conducted manually.

These criteria are designed to minimize stressing fish during crowding between the floor brail and the point where water in the lock exits over an egress weir.

7.5.8 False Weirs

A false weir is a specialized floor diffuser used to introduce water at the top of a fishway or entrance to a distribution flume for the purpose of attracting and encouraging fish to volitionally move into a specific area (Figure 7-3). The device usually creates a strong upwelling flow that simulates flow cascading over a weir. Fish are attracted to the cascading flow and swim through the upwelling into the distribution flume. Care should be taken when locating a false weir to avoid light-to-dark transition at the location of the false weir (shadows) or movement by operator personnel around the false weir. These conditions could cause a fish to reject (not enter) the false weir.

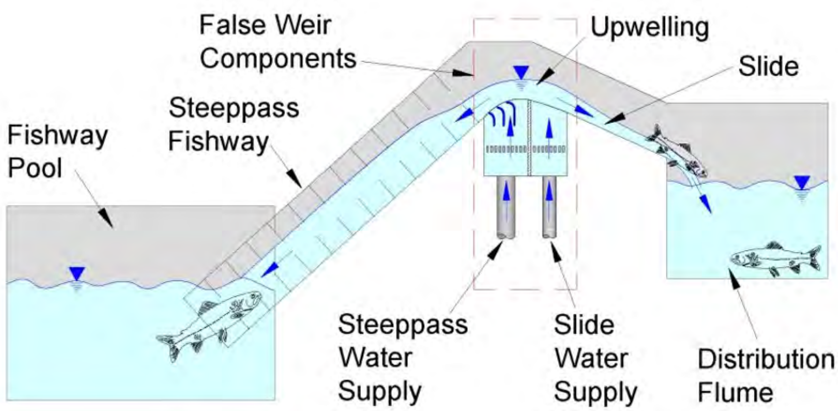

Figure 7-3. Cross section of a false weir

7.5.8.1 Depth

Water depth over the crest of the false weir should be at least 6 inches to facilitate fish egress from the holding pool.

7.5.8.2 Water Supply and Dewatering

The false weir design should include independent water control for both the weir side (steeppass water supply side in Figure 7-3) and flume side (slide water supply in Figure 7-3). Additionally, the slide side of the false weir should include a dewatering screen/system to allow the operator to trim the flow down the slide/flume.

Tuning the amount of flow over the false weir to encourage fish movement while having the ability to limit the amount of flow down the flume is very important. Too much flow down the flume, may allow the fish to try to swim against the flow until exhaustion (Section 7.5.9.3). Achieving the balance between sufficient weir flow and reduced flume flows can be impossible with a common water supply. The addition of a drain between the weir supply and the flume supply is very helpful and allows the operator to maximize attraction flow entering the holding pool. Finally, the independent water control and drain allows the operator to continue to supply the flume with flow both before and after the weir is turned on and off, respectively.

7.5.8.3 Adjustability

The false weir and the downstream water level should have enough adjustability to backwater the false weir and create a streaming flow condition, rather than a plunging flow condition over the weir.

Incorporating this adjustability in the design of the false weir allows the operator to adjust conditions at the false weir to allow adult fish to swim through the weir, rather than having to leap at it to pass the weir. Care should be taken when raising the downstream water surface elevation to ensure this does not adversely affect hydraulic conditions in the trap facility further downstream of the false weir.

7.5.8.4 Fish entering a distribution flume

In situations where fish are entering a distribution flume after passing over a false weir, the ability to change the amount of flow coming from the false weir should be rapid and easy to change in order to regulate the movement of fish over the weir.

Oftentimes it is necessary to control (i.e., meter) the number of fish passing through the false weir so operator personnel can identify and sort fish into various holding tanks. Having the ability to rapidly change the amount of flow coming from the false weir allows the operator some control over how many fish enter the false weir at time. Operator-controlled neoprene doors that open and close in front of, or vary the width of, the entrance to the false weir can be used to allow the operator to more efficiently meter fish through the false weir. Care should be taken in providing sufficient freeboard (around, above, through and downstream of the false weir), since very strong leapers (like steelhead) can jump much higher than the water level on the weir crest.

7.5.8.5 Edges

Provisions, such as neoprene padding (covered by UV stabilized rubber), should be installed around a false weir to protect fish that make an inaccurate leap at the weir from being injured.

7.5.8.6 Gravity flow

A gravity flow (i.e., not pumped) water supply should be used for false weirs and steeppass ladders to prevent fish from potentially rejecting the trap component due to the production of noise or vibration from a pump or motor. At sites where it is necessary or *desirable to use a pumped water supply, care should be taken to isolate the pump noise and vibration from affecting the fish.*

7.5.9 Distribution Flumes and Pipes

7.5.9.1 General

A distribution flume (or pipe) should be used whenever fish are routed from one area to another.

Distribution flumes are used to convey fish to anesthetic tanks, recovery tanks, pre-transport holding tanks, fish ladders, and project forebays. They are also used to convey fish to various locations after they pass through false weirs.

7.5.9.2 Smoothness

The flume should have smooth joints, sides, and bottom, with no sharp or abrupt edges and no abrupt vertical or horizontal bends.

7.5.9.3 Wetted surfaces, water depth, and velocity

The following criteria should be followed with regard to wetted surfaces, water depth, and velocity:

- *The flume should have continuously wetted surfaces.*
- *For flumes less than 50 feet in length, water depth in the flume should be between 1 and 3 inches, and water velocity should be between 6 and 8 ft/s.*
- *For flumes that are longer than 50 feet, a closed pipe with open channel flow should be used for the entire length of the flume. The water depth in the pipe should be between 2 and 4 inches (a depth of 4 inches is preferred), and water velocity should be greater than 8 ft/s, but less than 15 ft/s.*
- *Site-specific adjustments to these values may be required.*

The combination of low water depth and high velocity is intended to prevent adult fish from holding in the pipe or swimming upstream in the pipe. If the pipe is above ground, observation ports with removable covers should be provided so that conditions in the flume can be observed and the pipe can be accessed for maintenance and debris removal. If the pipe is located belowground, access ports should be provided for inspection and maintenance.

7.5.9.4 Outfalls

When distribution flumes lead to holding tanks or raceways, care should be taken so that adults entering the tank do not hit the walls, floor, or end of the tank or collide (land on top of) with other fish. A dewatering drain should be located immediately upstream of the outfall to eliminate flow from the outfall which can cause false attraction and jumping.

When a distribution flume is used to return adults to the river, the criteria for juvenile outfalls (Section 8.6.4) should be followed (i.e., the bypass flow should not impact the river *bottom or other physical features at any stage of river flow, and the maximum bypass outfall impact velocity should be less than 25 ft/s).*

7.5.9.5 Bends

Horizontal and vertical radii of curvature should be at least 5 times the width of the flume to minimize the risk of fish-strike injuries. A removable flume cover should be provided when flumes go through bends greater than 30 degrees in alignment.

Removable covers are necessary to prevent active fish from leaping out of the flume and allow personnel to inspect the flume for debris accumulation in the bend.

7.5.9.6 Size

The minimum inside diameter of the distribution flume should be 15 inches for fish weighing 20 lb or less and 18 inches for fish weighing 20 lb or more.

The minimum sidewall height of a distribution flume is 24 inches.

This height is in addition to the radius of the flume. For example, the minimum total height of a 15-inch diameter flume would be 31.5 inches (24 inches plus half of the diameter at 7.5 inches), as measured from the invert of the flume.

7.5.9.7 Length

Distribution flumes should be as short as possible.

7.5.9.8 Flume structure

Overhead structures that are part of the flume, such as overhead bracing to stiffen the walls of the flume or gate operation arms, should be eliminated if possible, or minimized. If overhead structures are necessary, they should be located above the top of the flume sidewalls or 30 inches above the invert of the flume, whichever is greater.

7.5.10 Anesthetic Recovery Pools

The following criteria should be followed with regard to anesthetic recovery pools:

- *Anesthetized fish should be routed to a recovery pool to allow the fish to be monitored prior to release to ensure they have fully recovered from the anesthesia.*
- *Fish that are recovering from anesthesia should not be routed directly back to the river where unobserved mortality may occur.*
- *Recovery pool inflow should satisfy the water quality guidelines specified in Section 7.5.5.*
- *Recovery pool hydraulic conditions should not result in partially or fully anesthetized fish being impinged on an outflow grating or any other hazardous area.*
- *A recovery pool should allow fully recovered fish to volitionally exit the pool.*
- *The recovery pool should have a brail or crowder system to force fish from the recovery pool if necessary.*

Often, fish require time to recover from effects of anesthetic. Anesthetized fish released directly to an uncontrolled environment (i.e., directly back to the river or into a ladder) often fail to orient themselves upright and sometimes sink to the bottom where they may suffocate or are swept downstream. It is important to provide fish recovering from anesthetic with a safe recovery area where they can be monitored by personnel. Some indications that fish are fully recovered include they are upright and oriented, display normal gilling activity, and are responsive to stimuli. If a fish appears to be struggling to recover or appears distressed, it may be necessary to retrieve the fish and revive it. Revival may involve manually ventilation of the gills by gently moving the fish forward and backward in the water. The ability of a fish to volitionally exit the recovery pool is an indication that the fish has recovered sufficiently from the anesthetic. Fish should not be forced out of the recovery pool for at least 30 minutes after exposure to anesthetic.

7.6 Lifting Devices

Section 7.6 provides criteria and guidelines that apply to fish lifting devices.

7.6.1 Fish Lifts and Hopper Passage Systems

A fish lift is a mechanical system that utilizes a hopper and hoist to allow fish to be trapped at one elevation and raised to a higher elevation. Once raised to the higher elevation, fish can be loaded into a transport tank or truck for release at a remote location, routed to a monitoring and sorting facility, or released above a dam directly into the forebay.

7.6.1.1 Maximum hopper loading densities

The hopper water volumes should be greater than or equal to 0.15 ft^3/lb of fish estimated to occur at the maximum fish load. When large fish (fish ranging from 30 to 40 lb in weight) are being transported, the poundage being transported should be reduced by 50% (Bell 1991).

Hopper loading densities are designed to ensure that a sufficient volume of water is available to fish to be raised safely. Normally, the size of the hopper and transport tank loading match, such that a full hopper volume equals a full transport tank volume. The density of fish being held when water temperatures become elevated is a concern that needs to be considered. Bell (1991) recommends that the poundage of fish being transported in tanks be reduced by 10% for each degree of water temperature above 60°F.

7.6.1.2 Hopper freeboard

The distance from the water surface in the hopper to the top of hopper bucket should be greater than the water depth within the hopper.

This is to reduce the risk of fish jumping out of the hopper during lifting operations.

7.6.1.3 Sump

When a trap design includes a hopper sump into which the hopper is lowered during trapping, side clearances between the hopper and sump sidewalls should not exceed 1 inch to *minimize access to the area below the hopper. Flexible side seals or brushes should be used to ensure that fish do not pass below the hopper.*

It is very important that the hopper and gates around the sump provide a positive seal and do not allow fish to get into the sump area. If fish do get into this area, they can be very difficult to remove due to the water depth and confined area.

7.6.1.4 Fish hopper egress opening

The fish egress opening from the hopper into the transport tank should have a minimum horizontal cross-sectional area of 3 square feet and a smooth transition to minimize the potential for fish injury.

7.6.1.5 Safeguarding fish

Fail-safe measures should be provided to prevent fish entering the holding pool area from accessing the area occupied by the hopper before the hopper is lowered into position. The interior surfaces of the hopper should be smooth to eliminate fish injuries.

7.6.2 Fish Lock

A fish lock is a mechanical-hydraulic system that utilizes a water chamber or tower to raise fish from one elevation to another. It allows fish that are collected (trapped) at a lower elevation to be raised to a higher elevation by increasing the water level in the chamber or tower until it reaches a predetermined elevation where fish can be released. The fish can be brailed (i.e., crowded) to the higher elevation and then loaded into a transport truck for release at a remote location, routed to a monitoring and sorting facility, or released directly above a dam into the forebay (Clay 1995).

Section 7.6.2.1 outlines the process for routing fish from a holding pool to the forebay or transport vehicle using a fish lock.

7.6.2.1 Holding pool crowding

The following criteria and guidelines should be followed with regard to holding pool crowding:

- *Fish are crowded into the lock; the crowder should meet up with the entrance to the lock so that no fish can become trapped or crushed between the crowder and the lift structure or closure gate.*
- *When the closure gate to the fish lock chamber is shut it should create a uniform surface with the interior of the lock so that the brail can pass the gate without creating excessive gaps that could allow fish to get past the brail.*
    - The closure gate is the gate that seals the lock chamber from the holding pool.
- *Once the closure gate is shut, the crowder should be backed up to reduce the stress on the fish.*

- Crowding, especially the last part of the crowd when fish are forced from the holding pool, can be very stressful to the fish. If there is a break in the crowding operation for some reason (lifting and operating the hopper for example), the crowder should be backed off to reduce the stress on the fish.

- *Flow to fill the lock should be introduced into the lock through floor diffusers below the floor brail.*
  - As the water level rises within the lock, it will ultimately reach an equilibrium elevation with a control weir or false weir.
- *The floor brail should be raised only after the water surface elevation in the lock is at an equilibrium with the control weir or false weir. If the brail is being operated while the fish lock is being filled, the speed of the brail should not exceed the rate of change in water surface elevation. The brail should be greater than 4 feet from the water surface until the water level reaches equilibrium with the control or false weir. The brail should not be used to lift fish out of the water (Section 7.5.7.4).*
  - Speeds for brails (vertically oriented crowders) are typically in the 0.5- to 1-ft/s range for pre-anesthesia, sorting, and holding pools, but can range up to 2.3 ft/s for vertical fish locks.
- *Fish should exit the lock via a false weir or through the overflow water draining over the control weir.*
- *Fish and water that pass over the control weir or false weir can be routed using a distribution flume to other destinations, including an anesthetic tank, sorting or holding pools, or a transportation vehicle.*
  - Floor dewatering screens in the distribution flume can be used to drain off excess flow just before fish are delivered to anesthetic tanks, holding pools, or transportation vehicles.

7.6.2.2 Lock inflow chamber

The lock inflow chamber located below the lowest-floor brail level should be of sufficient depth and volume (Section 5.5.3.5) to limit turbulence into the fish holding zone when lock inflow is introduced. The inflow sump should be designed so that flow upwells uniformly through add-in floor diffusers (Section 5.3.7; Bell 1991).

Properly designed lock inflow chambers will limit turbulence and unstable hydraulic conditions within the lock that may agitate fish.

7.7 Single Holding Pool Traps

Single pool traps are often used in tandem with intermittent exclusion barriers (Figure 6-5) for broodstock collection from small streams. These trapping systems are used to collect, sort, and load adult fish. Key criteria for single holding pool traps are as follows:

- *The trap holding pool water volume should be designed according to Section 5.5.3.5 to achieve stable interior hydraulic conditions and minimize jumping of trapped fish.*
- *Intakes should conform to Section 5.3.2.*

- *Sidewall freeboard should be a minimum of 4 feet above the trap pool water surface at high design streamflow.*
- *The trap holding pool interior surfaces should be smooth to reduce the potential for fish injury.*
- *A description of the proposed means of removing fish from the trapping pool and loading them onto a transport truck should be submitted to NMFS for approval as part of the ESA incidental take permit application.*

7.8 Upstream Transportation Criteria

Section 7.8 provides criteria and guidelines that are applicable to truck transportation equipment and facilities.

7.8.1 Maximum Transport Tank Loading Densities and Time

Transport tank loading water volumes should be greater than or equal to 0.15 ft^3/lb of fish at the maximum fish loading density to provide a sufficient volume of water for fish safety. When large fish (fish ranging from 30 to 40 lb in weight) are being transported, the poundage being transported should be reduced by 50% (Bell 1991). Every effort should be made to reduce the amount of time fish spend in a transport tank.

These loading densities are to ensure that a sufficient volume of water is available in the tank for fish to be transported safely. Normally, the size of the hopper and transport tank loading match, such that a full hopper volume equals a full transport tank volume. The density of fish being held when water temperatures become elevated is a concern that needs to be considered. Bell (1991) recommends that the poundage of fish being transported in tanks be reduced by 10% for each degree of water temperature above 60°F.

Due to the high loading densities in transport tanks and the stress it may create, every effort should be made to minimize the amount of time the fish spend in these tanks. Fish should not be held for long in a transport tank while waiting for other fish to be processed or while waiting for other fish to fill the tank.

7.8.2 Transport Tanks

To minimize handling stress, truck transport tanks should be compatible with the hopper design. If an existing vehicle will be used, the hopper should be designed to be compatible with existing equipment. If the transport tank opening is larger than the tube or hopper opening, a cap or other device should be designed to prevent fish from jumping at the opening. Truck tanks for hauling adults should be closed systems, and the tanks should be kept full to prevent sloshing (Bell 1991).

7.8.2.1 Fish transfer from hopper to tank

The transfer of fish should be made water-to-water. The design of the hopper and transport tanks should allow for hopper water surface control to be transferred to the truck *transport tank during loading so that water and fish do not plunge abruptly from the hopper into the fish transport tank.*

7.8.2.2 Transport tank egress

The fish egress opening from the transport tank should have a minimum cross-sectional area of 2 square feet (Clay 1995). The bottom of the transport tank should be sloped (front to back and side to side) toward the release opening and have a smooth transition that minimizes the potential for fish injury.

7.8.2.3 Oxygen and temperature requirements

Depending upon site-specific conditions, the transportation tank should have the capability to maintain dissolved oxygen levels between 6 and 7 parts per million. The transportation tank should also contain water chillers to maintain ambient water temperature if the transport cycle time could result in unhealthy increases in the water temperature in the tank or temperature differential between the tank water temperature and the ambient water temperature where the fish are released exceed the water tempering described in Section 7.8.3.5.

Many existing fish transport trucks do not include water chillers because they are designed for short transport trips during which the water temperature conditions in the tank do not result in temperature changes that exceed the water tempering requirements when the fish are released. Water tempering can be performed using chillers or mixing with cooler or warmer water at loading or release sites.

7.8.3 Release Location

After being transported, fish should be released in a safe location with sufficient depth and good water quality.

The criteria and guidelines in Sections 7.8.3.1 through 7.8.3.6 apply to release locations.

7.8.3.1 Direct release from a transport tank

Fish should not be dropped more than 6 vertical feet during release. The receiving water should be at least 3 feet deep, and fish should not contact the bottom. The impact velocity of fish entering the receiving water should be less than 25 ft/s.

7.8.3.2 Release pipe from a transport tank

For locations where release pipes are required, the minimum diameter for a release pipe is 24 inches (30 inches is preferred). The end of the release pipe should not be submerged. The internal surface of the pipe joints should be smooth to the touch to prevent descaling and injury to fish. The release pipe elevation criteria, receiving water depth, and impact velocity are the same as for fish being released directly from a transport tank (Section 7.8.3.1).

Depending on how fish are released from the transport tank, the entrance to the release pipe may have to be larger (e.g., 36 inches), or a funnel or flume should be created that smoothly transitions from the release tank outlet to the release pipe. Care should be taken to minimize the possibility of a fish leaping out of the system during transfer from the tank to release pipe.

7.8.3.3 Release water

Water should be supplied to the release pipe prior to fish being released and also used to flush the last fish out of the pipe.

7.8.3.4 Water quality

Water quality (i.e., water temperature and dissolved oxygen) at the release site should be representative of the general water conditions in the river in the vicinity of the release site.

7.8.3.5 Water tempering

Fish should not be subjected to rapid temperature changes. Temperature differentials between the transport tank and release location should be no more than 2 degrees Celsius (°C). If tempering is required to meet this criterion, changes in temperature should not exceed 1°C every 2 minutes or 5°C per hour. Tempering may take longer when temperatures are further away from the optimal temperature for the target species and life stage.

Changes in water temperature that occur too rapidly or are beyond the normal survival range of fish may cause thermal trauma (Post 1987). Mortality associated with rapid temperature changes may occur in the short term from loss of equilibrium (Bell 1991) and increased predation (Groot et al. 1995). Over longer time periods, thermal stress can act as an additive stressor and increase susceptibility to disease (Piper et al. 1982). Fish adapt more rapidly when the temperature change is nearer their thermal optimum than when the change is further away from that temperature (Schreck and Moyle 1990). Rapid changes in temperature have more significant negative effects at the upper end of a fish’s temperature tolerance. As temperatures increase, fish are more active and have greater potential for self-inflicted injury, oxygen consumption is higher, and the saturation level of oxygen is lower, which increases the possibility of hypoxia (Murphy and Willis 1996).

7.8.3.6 Release site egress

The release site should provide direct and simple egress for fish into the river for continued migration upstream.

8 Fish Screen and Bypass Facilities

8.1 Introduction

Chapter 8 provides criteria for designing fish screen facilities for hydroelectric, municipal, irrigation, and other water-withdrawal projects that prevent fish (primarily young fish, fish with poor swimming capabilities, and larvae) from being entrained into water diversions. The objectives of these criteria are to develop fish screen facility designs that prevent fish impingement on the outward face of all fish screen material, do not increase predation above background levels, and ensure the structural integrity and longevity of all facility components is maintained. This allows the facility to be operated within its design criteria and protects fisheries resources over the design life of the project.

Striped Bass, Herring, Shad, Cyprinids, and other anadromous fish species may have eggs and/or very small fry which are moved with any water current (tides, streamflows, etc.). Installations where these species are present may require individual evaluation of the proposed project using more conservative screening requirements. In instances where state or local regulatory agencies require more stringent screen criteria to protect species other that salmonids, NOAA will consider deferring to the more conservative criteria on a case by case basis.

The criteria are to be used when designing new facilities or performing major retrofits to existing facilities. The criteria are also to be used for temporary diversions such as water drafting operations (Section 8.7) and when stream flow is to be routed around a construction site. In addition, information presented in Chapter 1, Introduction; Chapter 3, Design Development; and Chapter 4, Design Flow Range, of this document apply to the design of fish screen and bypass facilities.

8.1.1 100% Flow Screening

All facilities that divert or use water from a body of water should convey 100% of the diverted flow through a fish screen or bypass that is designed, constructed, tested, and operated using the criteria contained herein.

The application of these criteria to existing fish screen facilities is addressed in Section 8.2.

8.1.2 Deviation from These Criteria

The criteria can be adjusted by NMFS as needed to meet the specific requirements of a project. It is the responsibility of the applicant to provide compelling evidence in support of any proposed waiver (Section 1.6) or modification of a criterion to NMFS early in the design process and well in advance of a proposed federal action. Appendix C (Experimental Technologies) *provides additional information on the NMFS approval process for unproven fish passage technologies.*

There may be cases where site constraints or extenuating circumstances weigh in favor of a deviation or waiver of these criteria. Extenuating circumstances may include environmental factors that affect a fish's swimming ability or condition such as abnormally warm or cold waters or waters low in dissolved oxygen.

The swimming ability of target fish species and their life stages are primary considerations in designing effective fish screen facilities. The swimming abilities of fish vary with species, age-class, size, and duration (i.e., endurance) and type of swimming activity required (e.g., sustained versus burst swim speed). Bell (1991) provides information on swimming speeds for multiple fish species and age-classes and for different functional speeds (cruising, sustained, and darting). Swimming ability also depends upon a number of biological and physical factors, including the physical condition of individual fish; water quality parameters, such as dissolved oxygen concentration and water temperature; and ambient lighting conditions. For example, swimming effort may be reduced by 60% at oxygen levels that are one-third of saturation, and temperatures above and below the optimum range for any species affect swimming effort (Bell 1991). Adverse temperatures may reduce swimming effort by 50% (Brett et al. 1958).

8.1.3 Experimental Technology

The process to evaluate experimental screening technology is described in Appendix C. Proponents of new, unproven fish passage designs (i.e., designs not meeting the criteria and guidelines contained in this chapter) should provide NMFS with the types of information identified in Section 1.5.

NMFS considers several categories of screen designs that are currently in use to be experimental technologies. These include Eicher screens, modular inclined screens, and Coanda intake screens. Infiltration galleries may be considered an acceptable alternative for excluding fish at water diversions, but these are not considered positive exclusion barriers. Therefore, they are not addressed in this chapter. Information on the design and use of infiltration galleries is presented in Appendix B. The design and use of experimental technologies may be considered on a case-by-case basis through discussions with NMFS and in accordance with the procedures outlined in Appendix C.

8.2 Existing Fish Screens

8.2.1 General

If a fish screen was constructed prior to the date of this document, but in accordance with the NMFS criteria that were established on August 21, 1989, or later, NMFS considers these screens to be compliant provided that all of the following conditions have been met:

- *The entire screen facility functions and is operated as designed.*
- *The entire screen facility has been maintained and is in good working condition.*

- *When screen material wears out, it is replaced with screen material meeting the current criteria stated in this chapter (Section 8.5.8). To comply with this condition, structural modifications may be required to retrofit an existing facility with new screen material.*
- *Mortality, injury, entrainment, impingement, migration delay, or other harm to anadromous fish caused by the facility has not been observed.*
- *Emergent fry are unlikely to be located in the vicinity of the screen, as agreed to by NMFS biologists familiar with the site.*
- *When biological uncertainty exists, access to the diversion site by NMFS is permitted by the owner or operator of the facility for verification that the criteria in this chapter are being met.*

8.3 Project Design Review

The most effective approach to designing fish screening and bypass projects is to have NMFS included in all phases of the design. This can occur by having NMFS participate in a technical advisory team convened for the project or having NMFS review and comment on project designs, or both. While both the preliminary and final designs should be developed in cooperation and interaction with engineering staff from NMFS WCR Environmental Services Branch (Section 3.2), it is especially important that NMFS be involved in the preliminary design phase of a project. This is to ensure that the design parameters needed to produce a functional fish passage project are established early in the design process.

The project design process is most efficient when design criteria are identified and accepted by NMFS while a project is in its infancy. The entire project design development process and information typically required for a preliminary design are discussed in Chapter 3.

8.4 Structure Placement

All screen facilities should be designed to function properly and protect fish from being entrained into the water diversion throughout the full range of hydrologic conditions expected to occur at the location.

For in-stream facilities, the full range of conditions is normally from the minimum stream flow during which water diversions may take place, up to a 100-year flood event. In situations where streambanks will overtop allowing flow into the canal outside of the screen area at flows lower than the 100-year flood event, the screen may be designed to resist overtopping up to the lower flows. NMFS may require the facility operator to capture and relocate fish that become stranded behind a fish screen.

8.4.1 In-Stream Installations

Where it is physically practical and biologically desirable to do so, the fish screen should be constructed at the point of water diversion, and the screen face should be oriented parallel to the streamflow.

Several physical factors may preclude a fish screen from being located and constructed at the water diversion. These include excess channel gradient; the potential for large debris to damage the screen facility; access for personnel and equipment to conduct facility maintenance, operations, and repair; unsuitable soils for constructing a fish screen facility at the point of diversion; and the potential for heavy sediment accumulations.

Depending on site-specific conditions, in-stream screens may be subject to increased damage by debris. However, they typically offer the following advantages:

- They do not require a formal bypass system.
- They keep migrating fish in the streamflow.
- They may reduce fish proximity to the screen face.

8.4.1.1 Bankline screens

For screens constructed at the edge of a stream (Figures 8-1 through 8-3), the screen face should be aligned with the adjacent bankline, and the transition between the native streambank and the fish screen face should be shaped to minimize turbulence and eddying in front, upstream, and downstream of the screen. For inclined, flat plate screen designs, the screen angle should not be greater than 45 degrees from vertical, and the top of the screen should be submerged a minimum of 1 foot at low stream design flow. The design should also minimize any adverse alteration of riverine and riparian habitat.

Figure 8-1. Aerial view of the Garden City-Lowden 2 water diversion on Walla Walla River near Touchet, Washington (Notes: River flow is from left to right. The bankline screen is located at the head end of the canal, just upstream of the spillway and adult ladder exit.)

Figure 8-2 Bankline screens at the Garden City-Lowden 2 diversion on the Walla Walla River near Touchet, Washington, under construction

Figure 8-3 Bankline vertical flat plate fish screen sized for 3,000 ft3/s (Glenn-Colusa Irrigation District) along the Sacramento River in California (Note: the screen is shown in operation (left) and during construction (right).)

8.4.2 In-Canal Installations

All screen facilities installed within canals should include an effective fish bypass system (Section 8.6) to collect and transport screened fish safely back to the river with minimum delay (Figure 8-4). In instances where the returned bypass flow represents a substantial proportion of the remaining instream flow downstream from the water diversion, the bypass outfall should be placed as close to the point of diversion as practicable to minimize the length of the dewatered stream channel.

Where installation of fish screens at a diversion entrance is not desirable or is deemed impractical, the screens may be installed at a suitable location in the canal downstream of the water diversion. Locating the bypass outfall as close to the point of diversion as possible reduces the length of dewatered stream channel.

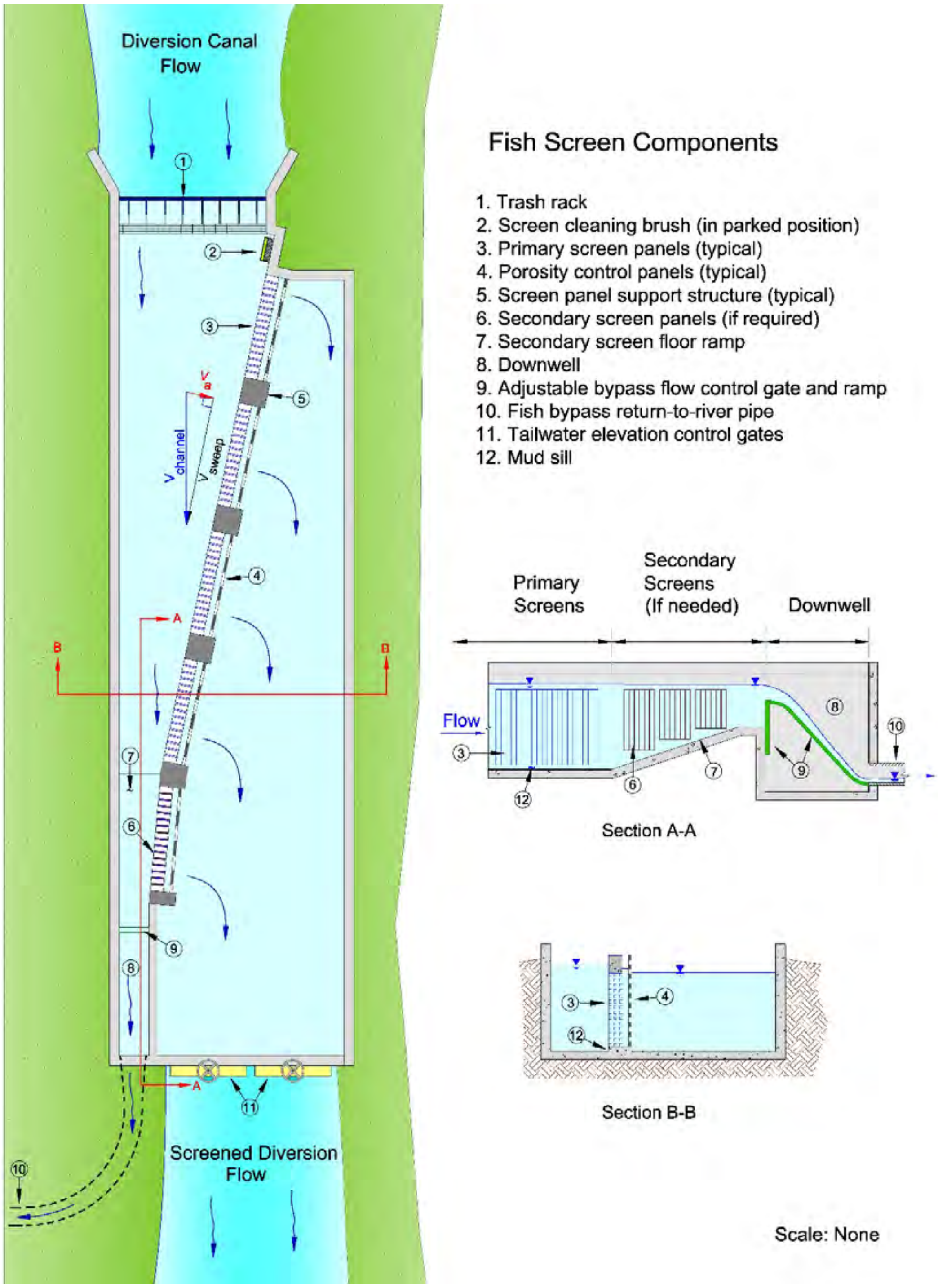

Figure 8-4 Schematic of a typical in-canal fish screen system layout and components at water diversions

Figure 8-5 Vertical plate screen facility under construction in a diversion canal located on the Santiam River near Stayton, Oregon

8.4.2.1 Headworks Control Gates

Canal flow should be controlled with gates located downstream from the screen (Figure 8-4, tailwater control gates). If headworks gates must be used to throttle flow, they should not create a head differential greater than 12 inches. Submerged headworks control gates should be operated fully closed or open at least 12 vertical inches.

Fish can be injured if forced to pass through a small opening created by a partially open headgate. Head drops greater than one foot through gates can prevent bidirectional movement of fish. Higher heads can create high water velocities and pressure differentials that may injure fish from shear stresses or impacts with hard surfaces.

8.4.2.2 Headworks trash rack

All in-canal screens should have a trash rack at the canal headworks to minimize the amount of debris that will reach the fish screen structure (Bell 1991). Trash racks should have openings that are at least 10 inches wide for Chinook salmon passage and 8 inches wide for all other salmonid species.

Additional trash rack design criteria are provided in Section 5.8 of this document. Bell (1991) recommends that openings be 12 inches wide for large salmon.

8.4.3 Lakes, Reservoirs, and Tidal Areas

Intakes in lakes, reservoirs, and tidal areas should be located offshore where feasible to minimize shoreline-oriented fish from coming into contact with the facility. When possible, intakes should be located in areas with sufficient ambient velocity to minimize sediment *accumulation in or around the screen. Intakes in reservoirs should be at an appropriate depth to reduce the number of juvenile salmonids that encounter the intake.*

The appropriate depth for intakes in lakes, reservoirs, and tidal areas will be determined on a case-by-case basis. One factor that will be considered when locating these intakes is that although juvenile salmonids are surface oriented, they may congregate in colder water located at depth if surface waters are too warm.

8.4.3.1 Required submergence

For facilities in lakes, reservoirs, and tidal areas, the facility should be placed such that the screen area is adequately submerged to meet the design approach velocity criterion at the historical low water conditions (Section 8.5.7).

8.5 Screen Design Specifications

8.5.1 Approach Velocity

The design approach velocity for active screens should not exceed 0.4 ft/s for fish screens where exposure time is limited to less than 60 seconds, or 0.33 ft/s where exposure time is greater than 60 seconds (Smith and Carpenter 1987; Clay 1995). The design approach velocity for passive screens, as described in Section 8.5.6, should not exceed 0.2 ft/s (Cech et al. 2001).

For the purposes of this document, approach velocity, "V_a" in Figure 8-4, is defined as the water velocity component normal (perpendicular) to the screen surface. The minimum amount of screen area required is calculated by dividing the maximum diversion rate (in ft^3/s) by the design approach velocity (in ft/s). The porosity of the screen is not considered in the calculation of approach velocity. The operating approach velocity for any fish screen at any diversion rate may be calculated by dividing the current diversion flow rate by the effective screen area (Section 8.5.2).

Exposure time is defined as the time it takes a particle to traverse the length of the fish screen when moving at the speed of the sweeping velocity (Section 8.5.3). The design approach velocity criteria have been shown to minimize juvenile fish contact with, and impingement on, screen materials. This includes the impingement of emergent fry under cold water temperature conditions. (Appendix E provides a discussion of how to measure approach velocity.)

Note that these criteria apply to salmonids. Other species may require different approach velocity standards. For example, in California, the U.S. Fish and Wildlife Service requires that a design approach velocity of 0.2 ft/s be used at locations where Delta smelt (*Hypomesus transpacificus*) are present.

8.5.2 Effective Screen Area

The effective screen area is defined as the total wetted screen area minus the area occluded by major structural elements. The minimum effective screen area required is defined as the maximum screen flow divided by the allowable approach velocity. For rotary drum screens, *the effective screen area is defined as the vertical projection of the wetted screen area minus the vertical projections of the area occluded by major structural elements.*

When calculating effective screen area, components (bars and rods) that make up the screen material are not considered to be "major structural elements" as long as the screen porosity remains greater than 27% when considering those structural elements. Major structural elements are elements of the facility that support the screen panels or cylinders.

8.5.3 Sweeping Velocity

The design sweeping velocities should never be less than the design approach velocity and should not decrease along the length of the screen.

Sweeping velocity is defined as the water velocity component parallel to the face of a fish screen (Figure 8-4). A swift sweeping velocity may help move fish and debris past the fish screen and reduce the chance of impingement of juvenile salmonids on the screen material (Cech et al. 2001). Based on laboratory studies, (Cech et al. 2001) a high sweeping velocity (2 ft/s) minimized juvenile Chinook salmon contacts with screens during daylight conditions and maximized downstream passage during day and night conditions. Sweeping velocities between 0.8 and 3 ft/s are generally considered to be optimal. Higher sweeping velocities may be desired to prevent fish from swimming upstream out of the fish screen forebay.

8.5.3.1 In-canal screens

In-canal screens should be angled across the canal to provide a sweeping velocity within the optimal range for the entire range of design conditions (Clay 1995). For screens shorter than 6 feet in length, the screen may be arranged perpendicular to canal flow. The sweeping velocity should remain constant or increase, but may not accelerate faster than 0.2 feet per second per foot (ft/s/ft) toward the bypass entrance.

Studies show juvenile salmonids may resist entering a bypass system when encountering a sudden acceleration in water velocity (Haro et al. 1998). The acceleration criterion is designed to gradually guide fish toward and into the bypass entrance.

In some situations, angling of the screen for sweeping velocity optimization may best be accomplished using a vee-shaped arrangement, as shown in figure 8-5.

Brett and Alderdice (1953), as referenced in Clay (1995), recommend a uniform acceleration rate of no more than 0.1 ft/s/ft of length.

8.5.3.2 On-river screens

Designers have less control over sweeping flow for screens built in a river or on the bank of a river; however, designers should make every attempt to ensure that sweeping velocity does not decrease along the length of the screen. This is to encourage fish to move past the facility and reduce the chance that sediment will deposit along the length of the screen.

8.5.3.3 Quiescent and tidal areas

To mitigate for a lack of sweeping velocity in quiescent and tidal areas, designers should use a design approach velocity not greater than 0.33 ft/s when calculating the effective screen area.

Fish screens in lakes and tidal areas usually cannot meet the sweeping velocity criteria for in-canal or on-river screens. A lower approach velocity is required for these types of screens to allow fish to volitionally swim away from the screen face.

8.5.4 Flow Distribution

The screen design should provide for nearly uniform flow distribution over the screen surface, thereby minimizing approach velocity over the entire screen face. The designer should demonstrate how a uniform flow distribution will be achieved. The maximum deviation from the target design approach velocity is 10%.

Achieving a uniform flow distribution eliminates localized areas of high velocity that have the potential to impinge fish and debris. Methods that could be used to achieve uniform flow distribution include incorporating porosity control features on the downstream side of screens that can be adjusted and training walls to direct flow into the design. Large facilities may require hydraulic modeling to identify areas of flow distribution that are of concern to NMFS.

8.5.4.1 Porosity controls

To ensure uniform flow distribution, most screens should be equipped with some form of tunable porosity controls (i.e. baffles) placed immediately behind the screen. Screen porosity controls should be tuned to achieve approach velocity criteria at the earliest opportunity available. For screens greater than 10 feet tall, NMFS may require that the baffles be capable of controlling flow through the lower parts of screen panels independently of the upper parts. The use of louver-style porosity control baffles should be limited to flat plate screens 6 feet in height or shorter.

A fish screen facility equipped with adjustable baffles to distribute flow uniformly over all wetted screen area is not considered complete until it undergoes a hydraulic evaluation to adjust the baffles. NMFS will determine one or more operating scenarios under which the hydraulic evaluation should take place. For most facilities, hydraulic evaluations should take place at or near the maximum diversion rate but there are cases where a lower diversion rate may be justified. In rare cases, a hydraulic evaluation may be required at two or more operating scenarios to account for various operating conditions such as, but not limited to, the following examples:

- A possible worst-case scenario for a fish screen may be when head waters are too low to submerge all screen area. In such cases, the fish screen hydraulics may need to be studied at a low water condition under a reduced diversion rate.
- At a high-water condition under the full diversion rate.
- At a low water condition under the full diversion rate.

The most common porosity control devices used to date have been louvers, where the angle of the louver can be varied to control the quantity of water flowing through the screen in front of the louver. However, it has been shown that it can be difficult to achieve uniform flow when using louver baffles (e.g., AECOM 2009). A newer method provides a more effective means of tuning screen velocity and flow distribution. It consists of sliding, overlapping porosity plates that are in contact with each other (Figure 8-6). As the moveable plate (vertically adjustable slotted plate; Figure 8-6) is adjusted, it obscures a progressively larger percentage of the perforations of the fixed plate (the stationary slotted plate; Figure 8-6). These panels (baffles) are typically installed in sections no greater than 2 feet wide, which provides fine-scale porosity adjustments for the screen as a whole. Porosity plates with square or slotted openings provide linear adjustability unlike porosity plates with circular openings (i.e., the change in porosity is linearly proportional to the distance the adjustable plate is moved). The adjustable and stationary slotted plates (parts 2 and 3, respectively, in Figure 8-6) should be of the same material or of different materials with similar coefficients of thermal expansion to maintain relative positioning over a range of temperatures. Ultra-high-molecular-weight (UHMW) polyethylene has a high coefficient of thermal expansion and should not be paired with aluminum or steel for this purpose. Using UHMW for both panels works well as the two sheets will slide easily and prevent leakage between sheets, but both panels should be manufactured under identical conditions to ensure holes align well. Metal panels may warp during fabrication which may prevent the panels from mating well.

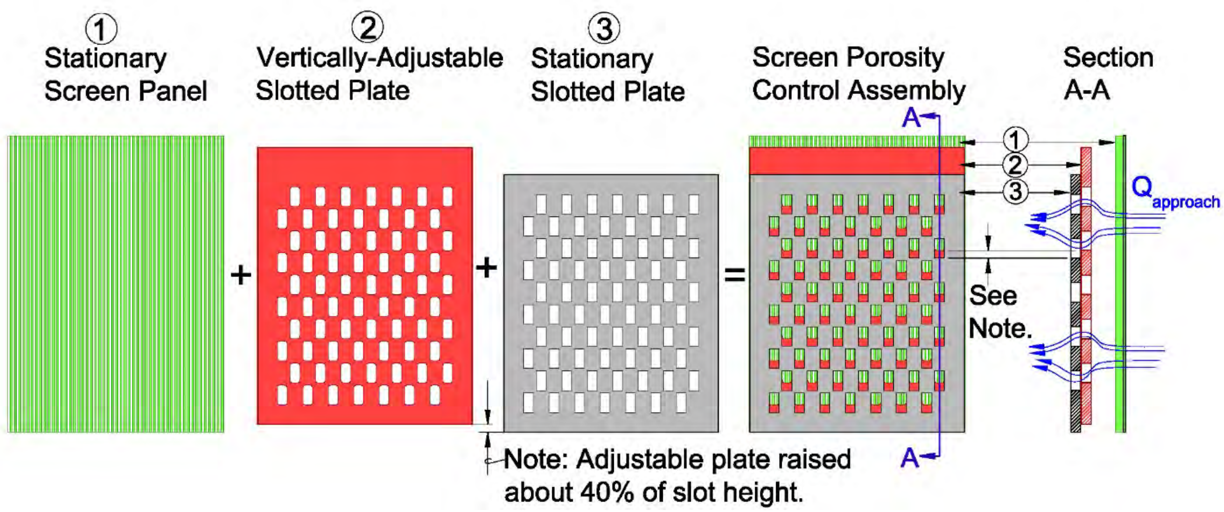

Figure 8-6 Schematic diagram of sliding, overlapping porosity plates used to control porosity and achieve uniform flow conditions through fish screens

8.5.5 Active Screen Cleaning Systems (Active Screens)

All new fish screens should incorporate an automated cleaning system unless the project meets the requirements for passive screens listed in Section 8.5.6.

8.5.5.1 Screen cleaning systems (in-canal or on-river screens)

Screen cleaners should be capable of removing debris from the entire screen surface at least once every 5 minutes and should be operated as required to prevent debris accumulation. Cleaning systems should be designed to operate continuously or on an adjustable timer. On larger screens, the cleaning system should also be triggered whenever the head differential across the screen exceeds 0.3 foot over the clean screen condition. The cleaning system and operations protocol should be effective, reliable, and satisfactory to NMFS. Physical cleaning systems that use a travelling brush or wiper should provide a means for the brush to move away from the screen face at the downstream end of brush travel to allow for the release of accumulated debris.

Fish screens operate most efficiently when they are clean and free of impinged material and attached growth such as algae or sponges (Bell 1991). Fish screen material with a porosity of about 50% will result in negligible head loss at the design approach velocity values identified in Section 8.5.1. Head loss across a screen due to impinged debris increases with the loss of screen open area at a geometric rate (BOR 2006). With increasing head loss, the force impinging debris (or fish) on the screen material also increases, making cleaning the screen more difficult. A screen experiencing 0.3 foot of head loss under an operating approach velocity of 0.4 ft/s may have less than 10% open area due to debris impingement. Under this condition, any weak-swimming fish coming in contact with the screen would experience injury or death due to the excessive forces acting on its body. Additionally, the water diversion would begin to experience significant reduction in diversion rate, and the facility could experience structural damage. Systems to monitor head differential across a screen should be designed to distinguish head loss due to debris impingement from loss caused by wave action or other transient disturbances.

Automated screen cleaning systems are generally categorized as physical, hydraulic, or pneumatic. Physical cleaning systems use a brush or other wiper device to physically remove impinged debris and attached growth and have a long history of successful deployments. NMFS recommends the use of a physical cleaning system for most screen applications; however, there are instances when a hydraulic or pneumatic cleaning system may be more practical.

Hydraulic cleaning systems use high-pressure water jets to remove debris from the screen face and rely on a current (or trash removal systems in the case of traveling belt screens) to remove debris from the vicinity of the screen facility. However, hydraulic cleaning systems do not remove attached growth as effectively as physical cleaning systems and may stimulate the growth of some types of algae.

Pneumatic cleaning systems use compressed air to lift debris from the screen face and rely on a current to remove debris from the vicinity of the screen facility. Pneumatic cleaning systems provide a cleaning force by displacing water primarily in the upwards direction; therefore, air burst cleaning systems in horizontal cylindrical screens may not remove debris impinged on the bottom of those screens. Pneumatic cleaning systems cannot completely remove attached growth and may stimulate the growth of some types of algae. If a screen material were to become occluded with attached growth, the compressed air can impart tremendous buoyant forces on the screen material and the facility overall. Screens employing a pneumatic cleaning system should consider the buoyancy force of trapped air when designing facility foundation and structural components. An additional problem faced by pneumatic cleaning systems is that they are frequently undersized and cannot provide the required volume of air to clean the entire screen face. This is exacerbated by the tendency for the air bubbles to take the path of least resistance, which can often be the clean portions of the screen. Because pneumatic cleaning systems only lift debris from a screen, adequate sweeping flow should be present to move debris downstream away from the water intake.

8.5.5.2 Screen cleaning systems for screens in quiescent and tidal areas

At locations that do not have sufficient sweeping velocity, fish screens should be equipped with an automated cleaning system that is capable of removing debris from the body of water, rather than one that may merely push debris to one side or the other.

Effective cleaning systems rely on the sweeping flow, sometimes combined with the mechanical action of the cleaner, to carry the debris downstream and away from the screen face. Cleaning systems that merely push debris to the side of the screen face are inappropriate for low-velocity locations. This is because without a means to collect and remove debris, the debris lifted from the screen face is likely to become impinged again on the screen face. Additional measures are recommended in these situations to keep floating debris away from the face of a fish screen. Cleaning systems that push debris to the side of a screen are best suited for situations where sweeping flow is present that will carry any debris away from the screen.

8.5.6 Passive Screens

A passive screen, meaning a screen without an automated cleaning system, may only be used when all of the following criteria are met:

- *The combined rate of flow at the diversion site is less than 3 ft^3/s.*
- *Sufficient ambient river velocity exists to carry debris away from the screen face.*
- *The site is not suitable for an active screen.*
- *Uniform approach velocity conditions exist at the screen face, as demonstrated by laboratory analysis or field verification.*
- *The debris load is low.*
- *A maintenance program exists that is approved by NMFS and implemented by the water user.*
- *The screen is frequently inspected, and debris accumulations are removed as site conditions dictate.*
- *For cylindrical screens, sufficient stream depth exists at the site to provide a water column of at least 1 screen radius around the screen surface.*
- *The screen is designed to be easily removed for maintenance and to protect it from flood events.*

8.5.7 Screen Submergence and Clearance

Fish screens should be submerged sufficiently to maintain adequate wetted screen area to meet the approach velocity design criterion whenever the diversion is in operation; additional submergence is required in some circumstances.

Effective screen area will be reduced if screen area becomes exposed due to a drop in the water surface. (Section 8.5.2) Under this condition the diversion rate should be adjusted and maintained such that the operating approach velocity does not exceed the design approach velocity criteria at any given time.

8.5.7.1 Vertical flat plate screens

Fish screen facilities with flat, vertical screen panels, or panels inclined less than 20 degrees from vertical, should be designed to remain fully submerged over the entire range of expected water surface elevations. Facility designs may allow for vertical screen panels, or panels inclined less than 20 degrees from vertical, to become partially exposed when water surface elevation is lowered so long as the operating approach velocity does not exceed the design approach velocity.

8.5.7.2 Inclined flat plate screens

Fish screen facilities with flat plate screens installed at an incline of more than 20 degrees but less than 45 degrees from vertical should be designed to remain fully submerged over the entire range of expected water surface elevations. The top of the screen should be submerged a minimum of 1 foot at low stream design flow.

The tops of inclined flat plate screens need to be sufficiently submerged at low stream design flow to prevent hydraulic conditions from forming at the interface between the screen and the water surface that could trap and impinge debris and fish.

8.5.7.3 Rotary drum screens

For rotary drum screens, the design submergence should be between 65% and 85% of the drum diameter. In many cases, stop logs may need to be installed downstream of the drum screens to achieve the design submergence criteria. The stop logs should be located at least two drum diameters downstream from the back of the drum.

Submergence levels greater than 85% of the drum diameter increase the possibility of entrainment over the top of the screen, fish impingement on the screen, and the subsequent entrainment of any fish impinged on the narrow screen area above the 85% submergence level due to the almost horizontal angle of impact of surface-oriented fish. Submergence levels that are less than 65% may reduce the self-cleaning capability of the screen due to the inability of material to temporarily adhere to the screen face and be carried over the top of the screen. Clay (1995) recommends that submergence be between 66% and 75% of the screen diameter. Examples of rotary drum screens are shown in Figures 8-7, 8-8, and 8-9.

Figure 8-7 Large-sized rotary drum screen at the Sunnyside Canal located on the Yakima River near Yakima, Washington

(Note: The person standing upstream of a drum and an intermediate bypass entrance. Water flow direction is from the foreground to the background of the photograph.)

Figure 8-8 Medium-sized rotary drum screen at the Burlingame Diversion located on the Walla Walla River near Walla Walla, Washington

Figure 8-9 Rotary drum screens installed in a water diversion canal and operated (i.e., powered) by paddle wheels

8.5.7.4 Cylindrical screens

Cylindrical screens (other than rotary drum screens) should be submerged to a depth of at least 1 screen radius below the minimum water surface and have a minimum of 1 screen radius clearance between the screen surfaces and natural or constructed features.

These clearances provide escape routes for fish to avoid the draw of water passing through the screen material.

8.5.7.5 End-of-pipe screen submergence and clearance

All end-of-pipe screens should have adequate submergence below the water surface and adequate clearance from the streambed and any structure to provide an escape route for fish approaching the screen. For cylindrical-shaped screens, 1 screen radius or 6 inches, whichever is greater, is normally adequate submergence and clearance.

Submergence and clearance requirements for screens with other shapes will be determined by NMFS on a case-by-case basis. An example of an end-of-pipe screen is shown in Figure 8-10.

Figure 8-10 Typical end-of-pipe screen equipped with "wagon wheels" to elevate the screen off the stream bottom

8.5.7.6 End-of-pipe screen design

All end-of-pipe screens should meet the approach velocity criteria described in Section 8.5.1 and should be located in areas with sweeping velocities great enough to aid in moving fish and debris away from the intake. All end-of-pipe screens should be oriented to take maximum advantage of sweeping velocity in moving fish and debris away from the screen face.

For the purposes of this document, an end-of-pipe screen is defined as a fish screen of any shape that may be attached to the end of a pipe or hose.

8.5.7.7 Horizontal flat plate screens

Design criteria specific to horizontal screens are provided in Section 8.8.

8.5.7.8 Conical screens

Design criteria specific to cone screens are provided in Section 8.9.

8.5.8 Screen Material

Screen materials should be corrosion-resistant and sufficiently durable so as to maintain a smooth, uniform surface over the course of long-term use. Perforated plate surfaces should be smooth to the touch, with the openings punched through in the same direction as the water flow.

Screen materials commonly used include stainless steel, aluminum, plastic, and antifouling alloys containing copper and other metals.

8.5.8.1 Opening size

The maximum screen opening allowed is based on the shape of the opening:

- *Circular screen face openings should not exceed 3/32 inch in diameter (Neitzel et al. 1990a).*
- *Slotted screen face openings should not exceed 0.069 inch (1.75 millimeters [mm]) in the narrow direction (Mueller et al. 1995).*
- *Square screen face openings should not exceed 3/32 inch as measured on a diagonal (Neitzel et al. 1990b).*

8.5.8.2 Open area

The percent open area (porosity) for any screen material should be at least 27%.

8.5.8.3 Gaps

Screens and associated civil works that are exposed to fish should be constructed such that there are no gaps greater than 0.069 inch (1.75 mm). For traveling belt screens or other screens with moving screen material, screen seals should be sufficient to prevent gaps larger than 0.069 inch (1.75 mm) from opening during screen operations.

Clay (1995) notes that care is required in the construction, adjustment, and operation of rotary drum screens. The drum should be fitted carefully in the box to eliminate spaces around the edges that are larger than the openings in the screen mesh.

8.5.9 Civil Works and Structural Features

8.5.9.1 Smoothness

All concrete and steel surfaces, including edges and corners, in areas fish have access to should be smooth to the touch and free from burrs and sharp edges. These can injure fish or people that come in contact with the structure.

8.5.9.2 Pressure differential protection

Larger fish screen structures should be equipped with fail-safe systems that protect the structure from large pressure differentials across the screen face, should the screen become plugged. If a fail-safe system is tripped, the diversion operation should cease until the system can be reset and protection from entrainment into the diversion is restored.

The fail-safe systems installed so that the structural integrity of the facility is never compromised may include governors that reduce the water diversion rate when the pressure differential exceeds a given value. Fused blow-out panels, slide gates, and pressure relief valves may also be acceptable solutions for preventing excessive pressure differentials that can result in screen facility failure.

8.5.9.3 Placement of screen surfaces

The face of all screen surfaces should be placed flush with any adjacent screen bay, pier noses, and walls to the greatest extent possible.

This is needed to allow fish to have unimpeded movement parallel to the screen face and unobstructed access to bypass entrances and routes.

8.5.9.4 Structural features

Structural features should be provided to protect the integrity of fish screens from large debris and to protect the facility (Bell 1991).

A trash rack, log boom, sediment sluice, and other measures may be required to protect the structural integrity of a fish screen, especially for on-river screens.

8.5.9.5 Civil works

The civil works should be designed in a manner that prevents undesirable hydraulic effects, such as eddies and stagnant flow zones, that may delay or injure fish or provide predator habitat or openings that allow predators to access the facility.

8.5.9.6 Canal dewatering and fish salvage

For in-canal screens, the floor of the screen civil works should be designed to allow fish to be routed back to the river safely when the canal is dewatered. An acceptable fish salvage plan should be developed in consultation with NMFS and included in the O&M plan.

Canal dewatering and fish salvage may be accomplished via the bypass system or by using a small gate and drain pipe, or similar provisions, to drain all flow and fish back to the river. The operations and maintenance plan should address the rate at which water can be drained back to the river to allow fish to move volitionally to the river to minimize stress. Trained personnel should be on site to rescue stranded fish. A rescue plan may need to consider collect lamprey larvae (ammocoetes) that may be living in sediments deposited in a diversion canal, and possibly even in sediments behind a fish screen.

8.6 Bypass Systems

Bypass systems are required for in-canal screens to provide a safe and efficient means of routing fish from the area in front of in-canal screens to the stream from which they were diverted.

8.6.1 Bypass Design

Bypass systems should work in tandem with the fish screens to move all fish present (target and non-target species and all life stages) from the area in front of the screens and return them back to the stream or river (or to a holding pool, in the case of collection and transport facilities) with a minimum of injury and delay (Clay 1995).

8.6.2 Bypass Entrance

The bypass entrance should be located at the downstream terminus of the fish screens and should be designed to allow downstream migrants to easily locate and enter the bypass (Clay 1995). The screen and any guidewalls should naturally funnel downstream migrants and flow to the bypass entrance. For screens that are less than 6 feet in length and are constructed perpendicular to canal flow, the bypass entrance(s) may be located at either end (or both ends) of the screen.

8.6.2.1 Flow control

Each bypass entrance should be capable of controlling the flow rate through that entrance. If an orifice plate is used, the opening should have smooth, rounded-over edges and the opening should be large enough to safely pass the largest fish that may be entrained into the diversion canal. For steelhead kelts, the opening should be at least 8 inches in the smallest dimension.

Typically, an overflow weir is used to regulate flow through the entrance. Orifice plates are discouraged from being used because they may hinder fish from moving into the bypass and they are more likely to clog with debris.

8.6.2.2 Minimum velocity

The minimum bypass entrance flow velocity should be greater than 110% of the maximum canal velocity upstream from the bypass entrance. At no point may flow decelerate along the screen face or in the bypass channel. Bypass flow amounts should be of sufficient quantity to ensure these hydraulic conditions are achieved whenever downstream passage is required.

8.6.2.3 Lighting

Lighting conditions upstream of a bypass entrance should be ambient and extend downstream to the structure or device controlling bypass flow. In situations where transitions from light to dark conditions or vice versa cannot be avoided, they should be gradual or occur at a point in the bypass system where fish cannot escape the bypass and return to the canal (i.e., at a location where bypass flow velocity exceeds fish swimming ability).

8.6.2.4 Dimensions

For diversions greater than 3 ft^3/s, the bypass entrance should extend from the floor of the canal to the water surface and be at least 18 inches wide (Ruggles and Ryan [1964] as cited in Clay [1995]). For diversions of 3 ft^3/s or less, the bypass entrance should be a minimum of 12 inches wide. The bypass entrance should be sized to accommodate the entire range of bypass flow, utilizing the criteria listed in Section 8.6.

8.6.2.5 Weirs

For diversions greater than 25 ft^3/s and where weirs are incorporated into the bypass entrance, the minimum water depth over the weir is 1 foot; however, a depth of 1.5 feet over a weir is preferred. Similarly, weir width should be a minimum of 1.5 feet; greater widths are preferred.

Juvenile outmigrating salmonids appear to be less reluctant to go over a weir when water depth over the weir is greater than 1 foot (Manning et al. 2005). As a general rule and based on field observations, NMFS believes that water depth over a weir should be at least 1 foot, but if additional flow is available, a depth of 1.5 feet or even 2 feet is preferred. Manning et al. (2005) reported significantly faster travel times for steelhead moving through a dam forebay when the crest of an inflatable spillway was deformed and water depth and velocity over the spillway were increased. Water depth increased from 0.13 foot to 2.4 or 3 feet, and water velocity increased from 0.2 ft/s to 3.9 or 4.6 ft/s during test replicates. Also, wider passageways are preferred; the recommended minimum width is 1.5 feet.

8.6.2.6 Intermediate bypass entrances

The fish screen design should include intermediate bypass entrances if the design approach velocity is greater than 0.33 ft/s and the sweeping velocity may not convey fish to a terminal bypass entrance within 60 seconds, assuming that fish are transported along the length of the screen face at a rate equal to the sweeping velocity.

Clay (1995) notes that if the screen is extremely long, it may be advisable to place bypass entrances at intervals across the face.

8.6.2.7 Training walls

All intermediate bypass entrances should have a training wall to guide fish into the bypass system.

8.6.2.8 Flow acceleration

All bypass entrances should be designed to gradually accelerate flow into the bypass entrance and between the entrance and the flow control device at a rate not to exceed 0.2 ft/s per linear foot.

Juvenile salmonids have been observed to resist moving with water flow that accelerates too quickly (Haro et al. 1998). Brett and Alderdice (1953), as referenced in Clay (1995), recommend a uniform acceleration rate of no more than 0.1 ft/s per linear foot.

8.6.2.9 Secondary dewatering screens

Secondary dewatering screens should meet all design criteria (e.g., approach velocity, sweeping velocity, cleaning, and screening material) of the primary screens.

Secondary dewatering screens may be used within the bypass system to reduce bypass flow.

8.6.3 Bypass Conduit and System Design

8.6.3.1 Bypass conduit

Depending on the site-specific conditions, the bypass conduit can be either U-shaped flume or round pipe.

8.6.3.2 Surface smoothness

The interior surfaces and joints of bypass flumes or pipes should be smooth to the touch to provide conditions that minimize turbulence, the risk of catching debris, and the potential for fish injury.

Pipe joints may be subject to inspection and approval by NMFS prior to completion of the bypass. Every effort should be made to minimize the length of the bypass pipe while meeting the hydraulic criteria listed in Sections 8.6.3.4 through 8.6.3.6.

8.6.3.3 Bypass pipe diameter

The minimum bypass pipe diameter is 10 inches.

The bypass flume or pipe diameter is a function of the bypass flow and slope, and the diameter incorporated into the bypass pipe design should achieve the velocity and depth criteria identified in Sections 8.6.3.5 and 8.6.3.6. Bypass flume or pipe hydraulic characteristics should be calculated to determine a suitable pipe diameter.

8.6.3.4 Bypass flow rate

The minimum design bypass flow is 5% of the total diverted flow rate unless otherwise approved by NMFS.

While the minimum bypass flow is 5% of the total diverted, larger bypass flow proportions will aid in cleaning the fish screen and will guide fish toward the bypass system more quickly.

8.6.3.5 Bypass velocity

Water velocity in the bypass conduit should be between 6 and 12 ft/s for the entire operational range of bypass flow, and should always be greater than 2 ft/s. If higher velocities are approved by NMFS, special attention to pipe and joint smoothness should be demonstrated by the design.

Bypass systems with velocities that are less than 2 ft/s can accumulate sediment deposits within the bypass system.

8.6.3.6 Water depth

The design minimum depth of free surface flow in a bypass pipe should be at least 40% of the bypass pipe diameter unless otherwise approved by NMFS.

8.6.3.7 Closure valves

Closure valves cannot be used within the bypass system unless specifically accepted by NMFS.

8.6.3.8 Pumps

Fish should transition through bypass system components via gravity flow and never be pumped. Use of a pump would only be acceptable if NMFS required the installation of a bypass where insufficient head was available to support gravity flow.

8.6.3.9 Downwells and flow transitions

Downwells should be sized based on an EDF between 8 to 10 ft-lb/ft^3/s. Fish should never free-fall within a bypass system pipe or enclosed conduit. Downwells should be designed to produce a free water surface when turbulence, geometry, and alignment aspects of the design are considered.

Equation 8-1 should be used to calculate downwell volume.

$$V = \frac{(\gamma)(Q_{bypass})(H)}{EDF} \tag{8-1}$$

where:

V = pool volume (ft^3)
γ = unit weight of water (62.4 lb/ft^3)
Q_{bypass} = bypass flow, in ft^3/s
H = height of drop between water surfaces, in feet
EDF = energy dissipation factor, from 8 to 10 ft-lb/ft^3/s

8.6.3.10 Pressurized flow

Flow in all types of fish conveyance structures should be open channel (i.e., not pressurized). Bypass systems should be vented or open to the atmosphere. If a pressurized bypass conveyance is required by site constraints, pressures in the bypass pipe should remain equal to or above atmospheric pressures. Transitions from pressurized to non-pressurized conditions within a bypass pipe, and vice versa, should be avoided.

8.6.3.11 Bends

The ratio of bypass pipe center-line radius of curvature (R) to pipe diameter (D), or R/D, should be greater than or equal to 5. If mitered pipe fittings are used to change conveyance direction, the maximum miter angle allowed is 15 degrees (11.25 degrees is preferred). If multiple miter joints are used to change the direction of the conveyance more than 15 degrees, *each miter joint should be separated by length(s) of pipe that are sufficiently long to achieve the required ratio of R/D for the bend assembly as a whole.*

In situations that involve super-critical flow velocities, R/D ratios greater than 5 may be required. Bends should be minimized in the layout of bypass systems due to their potential to facilitate debris clogging and produce turbulence.

8.6.3.12 Debris management

Bypass pipes or open channels should be designed to minimize debris clogging, sediment deposition, and facilitate their inspection and cleaning as necessary.

8.6.3.13 Access for maintenance

Access for maintenance inspections and debris removal should be provided at locations in the bypass system where debris accumulations may occur. Bypass systems greater than 150 feet in length should include access ports at appropriate spacing to allow for the detection and removal of debris.

Alternate means of providing for bypass pipe inspection and debris removal may be considered by NMFS.

8.6.3.14 Natural channels and fishways

Natural channels and fishways may be used as a bypass transit channel under limited circumstances and only upon approval by NMFS.

Use of natural channels and fishways as juvenile fish bypasses expose fish to increased delay and predation (compared to a typical bypass system). Use of a natural channel will require that adequate water depth and velocity, flow volume, protection from predation, and good water quality conditions can be provided. The potential for increased predation is typically extremely high for natural channels due to the high concentration of fish in a small amount of flow in the bypass system and area. Additionally, sufficient flow would be required to mitigate for any seepage occurring within the bypass system while maintaining adequate water depth and velocity. If a natural channel is to be used, special consideration needs to be given to where the bypass channel connects to the river.

8.6.3.15 Sampling facilities

Sampling facilities installed in the bypass conduit should not impair the operation of the facility during non-sampling periods in any manner.

Refer to Appendix F for additional information on the design of juvenile fish sampling facilities.

8.6.3.16 Hydraulic jumps

There should be no hydraulic jump(s) within a bypass system.

8.6.4 Bypass Outfalls

8.6.4.1 Location

Bypass outfall locations should meet the following conditions:

- *Bypass outfalls should be located to minimize predation by selecting an outfall location that is free of eddies and reverse flow and does not place bypassed fish into an area of known predator habitat (Bell 1991).*
- *The point of impact for bypass outfalls should be located where ambient river velocities are greater than 4 ft/s when in operation (Shively et al. 1996).*
- *Bypass outfall locations should provide good egress conditions for juvenile fish exiting the bypass and re-entering the stream channel (Bell 1991).*
- *The bypass flow should not impact the river bottom or other physical features at any stage of river flow. Bypass outfalls should be located where the receiving water is of sufficient depth to ensure that fish injuries are avoided at all river and bypass flows.*
- *The bypass outfall should not release fish into areas where conditions downstream from the bypass discharge point will pose a risk of injury, predation, or stranding (Bell 1991). For example, bypass outfalls should avoid discharging fish into areas from which they can enter reaches where flows run subsurface. Also, bypass outfalls should not discharge in the vicinity of any unscreened water diversion or near eddies that may be habitat for predator fish.*

8.6.4.2 Impact velocity

Maximum bypass outfall impact velocity (i.e., the velocity of the bypass flow as it enters the receiving water) should be less than 25 ft/s, including both the vertical and horizontal velocity components (Bell 1991).

Impact velocity may be greater for very large bypass flows that discharge a confined jet that plunges deep into the receiving waters and results in fish deceleration occurring over a longer distance compared to a broader jet not plunging far into the receiving water. For example, Johnson et al. (2003) reported no injuries to juvenile Chinook salmon that were returned to the Columbia River in bypass flow greater than 1,000 ft^3/s and when impact velocities ranged up to 50 ft/s.

8.6.4.3 Predation prevention

Predator control systems may be required in areas with a high potential for avian predation.

Predation suppression systems include bird wires (thin wires) strung over the bypass outfall area to prevent predatory birds from flying near the outfall or diving at fish exiting the outfall and high-pressure water spray nozzles over the outfall area to deter birds.

8.6.4.4 Adult fish attraction to bypass discharge

Bypass outfall discharge into the receiving water should be designed to avoid attracting adult fish to the discharge. If the potential exists that adult salmonids may be attracted to and *jump at the bypass outfall discharge, the design of the bypass outfall should include a provision for adult fish to land safely in a zone or location after jumping.*

8.7 Water Drafting

Water drafting is the practice of pumping water for short durations from streams or impoundments at low pumping rates to fill water trucks or tanks, often for dust suppression or wildfire management. Water drafting may also be used to dewater a construction site or temporarily divert water around a construction site. When dewatering a construction site an approved dewatering plan should be followed to rescue and relocate stranded fish.

The specifications below are primarily for the protection of juvenile anadromous salmonids in waters where they are known to exist. However, they may also be applied to protect a host of other aquatic organisms.

8.7.1 Water Drafting Operating Guidelines

When engaged in water drafting operations, the following restrictions apply:

- *Operations are restricted to 1 hour after sunrise to 1 hour before sunset.*
- *The pumping rate should not exceed the lesser of 350 gpm or 10% of the streamflow.* The operator should measure streamflow prior to initiating pumping to ensure the pumping rate will not exceed 10% of streamflow.
- *Pumping should be restricted to locations where the water is deep and flowing; pumping from isolated pools should be avoided.*
- *Pumping should not result in a drawdown of the water surface elevation by more than 10% in the area where pumping is taking place nor in any riffles downstream.*
- *Pumping should be terminated when the water truck or tank is full.*
- *An operator should be present during pumping operations and observe stream conditions during pumping to ensure the above restrictions are being met.*
- *A fish screen should be used when pumping. Fish screens should meet guidelines for end-of-pipe screens of this document (Section 8.5.7.5). The operator should be capable of cleaning debris from the fish screen when needed and possess the equipment necessary to do so.*
- *Water drafting truck parked on streambeds, floodplains, or within a riparian corridor should use drip pans or other devices such as absorbent blankets, sheet barriers or other materials as needed to prevent soil and water contamination from motor oil or hydraulic fluid leaks*

8.7.2 Fish Screens for Water Drafting

Design and operation criteria and guidelines for use of fish screens required during pumping operations for water drafting are described in Section 8.7.2.1 through 8.7.2.6.

8.7.2.1 Design

Fish screens for water drafting may be off-the-shelf designs or custom fabricated. The fish screen should be sturdy enough to not compromise the integrity of the screen during pumping when the screen becomes clogged with debris.

The screens may be cylindrical or rectangular in shape as long as the other screen criteria are met.

8.7.2.2 Cleaning

Fish screens for water drafting do not need to have an automated cleaning system; however, an operator should regularly clean the screen during the pumping operation to maintain the minimum amount of screen area that is required to not be occluded with debris.

8.7.2.3 Approach velocity

The design approach velocity should not exceed 0.33 ft/s.

Based on a pumping rate of 350 gpm, the screen for this flow rate should have at least 2.4 ft^2 of surface area.

8.7.2.4 Uniform flow

Screens should be designed to draw water relatively uniformly over the entire screen area.

Screens may require internal baffles to achieve this criterion.

8.7.2.5 Screen porosity and openings

The screen material should have a porosity of at least 27% and have openings consistent with criteria provided in Section 8.5.8.1. The screen surface should be smooth to the touch.

The size of screen openings depends on the shape of the openings.

8.7.2.6 Screen support and submergence

Fish screens should be supported off the stream bottom by at least 6 inches and be submerged by at least 6 inches (Figure 8-10).

8.8 Special Case: Horizontal Screens

Horizontal flat plate screens operate fundamentally differently than conventional cylindrical and vertically oriented screens. This fundamental difference relates directly to fish safety. When inadequate flow depth exists with vertically oriented screens, the bypass will usually remain operational, and there is only a slight increase in the potential for fish to become impinged on the surface of the screen. In contrast, when the water level on horizontal screens drops and most or all diverted flow goes through the screens, the bypass flow is greatly reduced or ceases completely and there is a high likelihood that fish will become impinged and expire on the screen surface.

8.8.1 NMFS Engineer Involvement

Since site-specific design considerations are required, NMFS should be consulted throughout the development of a horizontal screen design.

NMFS considers horizontal screens to be biologically equivalent to conventional screens if the design and operation of a horizontal screen meets the criteria and conditions listed in Section 8.8.

8.8.2 Design Process

The horizontal screen design process should include an analysis to verify that sufficient hydrologic and hydraulic conditions exist within the stream so as not to exacerbate a passage impediment in the stream channel or in the off-stream conveyance (including the screen facility and bypass system). This analysis should conclude that all of the following criteria can be achieved for the entire fish passage season, as defined in Chapter 2. If the criteria listed here in Section 8.8 cannot be maintained per this design analysis, a horizontal screen design should not be used at the site. If this analysis concludes that the removal of the bypass flow required for a horizontal screen from the stream channel results in inadequate passage conditions or unacceptable loss of riparian habitat, other screen design styles should be considered for the site and installed at the site if the other screen styles will reduce the adverse effects to passage or riparian habitat.

8.8.3 General Criteria

The screen and bypass criteria specified in Chapter 8 apply to horizontal screens. The exceptions to these general criteria are noted in Section 8.8.4.

8.8.4 Specific Criteria

As described in Section 8.8, horizontal flat plate screens are fundamentally different than conventional cylindrical and vertically oriented screens. Specific criteria and guidelines that apply only to horizontal screens are described in Sections 8.8.4.1 through 8.8.4.13.

8.8.4.1 Site limitation

Horizontal screens should be installed in an off-river canal.

Due to the need for very precise hydraulic controls, horizontal screens are not suitable for in-river or in-stream installations.

8.8.4.2 Flow regulation

For a horizontal screen facility to function properly, the site should provide a headgate facility that maintains a water diversion rate that is sufficient and consistent enough to allow the fish screen and bypass system to meet the criteria listed in this section (Section 8.8.4).

8.8.4.3 Channel alignment

Horizontal screens should be installed such that the approaching conveyance channel is parallel to, and in line with, the screen channel (i.e., there is no skew), and uniform flow conditions exist across the upstream edge of the screen. A straight channel should exist for at least 20 feet upstream of the leading edge of the screen, or for a distance of up to two screen channel lengths if warranted by approach flow conditions in the conveyance channel. Horizontal screens should be installed such that a smooth hydraulic transition occurs from the approach channel to the screen channel and there are no areas of abrupt flow expansion, contraction, or separation.

Flow conditions that require a longer approach channel include turbulent flow, supercritical hydraulic conditions, or uneven hydraulic conditions in a channel cross section.

8.8.4.4 Bypass flow depth

The bypass flow should pass over the downstream end of the screen at a depth of at least 1 foot.

8.8.4.5 Bypass flow amount

Bypass flow amounts should be sufficient to continuously provide the hydraulic conditions specified in this section and those specified in Section 8.6. In general, for diversion rates of less than 100 ft^3/s, approximately 15% of the total diverted flow should be used as bypass flow. For diversion rates greater than 100 ft^3/s, approximately 10% of the total diverted flow should be used for bypass flow. Small horizontal screens may require up to 50% of the total diverted flow be dedicated for bypass flow. The amount of bypass flow should be approved by NMFS.

Bypass flow is used for transporting fish and debris across the plane of the screen and through the bypass conveyance back to the stream.

8.8.4.6 Diversion shut-off

If hydrologic analysis demonstrates that the diverted flow rate could drop below the flow rate required to satisfy the diversion and supply the bypass with its full design flow rate, the horizontal screen design should include a means to automatically shut off the diversion flow or a means to route all diverted flow back to the originating stream.

8.8.4.7 Sediment removal

The horizontal screen design should include a means to simply and directly remove sediment that accumulates under the screen without compromising the integrity of the screen while water is being diverted.

8.8.4.8 Screen approach velocity

Screen approach velocity should be less than 0.25 ft/s and uniform over the entire screen surface area. If the horizontal screen is equipped with an automated mechanical screen cleaning system, screen approach velocity should be less than 0.4 ft/s and uniform over the entire screen surface area.

The best available science regarding horizontal screens is evolving. Therefore, NMFS may require a lower approach velocity or may specify a minimum ratio of sweeping velocity to approach velocity. Recent prototype development has demonstrated that better self-cleaning of a horizontal screen is achieved when the ratio of sweeping velocity and approach velocity exceeds 20:1, and approach velocities are less than 0.1 ft/s.

8.8.4.9 Screen sweeping velocity

Sweeping velocity should be maintained or gradually increase for the entire length of screen. Sweeping velocity should never be less than 2.5 ft/s or an alternate minimum velocity approved by NMFS that is based on an assessment of sediment load in the water diversion system.

Higher sweeping velocities may be required to achieve reliable debris removal and to keep sediment mobilized.

8.8.4.10 Post-construction inspection and testing

Upon completion of screen construction and watering up of the system, velocity testing should be performed to ensure that approach velocity is uniform over the entire screen area. For the purpose of this test, uniform is defined as all test velocities falling between 90% and 110% of the nominal screen approach velocity. Sweeping velocity should also be verified to be in a uniformly downstream direction to ensure that fish and debris are bypassed rapidly.

8.8.4.11 Monitoring and maintenance

Daily inspection and maintenance (if required) should occur on the screen and bypass system to maintain operations consistent with these criteria.

8.8.4.12 Post-construction monitoring

Post-construction physical and operational monitoring of all components of new horizontal screen facilities should occur for at least the first year of operation and cover all periods of operation.

8.8.4.13 Inspection log

An inspection log should be kept for each horizontal screen. A copy of the inspection log should be provided annually to the NMFS design reviewer upon request, who will review the inspection log and may make recommendations for the next year of operation. The inspection log should include:

- *Inspection dates, times, and the observer's name*
- *Water depth at downstream end of the screen (i.e., the entrance to the bypass)*
- *Debris present on the screen, including any sediment retained in the screen openings*
- *Fish observed on or passing over the screen surface*
- *Operational adjustments and maintenance performed on the facility*

8.9 Special Case: Conical Screens

Conical (or cone) screens were developed for small water diversions in shallow tidal areas. They have been installed on pumped and gravity diversions since 1996. The conical shape provides a large amount of screen area in a small footprint (Figure 8-11). The screen units sit on a constructed steel or concrete platform connected to a diversion pipe. They have rotating brush cleaning systems that are driven by hydraulic or electric motors, some of which run off batteries charged by solar panels. Turbine-driven units, where the cleaning system is driven by a propeller installed in the conveyance pipe and mechanically connected to the cleaning system through a large gear reducer, have been used successfully in a few cases. For turbine-driven units, screen cleaning does not occur unless water is being diverted. A turbine-driven cleaning system may not be appropriate for seasonal use unless the units are removed seasonally.

Figure 8-11 Conical screen

Conical screens were designed for use on inverted siphons in tidal areas where the screen units would be partially exposed at lower tides. Because they were used only on siphons, as the source water stage decreased on an ebb tide and screen area became exposed, the rate of diversion decreased proportionally so the operational approach velocity never exceeded the design approach velocity. As a side benefit, the daily exposure to air and sunlight helped keep the screen surface free of algal growth.

8.9.1 Locations

Conical screens should be sited in locations where fish have a clear escape route past a screen. They should not be installed in enclosed vaults or in close proximity to a structure that prevents fish from freely moving away from the screen.

8.9.1.1 Maximum ambient velocity

Conical screens are acceptable for use in lakes, reservoirs, backwater channels, and tidal areas where the ambient velocity does not exceed 1 ft/s. They may be used where the current is greater than 1 ft/s if other (i.e., superior) screening alternatives are not available, an appropriate flow distribution baffle system is used, and the design is acceptable to NMFS.

8.9.2 Approach Velocity

The maximum design approach velocity for conical screens is 0.33 ft/s.

The minimum effective screen area required for an installation may be determined by dividing the maximum diversion rate in ft^3/s by 0.33 ft/s.

8.9.3 Flow Uniformity

Conical screens have been equipped with two types of baffle systems to distribute flow over all screen area. Early screens used an inverted cone design that divided the interior space into upper and lower areas. That design performed well in quiescent water with a narrow plenum, but field testing in a live stream showed that the inverted cone baffle did not balance flows well when flow was moving past the screen. In fact, the approach velocity on the leading edge of the screen unit could exceed the design value even when not diverting water because stream flow could enter the upstream side and exit the downstream side. To solve this problem, a new baffle design was developed.

The BOR's Technical Service Center near Denver, Colorado, developed a relatively complex baffle system with vertical dividers and a central flow balancing cylinder to distribute intake flow more evenly into four hydraulically-isolated quadrants (Hanna 2011). The vertical dividers prevented stream flow from passing completely through the screen unit. The manufacturer routinely includes a simplified internal baffle based on the USBR design in all of their conical screens.

BOR also tested an external baffle system to control how water approaches and passes into a conical screen (Hanna 2013). The external baffle concept created more uniform flow into the screen but debris could accumulate on the baffles in a riverine setting; therefore, NMFS recommends the use of an internal baffle system to allow stream flow to move debris and fish away from the diversion intake.

8.9.4 Effective Screen Area

All screen area submerged greater than 6 inches may be considered as effective screen area (Figure 8-12). If conical screens become exposed to air, the rate of diversion should be reduced to meet the design approach velocity criterion (Section 8.9.2) due to the reduced effective screen area.

When conical screens become exposed to air in tidal or backwater environments, the top 6 inches of screen material below the water surface may become occluded by debris.

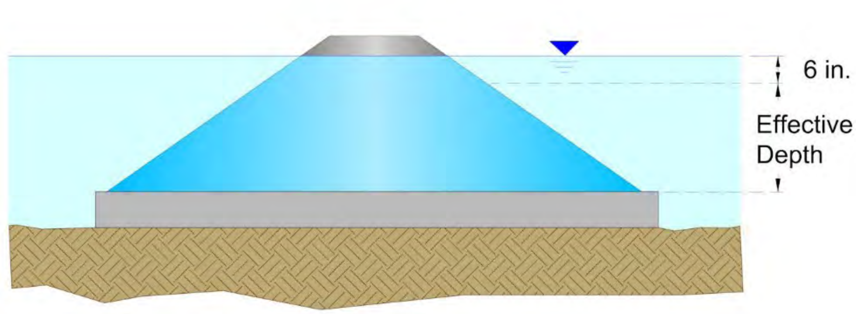

Figure 8-12 Elevation view of a conical fish screen showing the effective depth

8.9.5 Submergence

Conical screens may be operated while partially exposed above water but should be designed such that the screen is sufficiently submerged to maintain adequate effective screen area for the rate of diversion at any given moment.

The definition of effective screen area is provided in Section 8.5.2.

8.10 Project Inspections and Evaluations

8.10.1 General

Inspections and evaluations should be performed at each appropriate phase of a project. This includes during construction, when the project is substantially complete but not yet operating, and after construction.

Inspections of project details and evaluations of project systems are necessary to ensure that a fish screen project functions as intended.

8.10.2 Quality Assurance and Quality Control

An on-site project engineer or inspector should be assigned to every project. The inspector should provide notice to NMFS of key milestones in the construction process and access to the site for inspections.

The inspector is responsible for ensuring construction specifications and tolerances are met and for testing all project systems. NMFS should be allowed to witness testing of project systems.

8.10.3 Inspection

8.10.3.1 During construction

During the course of construction, activities may preclude various facets of screen and bypass construction from being inspected. In instances where these facets of construction may pose a risk of injury or mortality to fish later on during normal operations, the on-site engineer or inspector should inspect these items prior to construction continuing. In some instances, NMFS may require that a NMFS inspector be given the opportunity to inspect these items prior to construction continuing. If this is the case, NMFS will provide the project proponent with a list of screen and bypass elements that will require NMFS inspection during the course of construction. These may include (but are not limited to) the following:

- *Bypass pipe joints, either welded or mechanical*
- *Bypass downwells*
- *Bypass outfalls, if protected during construction by a cofferdam*
- *Any components that convey water that may contain fish*

8.10.3.2 Facilities near completion

Nearly completed fish screen and bypass facilities should be made available to NMFS staff for inspection prior to watering up to verify that the screen is operable in a manner consistent with the design criteria. NMFS staff may inspect construction quality, pipe joints, fit, and finish of components exposed to fish.

8.10.3.3 Evaluations

At some sites, screen and bypass facilities may need to be evaluated for biological effectiveness and to verify that hydraulic design objectives are achieved and debris removal systems are effective. At the discretion of NMFS, this may entail a complete biological evaluation, especially if waivers to screen and bypass criteria are granted, or merely a visual inspection of the screen in operation if the screen is relatively simple and designed and constructed to the standard criteria listed throughout the chapters of this document.

8.10.3.4 Mechanical and electrical systems evaluations

Testing of mechanical and electrical systems should be performed before initiating operations.

This should include testing of any alarm systems, including audible alarms, pagers, and other warning systems; data recording equipment, emergency shut-off systems, cleaning systems, actuators, and solenoids; backup systems; and other mechanical and electrical systems. These evaluations should be included in a list of final items to be completed by the contractor and carried out prior to contractor demobilization and should be written into the construction contract.

8.10.3.5 Automatic cleaning systems evaluations

Cleaning systems and their components should be tested in the dry, when possible, and again when screen facilities are operable, but prior to initiating normal operations.

Using O&M documentation of the cleaning systems provided by the designer or fabricator, all cleaning systems should be tested in automatic and manual operating modes. These evaluations should be included in a list of final items to be completed by the contractor and carried out prior to contractor demobilization and should be written into the construction contract.

8.10.3.6 Biological evaluations

Depending on the size of a project, any variances from established criteria, and the complexity and uniqueness of the project design, NMFS may require that biological evaluations be conducted on a fish screen facility. The biological evaluations may involve monitoring fish that naturally inhabit the site or releasing test fish obtained from another source such as a hatchery. If biological evaluations are required, the applicant must submit a biological evaluation study plan to NMFS for review and approval prior to completing a substantial portion of the project. Biological evaluations must be performed by qualified personnel using established methods.

The biological evaluations could include monitoring to assess the number of fish being injured or delayed, entrained behind the fish screen, impinged on the fish screen and evidence of fish predation associated with the water intake structure. The biological evaluation study plans should describe the source of fish, test equipment, and methods that will be used; the statistical analysis that will be conducted and associated precision of any tests; and the proposed frequency, timing, and duration of any monitoring and testing.

8.10.3.7 Juvenile fish bypass systems

Hydraulic testing of juvenile fish bypass systems is required to create rating curves for gate openings needed to achieve prescribed flow rates, and to ensure that the bypass system hydraulics conform to hydraulic design criteria.

Biological testing of juvenile bypass systems may be required to ensure that juvenile fish are being returned safely to the main river channel. If biological evaluations are required, the applicant must submit a biological evaluation study plan to NMFS for review and approval prior to completing a substantial portion of the project. Biological evaluations should be performed by qualified personnel using established methods.

The study plan should consider the complexity of the bypass system and the size and number of juvenile fish likely to be present during water diversion operations.

8.10.3.8 Fish screen hydraulic evaluations

The hydraulic evaluations described in this section are required for fish screen facilities. Appendix E (Performing Hydraulic Evaluations) provides information on how to conduct hydraulic evaluations.

Hydraulic evaluations are required on all screens equipped with adjustable flow tuning baffles designed to distribute flow evenly over all wetted screen areas, and where confirmation of hydraulic conditions at a fish screen is necessary. The applicant should submit a hydraulic evaluation study plan to NMFS for review and approval prior to completing a substantial portion of the project. The final hydraulic evaluation should be conducted under the high design (diversion) flow unless otherwise agreed to by NMFS.

Hydraulic evaluations involve taking water velocity measurements at locations that are oriented both perpendicular (i.e., the approach velocity) and parallel (i.e., the sweeping velocity) to the screen face. Hydraulic evaluations are used on screen facilities with flow-balancing baffles to adjust the baffles to achieve uniform approach velocities across all wetted screen surfaces. Baffle systems should be adjusted in this manner prior to initiating normal water diversion operations. The hydraulic evaluation plan should include the proposed equipment, methods, and time schedule that will be used when conducting the hydraulic evaluations.

In the event that hydraulic conditions are found by NMFS to be unacceptable and the existing baffle system is incapable of adjusting flows to meet the hydraulic criteria, physical modifications to the facility may be required along with follow-up hydraulic evaluations of the modified hydraulic conditions.

Hydraulic evaluations should be carried out as soon as practical to ensure the facility is operating as near to design criteria as practical using the guidelines described in Appendix E. If the facility cannot be operated at an optimal diversion rate for the hydraulic evaluation within the first year of operation, the facility owner should seek to extend the deadline for carrying out the hydraulic evaluation from NMFS.

Hydraulic evaluations should be performed by qualified personnel using established methods.

A final hydraulic evaluation report should be provided to NMFS that includes the following:

- *A description of site and environmental conditions at the time of testing*
- *A list of technicians performing tests*
- *The materials and methods employed in the test, including locations of all velocity measurements in the final iteration of baffle adjustments, including justification of the number of points at which velocity measurements were taken*
- *A description of the final baffle settings*
- *The approach and sweep velocity data for all measured points in the final iteration of baffle adjustments presented in a table format*
- *The approach and sweeping velocity values for all measured points in the final iteration of baffle adjustments presented in a graphical format*

- *An objective evaluation of hydraulics at the site and anticipated screen performance*

8.11 Operations and Maintenance Plans

8.11.1 General

All fish screen projects should have an approved O&M plan. The plan should include procedures deemed acceptable by NMFS for operating the screen facility under a variety of environmental conditions, the full range of water diversion operations, and the procedures for periodic inspections and maintenance required to achieve fish screening effectiveness over the design life of the facility.

The purpose of an O&M plan is to ensure that the facility performs as designed and is providing effective fish screening over the life of the project. The O&M plan is the manual that describes exactly how the fish screen facility will be operated and maintained as well as procedures and personnel to contact in the event of emergencies. The following guidelines provide a template that can be used to prepare an O&M plan.

8.11.2 Operations

The O&M plan should include procedures that will ensure the fish screen meets all previously agreed to criteria. In addition to normal operation conditions, the plan should include information, procedures (including fish salvage plans), and personnel contact information in case of emergencies.

The O&M plan should include the seasonal maximum diversion rates agreed to in the design process, other criteria identified in the project description, project mitigation measures, and any applicable permit conditions or ESA Biological Opinion requirements. Additionally, the plan should address specific criteria on pump use at pumped diversions and gate use at gravity diversions that are required to achieve uniform approach velocities across screen surfaces.

8.11.2.1 Posting

A list of operating procedures that is easy to follow should be posted in a highly visible location at the water diversion site.

The list should include specific operating procedures needed to achieve uniform approach velocities across the screen face at various diversion rates. Emergency power cut-off switches, pressure relief valves, instructions for operating any auxiliary equipment, and emergency shutdown procedures should also be placed in locations that are easily found.

8.11.3 Maintenance

The diversion owner should incorporate maintenance procedures recommended by the designers, contractors, and suppliers into the O&M plan.

The maintenance section of the O&M plan should specify the frequency and interval for performing each maintenance procedure. The project owner is responsible for obtaining documentation (including specifications and maintenance requirements) from suppliers of off-the-shelf and custom systems and equipment and ensuring that all necessary maintenance equipment, tools, and component parts are readily available and on-hand for the maintenance. The O&M manual should identify activities that need to be carried out on a periodic basis (e.g., daily, weekly, monthly, quarterly, annually, or another periodic schedule).

8.11.4 Maintenance Records

The facility owner should maintain a log of O&M activities, which should be made available upon request of appropriate federal and state agencies. The logbook should include the following:

- *One copy of the operating procedures list discussed above (Section 8.11.2)*
- *One copy of the periodic maintenance schedule discussed above (Section 8.11.3)*
- *Records of regularly scheduled and unscheduled maintenance procedures performed*

8.11.5 Periodic Visual Inspections

The project owner, or their agent, should perform visual inspections of the screens on an annual basis or more frequently if required to ensure design criteria are being met. Inspectors should examine cleaning system performance, structural integrity of the screen area, fish-exclusion integrity of seals and transition areas, and other factors affecting screen facility performance. Inspectors should determine if the current maintenance procedures are sufficient to ensure that screen performance will continue to meet the facility's design criteria into the future.

Guidelines for conducting periodic inspections are as follows:

- Auditing maintenance records:
    - Review the O&M logbook to identify any recurring problems.
    - Compare logged records with the O&M plan to ensure the plan is under compliance and note any areas that need troubleshooting.
- Inspecting underwater components:
    - Check for gaps at joints and seams that could compromise screen efficiency.
    - Note any accumulation of debris.
    - Inspect screen material for damage and material integrity.
    - Check screens and structural members for corrosion, wear, or other deterioration.
    - Check sacrificial anodes and replace if necessary.
    - Check screen hold-down plates and other protrusions from the screen face for damage and debris accumulation.
- Witness cleaning system operations:
    - Intentionally foul the fish screen with locally available materials if possible and view the efficiency of the screen cleaning system.
    - Inspect spray orifices for fouling and erosion and whether the water or air spray systems need to be enlarged.

- Inspect screen faces for undulations in the screen material that may reduce cleaning efficiency (i.e., for traveling brush systems).
- Inspect screen cleaning brushes for wear and deterioration (e.g., for traveling brush systems).
- Inspect seals for wear and deterioration.
- Assess the overall efficiency of the cleaning system and identify any recommended solutions in the inspection report.
- Inspect underwater moving parts for corrosion and damage.

* Inspect the morphology of the stream channel in the immediate vicinity of the project for debris, erosion, and sedimentation that may potentially damage screens and their supporting structures or adversely affect screen operation and effectiveness.
* If warranted, measure water velocities perpendicular to the screen face to determine flow uniformity over all screen surfaces. Above normal debris accumulation in small areas may indicate approach velocities exceed the design criteria in those locations. Excessively high approach velocities can result in debris accumulation. If the accumulation is not addressed in a timely manner it may result in less efficient water withdrawal and eventual damage to the screen material or its structure.
* Test backup systems and alarms that could include the following:
    - Pump shut-off controls
    - Blow out panels
    - Mechanical brush shut-off system controls
    - Screen cleaning system failure alarms

9 Operations and Maintenance

9.1 Introduction

The design criteria and guidance provided in this document were developed to produce a high level of effectiveness and reliability at installed fish passage and protection facilities. Achieving this requires that these facilities be operated and maintained properly to optimize their performance in accordance with the design objectives of the facility. Failure to do so is a key concern of NMFS. This is because insufficient attention to the operational and maintenance aspects of a facility can compromise its fish passage effectiveness and result in fish injury and mortality.

This chapter addresses O&M issues in general and describes the components needed in a facility O&M plan. Where necessary, other chapters of this document will also address O&M issues that apply specifically to the topics covered in those chapters (e.g., Chapters 5 and 8).

9.2 General Criteria

Passage and screening facilities at barriers, diversions, water intakes, traps, and collection facilities should be operated and maintained in accordance with the O&M plan over the entire life of the project. This is needed to meet the mechanical design and biological objectives of the facility and the goal of providing optimal conditions for fish that result in successful passage (i.e., no mortality and minimal injury and delay).

NMFS requires that facility owners and operators commit to accepting responsibility for installing and properly operating, maintaining, and repairing the fish passage facilities described in the Guidelines. This is to ensure that: 1) fish affected by the facility are protected in a manner that is consistent with the intended performance of the facility based on its design; and 2) fish protection is provided on a sustained basis. For example, the proper function and operation of a fish passage facility would need to be restored immediately after damage from flooding and prior to the arrival of migratory fish, including repairing damaged structures and removing accumulated gravel and sediment.

Where facilities are inadequately operated or maintained, and the injury or mortality of listed fish can be documented, the responsible party is liable to enforcement measures as described in Section 9 of the ESA.

9.3 Specific Criteria – Staff Gages

Staff gages should be installed and maintained at critical locations throughout the facility.

Staff gages allow personnel to quickly determine if the facility is being operated within the established design criteria. Staff gage locations will be identified in the O&M plan.

9.4 The Operations and Maintenance Plan

This section describes how O&M plans are developed and approved and their contents.

9.4.1 O&M Plan Development and Approval

The O&M plan for a facility should be submitted to and accepted by NMFS prior to initiating project construction. The design of facilities should be made in consideration of O&M requirements and vice versa. Therefore, O&M plans need to be developed during the planning and design processes and must be reviewed and approved by NMFS at this time, along with project design documents.

For new facilities, it is recommended that a description of intended operations be obtained from the designer and then incorporated into the O&M plan. Such a description is often referred to as the "designer's intent."

The complexity of the O&M plan should reflect the complexity of the facility it addresses. For example, a facility with complex components, narrow operating requirements, and sophisticated water control systems will require a detailed plan that addresses all of the components, systems, and operational scenarios. This should include potential emergency scenarios, including the identification of spare parts for essential components that need to be on hand in case of failure.

9.4.2 Group O&M Plans

Comprehensive O&M plans for a group of projects will satisfy the requirement for an O&M plan for each project in the group as long as NMFS is in agreement with the O&M of the passage facilities.

Examples of group projects include road maintenance plans for culverts and small screen facilities within a network of water diversions.

9.4.3 General

The O&M plan should include the following criteria, procedures, and staffing requirements.

9.4.3.1 Facility operating criteria

The O&M plan should list the facility operating criteria. This includes (but is not limited to) criteria for water levels at critical locations, gate operations, gate settings, how the system is adjusted to accommodate changes in forebay and tailwater levels, and inspection procedures and frequency (e.g., daily, monthly, and annually).

9.4.3.2 Procedures

The O&M plan should include a description of routine O&M procedures. In addition, the O&M plan should include procedures for dewatering the facility, salvaging fish during a dewatering event, sediment and debris removal, and emergency operations.

Procedures, such as dewatering plans, fish salvage plans, and emergency operations, can have a direct impact on the survival of fish in the facility. It is important that these procedures be incorporated into O&M plans and operators are familiar with them in order to minimize any adverse impacts.

9.4.3.3 Staffing requirements

The O&M plan should discuss the staffing requirements needed to support the O&M plan, including the hours staff are required to be on site to monitor and operate the facility. The staffing requirement component of the plan should incorporate automatic controls and telemetry into the O&M plan and facility that notify operators of problems to increase overall reliability of the facility.

9.4.4 Posting the O&M Plan

The O&M plan should be posted at the facility or otherwise made available to the facility operator. Operators should be familiar with and understand the O&M plan and operate the facility accordingly.

It is important that the O&M plan be available and easily accessed by the facility operator should questions or emergency situations arise.

9.4.5 Periodic Review of O&M Plans by NMFS

Operations and maintenance documents should be reviewed and revised (with NMFS involvement) annually for the first 3 years of operation and then periodically after that as conditions and operations dictate.

NMFS intends that O&M plans be “living” documents. O&M documents should be revised periodically as the owner and operator develop more experience with a new facility. This is important because over time, experience will be gained as to how the facility performs under various hydrologic and environmental conditions, and ideas on how to improve the O&M of the facility will develop. For example, it is important that facility owners and operators note areas in the O&M plan that are deficient or need revision.

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Performance Progress Report

NOAA Restoration Center, Office of Habitat Conservation

1. Federal Agency to Which Report is Submitted	2. Award or Subaward Number	3. Federal Program Officer - Name
NOAA National Marine Fisheries Service	NA24NMFX463C0038	Melanie Gange

Project Information

4. Project Name MF Quilceda Fish Passage				*5. Recipient or Subrecipient Organization* The Tulalip Tribes of Washington	*6. Is this the final report?* ☐ Yes ☒ No
7. Award or Project Period Dates		8. Reporting Period Dates			*9. Report Frequency* ☐ annual ☒ semi-annual ☐ other ☐ quarterly
Start Date 9/1/2024	*End Date* 8/31/2028	*Start Date*	*End Date*		

Project Information	*10. Main Project Contact - Name* Brett Shattuck		*11. Main Project Contact - Title and Organization* Restoration, Acquisition, & Stewardship Senior Scientist; Tulalip		
	12. Main Project Contact - Email bshattuck@tulaliptribes-nsn.gov			*13. Main Project Contact - Phone Number*	
	14. Project City		*15. Project State* WA	*16. Number of Project Sites*	
	17a. Project Site Coordinates *(decimal degrees)*	*Latitude*	*Longitude*	*18. Project Landowner Permission Received*	☐ Yes ☐ No
Monitoring Information	*19. Monitoring Contact - Name*		*20. Monitoring Contact - Title and Organization*		
	21. Monitoring Contact - Email			*22. Monitoring Contact - Phone Number*	
	23. Monitoring Level ☒ *Tier I* ☐ *Tier II* ☐ *None*				

24. List of Target Species	*25. List of Project Partners*

26. Problem the Project Addresses

The Tulalip Tribes will work with partners to plan and construct multiple barrier removals in several watersheds in the Stillaguamish and Snohomish Basins, part of the South Whidbey Basin in Puget Sound. This work will support several salmon and steelhead species that are of economic, recreational, and cultural importance to the Tulalip Tribes and other members of the local community. By removing or replacing undersized and aging culverts with structures designed to withstand climate change, these efforts will also help protect the community from flooding.

Project Name	Award or Sub-Award Number
MF Quilceda Fish Passage	NA24NMFX463C0038

27. Other Attachments (see instructions)

Certification. *I certify to the best of my knowledge that this report is correct and complete for performance of activities for the purposes set forth in the award documents.*

28. Authorized Representative - Name and Title	*29. Authorized Representative - Email*	*30. Authorized Representative - Phone*

31. Performance Narrative (no page limit, see instructions):

Project Name	Award or Sub-Award Number
MF Quilceda Fish Passage	NA24NMFX463C0038

Performance Narrative (continued)

Project Name	Award or Sub-Award Number
MF Quilceda Fish Passage	NA24NMFX463C0038

A. Project Activities

1. Activity Description	2. Activity Status	3. Explanation of Progress
Grant Administration		
Data Management Plan		
FFATA Reporting Requirement		
Selection of Sub-awards and/ or Sub-contracts		
Photo Submission		Before: [Enter date submitted] During: [Enter date submitted] After: [Enter date submitted]
Partner Coordination		
Landowner Coordination		
Engineering and Design		
Permitting and Compliance		

OMB Control No. 0648-0718
Expiration Date: 02/28/2025

Project Name	Award or Sub-Award Number
MF Quilceda Fish Passage	NA24NMFX463C0038

A. Project Activities - (Continued)

1. Activity Description	2. Indicator Status	3. Explanation of Progress
Construction		
Monitoring Activities		
Adaptive Management/ Maintenance Activities		
Outreach and Education and Volunteer Coordination		
Acknowledgment of Project Contributors		
Safety Plan and Briefing on Site		
Monitoring Plan and Monitoring Report		
Improve Public Safety/ Removal of Pre-existing Safety Hazards		
Community Enhancement		

Project Name MF Quilceda Fish Passage	Award or Sub-Award Number NA24NMFX463C0038

A. Project Activities - (Continued)

1. Activity Description	2. Indicator Status	3. Explanation of Progress
Strategic Foundation 1: Underserved or Tribal Community Identification		[Applicant Instruction: [Describe your methodology and/or data of how you systematically identified underserved communities or tribes affected by this project.]
Strategic Foundation 2: Barrier Identification		[Applicant Instruction: [Describe how you worked with underserved community members to address barriers to engaging in project planning and/or accessing benefits provided by the project. Provide lessons learned if applicable.]
Strategic Foundation 3: Priority Alignment		[Applicant Instruction: [Describe the needs of the underserved community, including how you identified them and aligned project activities with these needs.]
Strategic Foundation 4: Community Endorsement or Applicant		[Applicant Instruction: [Describe the support received from a tribal government or underserved community organization affirming that the proposed project is in alignment with the needs of the tribe or underserved community.]
Strategic Execution 1: Ongoing Community-based Decision-making		[Applicant Instruction: [Describe how tribes or underserved community members are integral to the vision and are actively participating in project decision-making]
Strategic Execution 2: Compensation -Decision-maker		[Applicant Instruction: [Describe the ways in which you have been compensating, such as through a paid position, tribal or underserved community members for their decision-making role in the project.]
Strategic Execution 3: Compensation ("other" position)		[Applicant Instruction: [Describe the ways in which you have been compensating tribal or underserved community members for their time in contributing to the project]
Strategic Execution 4: Professional development		[Applicant Instruction: "Describe how you have created opportunities for professional development of tribal, underserved or underrepresented community members]
Strategic Execution 5: Volunteer, outreach and educational programs		[Applicant Instruction: [Describe how you have collaborated with tribal or underserved community members to develop and incorporate outreach, education, volunteer, or hands-on opportunities that are tailored to meet the needs of their communities]

Project Name	Award or Sub-Award Number
MF Quilceda Fish Passage	NA24NMFX463C0038

A. Project Activities - (Continued)

1. Activity Description	2. Indicator Status	3. Explanation of Progress
Domestic Sourcing Considerations		

Project Name MF Quilceda Fish Passage	Award or Sub-Award Number NA24NMFX463C0038

B. Performance Measures

1. Objective/Goal Description	2. Measure (Unit)	3. Baseline	4. Target Year	5. Target	6. Actual To Date (cumulative)	7. Explanation
Habitat Restored	# acres	N/A		[x]	[x]	
Stream Habitat Made Available or Restored	miles	N/A		[x]	[x]	
Design Meets Fish Passage Criteria (Pre-implementation)	Y/N	N/A		Y	[x]	
Site Passability: Channel Width	feet	[x]		[x] to [x]	[x]	
Site Passablity: Average Channel Slope	%	[x]		[x] to [x]	[x]	
Site Passability: Max Channel Slope	%	[x]		[x]	[x]	
Site Passability: Max Jump Height	inches	[x]		[x] to [x]	[x]	
Site Meets Fish Passage Criteria (Post-implementation)	Y/N	N/A		Y	[x]	
Species X Presence/ Absence (Adult)	P/A	A		P	[x]	

Project Name	Award or Sub-Award Number
MF Quilceda Fish Passage	NA24NMFX463C0038

B. Performance Measures - (Continued)

1. Objective/Goal Description	2. Measure (Unit)	3. Baseline	4. Target Year	5. Target	6. Actual To Date (cumulative)	7. Explanation
Species X Presence/ Absence (Juvenile)	P/A	A		P	[x]	
Volunteer Involvement (hours)	#	N/A		[x]	[x]	
Volunteer Involvement (participants)	#	N/A		[x]	[x]	
Maintenance and Operations Cost	$/5 years	[x]		[x]	[x]	
ESA Recovery Plan Actions Addressed	#	N/A		[x]	[x]	
Fishery Management Plan Actions Addressed	#	N/A		[x]	[x]	
Built as Designed	Y/N	N/A		Y	[x]	
Jobs supported by grant funds	Labor hours					Hours of work supported by grant funds through the end of the current reporting period.

Project Name	Award or Sub-Award Number
MF Quilceda Fish Passage	NA24NMFX463C0038

C. NOAA Award Funding

Funding Duration: 3 years

☐ Lock Table

1. Object Class Expenditures	2. Year 1 NOAA Approved Funds	3. Year 2 NOAA Approved Funds	4. Year 3 NOAA Approved Funds	5. Total NOAA Approved Funds	6. Total NOAA Funding Expended	7. Notes
Personnel	$0.00	$0.00	$0.00	$0.00		
Fringe Benefits	$0.00	$0.00	$0.00	$0.00		
Travel	$0.00	$0.00	$0.00	$0.00		
Equipment	$0.00	$0.00	$0.00	$0.00		
Supplies	$0.00	$0.00	$0.00	$0.00		
Contractual	$1,400,000.00	$0.00	$0.00	$1,400,000.00		
Other	$0.00	$0.00	$0.00	$0.00		
Indirect	$0.00	$0.00	$0.00	$0.00		
TOTALS	$1,400,000.00	$0.00	$0.00	$1,400,000.00		

Project Name MF Quilceda Fish Passage	Award or Sub-Award Number NA24NMFX463C0038

D. Non-federal Recipient Share (Match Funds)

Funding Duration: 3 years

☐ Lock Table

1. Object Class Expenditures	2. Year 1 Match Funds Approved	3. Year 2 Match Funds Approved	4. Year 3 Match Funds Approved	5. Total Approved Match Funds	6. Total Expended Match Funds	7. Non-federal Recipient Share (Match Funds) Sources
Personnel						
Fringe Benefits						
Travel						
Equipment						
Supplies						
Contractual						
Other						
Indirect						
TOTALS						

8. Budget Deviations Description (see instructions)

OMB Control No. 0648-0718
Expiration Date: 02/28/2025

Project Name MF Quilceda Fish Passage	Award or Sub-Award Number NA24NMFX463C0038

E. Project Leverage *(Funds beyond committed match)*

1. Leverage Task Description *(Optional: Project Partner conducting task)*	2. Type of Funds (Federal or Non-federal)	3. Funding Source (Name of Organization)	4. Total Funds
		Total	

Project Name MF Quilceda Fish Passage	Award or Sub-Award Number NA24NMFX463C0038

F. Monitoring Funds *(Include all funding supporting monitoring activities)*

1. Monitoring Task Description	2. Type of Funds (Federal or Non-Federal)	3. Funding Source (Name of Organization)	4. Total Funds
		Total	

OMB Control No. 0648-0718
Expiration Date: 02/28/2025

NOAA Fisheries Guidelines for Salmonid Stream Crossings in WA, OR and ID

NOAA FISHERIES

Guidelines for Salmonid Passage at Stream Crossings in Oregon, Washington, and Idaho

Authors

National Marine Fisheries Service
West Coast Region
Environmental Services Branch

- Original Issue Date: June 2022
- Addendum Issue Date:
  - #1 February 22, 2023

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

For questions or to provide comments please contact the following:

NOAA Fisheries West Coast Region
Environmental Services Branch
1201 Northeast Lloyd Boulevard. Suite 1100
Portland. Oregon 97232

503-230-5400

Web address:
https://www.fisheries.noaa.gov/region/west-coast

Suggested citation:

NMFS (National Marine Fisheries Service). 2022. Guidelines for Salmonid Passage at Stream Crossings in Oregon, Washington, and Idaho. NMFS. WCR. Portland, Oregon

ADDENDUM #1: February 22, 2023

The year(s) in the title of this document was removed from the title page and the flow chart in Figure 1.

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Acronyms and Abbreviations

Symbol or Acronym	Term or Title
BOR	U.S. Bureau of Reclamation
ft^3/s	cubic feet per second
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
ft^3	cubic foot
ft/s	foot per second
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
O&M	operations and maintenance
USACE	U.S. Army Corps of Engineers
WCR	West Coast Region

1 Introduction

The guidance in this document applies to projects located in Washington, Oregon, and Idaho. Given significantly different hydrologic conditions, projects in California should refer to: Guidelines for Salmonid Passage at Stream Crossings in California (NMFS 2019 or most recent). The content herein primarily addresses road crossings and grade control projects, where the bankfull width is 20 ft or less. Projects where the bankfull width is greater than 20 ft may still benefit from the information contained here, but due to scale effects associated with wider channels (Frissell and Nawa 1992), it may not be applicable.

The WCR has developed a flow chart for how to use their various fish passage guidance documents (Figure 1-1). Prior to designing a stream crossing facility, NMFS recommends the project proponent familiarize themselves with the "NOAA Fisheries WCR Guidance to Improve the Resilience of Fish Passage Facilities to Climate Change" (Improving Resilience) guidance document. The Improving Resilience document outlines how to incorporate projected future flows the facility may experience over the life of the project and should be the starting point for the design process.

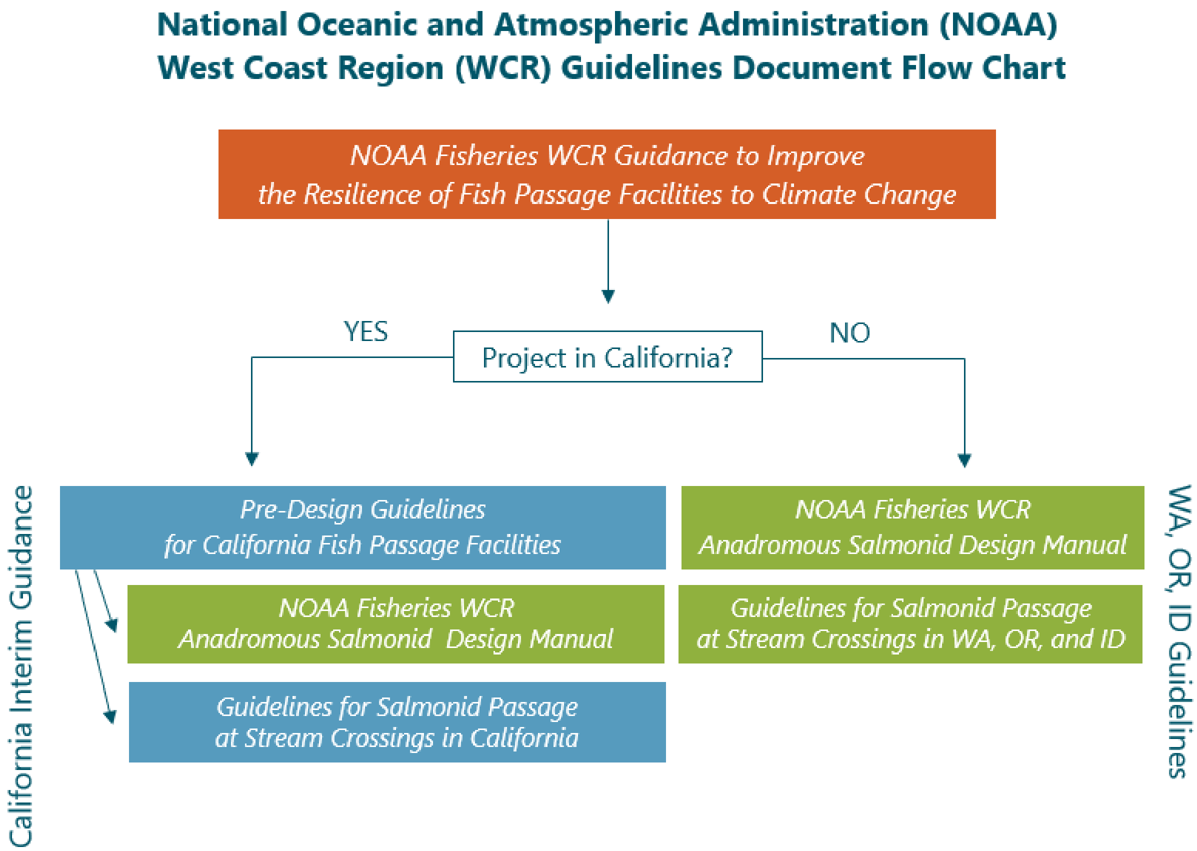


Figure 1-1. Flow Chart for Interaction of NMFS Design Guidance

The Environmental Service Branches provide technical and engineering assistance to National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) West Coast Region (WCR) fisheries biologists. NMFS also plays a supportive and advisory role in the management of living marine resources in the areas under state jurisdiction. This document is intended to assist with improving conditions for salmonids that must migrate past barriers to complete their life cycle. Effective Fish passage requires the integration of numerous scientific and engineering disciplines including, but not limited to, fish behavior, ichthyomechanics, hydraulics, hydrology, fluvial geomorphology and engineering. Installing a fish passage structure does not constitute providing satisfactory fish passage unless all the above components are adequately factored into the design.

This document is intended to: 1) provide internal assistance to NMFS biologists in designing effective fish passage; 2) promote consistency across the WCR region; and 3) support the implementation of NMFS's statutory authorities related to the conservation and protection of marine resources.

The efficacy of any fish passage structure, device, facility, operation, or measure is highly dependent on local hydrology, target species and life stage, obstacle orientation relative to the stream, facility operation, and many other site-specific considerations. While the information provided herein will apply to many structures, it should be regarded as general guidance for the design, operation, and maintenance of fishways throughout the Pacific Northwest. The criteria described in this document are not universally applicable and should not replace site-specific recommendations.

This document provides general guidance and is not intended as an alternative to interactive consultation with NMFS biologists and engineers. Application of these criteria in the absence of consultation does not imply approval by NMFS. This document provides criteria and additional guidelines for the design and operation of facilities at barriers to fish migration and water intakes in Washington, Oregon, and Idaho. The facilities are designed to create safe passage routes for adult and juvenile salmonids in rivers and streams and through reservoirs, restore habitat connectivity within watersheds, and enhance salmonid population productivity. NMFS will use the criteria and guidelines to advise project applicants on the design of future fish passage projects and modifications to existing projects. The criteria are based on decades of experience developing, testing, operating fish passage systems and relies on the best available scientific information.

This document, *Guidelines for Salmonid Passage at Stream Crossings in Oregon, Washington, and Idaho* supersedes sections of the following document:

- Northwest Region's *Anadromous Salmonid Passage Facility Design*, dated July 2011

This document provides criteria and guidance for anadromous salmonids only. For additional guidance concerning non-salmonids, refer to applicable state and federal entities.

Throughout the chapters all criteria are italicized to be easily identifiable.

NMFS has separated these fish passage engineering guidelines into two volumes: *NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual* represents guidelines that are based on decades of research, monitoring, and NMFS' experience with these types of passage systems. NMFS considers material in *NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual* to be in a mature state and does not anticipate it will change significantly over time. This Stream Crossings document, *Guidelines for Salmonid Passage at Stream Crossings in Oregon, Washington, and Idaho* represents a growing body of work that NMFS expects will expand significantly in the future. Separating these guidelines into two volumes will allow NMFS to refine and expand *Guidelines for Salmonid Passage at Stream Crossings in Oregon, Washington, and Idaho* in the near future as new information becomes available, without having to reopen and modify the entire guidelines document. This volume includes Stream Crossings (Chapter 3) and Grade Control (Chapter 4)

The criteria and guidelines in this Volume address more emerging fields of fish passage engineering and stream restoration. The criteria and rationale provided will be revised as needed if new information suggests that updated criteria would further improve passage conditions for fish.

1.1 Statutory Background

NMFS is mandated by U.S. Congress to manage, conserve, and protect living marine resources within the U.S. Exclusive Economic Zone. NMFS is authorized to conduct these actions under the Federal Power Act (FPA; administered by the Federal Energy Regulatory Commission [FERC]), the Fish and Wildlife Coordination Act (administered by the U.S. Fish and Wildlife Service), the Endangered Species Act (ESA), and the Magnuson-Stevens Fishery Conservation and Management Act (MSA). This document provides criteria and technical assistance to project proponents on the design of fish passage facilities in order to provide safe, timely, and effective fish passage, consistent with NMFS responsibilities under the ESA, FPA, and MSA.

The requirement of safe, timely and effective passage derives from the unofficial but reliable definition of a fishway presented by Congress in a report related to the Energy Policy Act of 1992. The definition of "safe and timely passage" was expanded to include both passage structures and operations "necessary to ensure the effectiveness" of such structures. None of the terms "safe," "timely," or "effective" are further defined. However, in practice NMFS typically includes provisions which give these terms meaning. Regarding "safe" passage, NMFS requires licensees to design and operate their fishways so that they minimize the occurrence of injury or mortality experienced by fish while attempting to utilize the fishway. Regarding "timely" passage, a fishway prescription may include provisions for reducing the time in which a fish utilizing the fishway is subjected to stressful interactions, such as time spent in a trap or in transit, or a requirement for flows which will attract fish to a passage facility. Regarding "effective" passage, NMFS typically includes provisions requiring the operator to ensure that its facility succeeds in passing as close to 100% of the fish attempting to migrate through the system as possible.

Following these criteria will likely streamline processes, improve certainty, and improve the likelihood of success. NMFS also provides support and advice to states regarding the management of living marine resources in areas under state jurisdiction. This includes salmon (*Oncorhynchus spp.*) and steelhead (*O. mykiss*) due to their economic, cultural, recreational, and symbolic importance to society (NRC 1996).

NMFS pursues fish passage to contribute to its fishery management and ESA recovery goals. In reviewing, planning, designing, and implementing fish passage facilities, NMFS engineers will coordinate with NMFS biologists to make sure the particular target species, population numbers, migration timing and recovery goals are met.

1.2 Design Process

Resolving effects on salmonid migrations from barriers involves the integration of information on fish behavior and physiology, biomechanics, hydraulic and hydrologic conditions, and fluvial geomorphology. Simply installing a fish passage structure does not constitute providing satisfactory fish passage. A successful design requires that information on each of these components be factored into the design.

Instances can also occur where a fish passage facility may not be a feasible solution for correcting a passage impediment due to biological, societal, or economic constraints. In these situations, removal of the impediment or altering project operations may be a suitable surrogate in lieu of constructing fish passage facilities (Clay 1995).

This document addresses design features that may provide for the safe, timely, and effective passage of fish. It is the responsibility of the design engineer to ensure that other design requirements are met, such as the structural integrity of the facility and public safety.

When determining whether NMFS will promote or prescribe solutions for fish passage issues, NMFS will rely on a collaborative approach that considers the views of other fisheries resource agencies, Native American tribes, non-governmental organizations, citizen groups, and other governmental agencies. The approach strives to consider fish passage objectives developed by other parties (e.g., well-placed stakeholder groups) to support fisheries restoration and habitat enhancement actions identified in conservation plans.

This document provides specific fish passage facility design criteria and guidelines for actions within the Pacific Northwest pertaining to the various authorities of NMFS. In consultation with the project proponent, NMFS will apply the criteria and guidelines to major upgrades to existing facilities and the design of new fish passage facilities. Existing facilities that are not compliant with this document may have to be modified using the criteria identified herein if fish passage problems are observed at these facilities.

1.3 Temporary and Interim Passage

Where construction or modifications to artificial impediments (e.g., dams), natural impediments (rockslides, other natural issues) or upstream passage facilities are planned, upstream and downstream passage may be adversely impacted or interrupted. If possible, these activities should be scheduled for periods when migrating fish are not present, as specified in the in-water work period allowable for construction of facilities in streams. However, this may not always be possible or advisable. In these cases, an interim fish passage plan should be prepared and submitted to NMFS for review, in advance of work in the field.

In the interim plan, upstream and downstream fish passage should be provided for any adult or juvenile fish likely to be present in the action area during construction, unless passage did not exist before construction or where the stream reach is naturally dry at the time of construction. Methods for work area isolation and dewatering, as necessary, should be determined in consultation with NMFS.

Design criteria listed elsewhere in this document also apply to the interim passage plan. Where this is not possible, project owners should seek NMFS review of alternate interim fish passage design criteria, and a final interim passage plan. Coordination with NMFS ahead of time is advised to determine appropriate work windows and other recommended alternatives or both.

1.4 Experimental Technologies

Proponents of new, unproven fish passage designs (i.e., designs not meeting the criteria and guidelines contained in this document) should provide NMFS with the following prior to moving into the 30% design phase:

- A biological basis for the concept
- A demonstrated, favorable fish behavioral response in a laboratory setting
- An acceptable plan for evaluating the prototype installation
- An acceptable alternate fish passage design developed concurrently with the unproven fish passage design that satisfies the criteria listed herein, should the prototype not perform as anticipated nor adequately protect fish

The experimental technologies process is intended for new and innovative technologies that can be broadly applied, rather than for a fish passage design that applies to a single site. Appendix C (Experimental Technologies) provides additional information on the NMFS approval process for unproven fish passage technologies.

1.5 Section 7 Consultation under the Endangered Species Act

This fish passage manual can be useful during Endangered Species Act consultations. Incorporating the criteria within this document will help project proponents design projects that provide fish passage in a variety of situations. During the design process project developers can incorporate criteria within this document and work with NMFS engineers and biologists to ensure their projects meet these fish passage criteria. While this document provides substantial criteria related to fish passage, there are aspects of project design that are beyond the scope of this document. For instance, this manual does not identify or endorse specific construction best management practices. Project developers should coordinate with NMFS on project elements that fall outside the scope of this document.

This manual can also be used to achieve regulatory streamlining by aiding in the development of programmatic ESA and EFH consultations on activities involving fish passage. By incorporating these criteria into programmatic actions, action agencies and other stakeholders can help ensure their actions provide fish passage and appropriate conservation for protected resources, while streamlining the regulatory process.

1.6 Additional Information

Additional information on fish passage is available at the WCR website: http://www.westcoast.fisheries.noaa.gov/. Questions regarding this document and requests for assistance from NMFS fish passage specialists can be directed to the following offices:

NOAA Fisheries West Coast Region
Environmental Services Branch
1201 Northeast Lloyd Boulevard. Suite 1100
Portland. Oregon 97232

2 Definition of Terms

Anadromous – pertaining to a fish species that displays the life history pattern known as anadromy in which adults spawn in fresh water and juveniles migrate to sea to grow to their final size and then return to fresh water to spawn (Quinn 2005).

Applicant – a person or entity that proposes to design, modify, or construct, a fish passage facility at an existing or new barrier, water diversion, or water conveyance that NMFS will review under its authorities identified in Chapter 1.

Apron – a flat or slightly inclined slab of concrete below a flow control structure that provides erosion protection and produces hydraulic characteristics suitable for energy dissipation or, in some cases, fish exclusion.

Attraction flow – flow that emanates from a fishway entrance with sufficient velocity and quantity, and in the proper location and direction, to attract upstream migrants into the fishway entrance. Attraction flow consists of gravity flow from the fish ladder and any auxiliary water system flow added at points within the lower fish ladder.

Baffles – physical structures placed in the water flow path designed to dissipate energy or redirect flow to achieve more uniform flow conditions.

Bankfull flow – the bank height when a stream or river channel is inundated under a flow that occurs at the 1.2-year to 1.5-year average flood recurrence interval. Bankfull height may be estimated by morphological features in the channel such as: 1) a topographic break from a vertical bank to a flat floodplain or from a steep to a gentle slope; 2) a change in vegetation from bare ground to grass, moss to grass, grass to sage, grass to trees, or no trees to trees; 3) a textural change of depositional sediment; 4) the elevation below which no fine debris (e.g., needles, leaves, cones, seeds) occurs; and 5) a textural change of fine sediment deposits (matrix material) between cobbles or rocks.

Bedload – sand, silt, gravel, soil, and rock debris transported by moving water on or near the streambed.

Channel Migration Zone - Channel migration zones are areas in a floodplain where a stream or river channel can be expected to move naturally over time in response to gravity and topography. Water bodies such as rivers and streams gain or release energy as they flow, carrying away or spreading out sediments, building new areas, and supporting a variety of fish, wildlife, and vegetation. Rivers with room to migrate have the highest diversity of aquatic habitats.

Conceptual design – an initial design concept based on the site conditions and biological needs of the species intended for passage, also sometimes referred to as preliminary design or functional design. This is the first phase in the design process of a fish passage facility and is discussed in Chapter 3.

Fish ladder – the structural component of an upstream fish passage facility (or fishway) that allows fish to move over a barrier by dissipating the potential energy caused by the head differential that results from a barrier being placed in a waterway. The ladder dissipates energy using a series of discrete pools, a series of baffled chutes and resting pools, or uniformly with a single baffled chute placed between an entrance pool and an exit pool.

Fish passage season – the range of dates that characterize when juvenile or adult life stages of a species will arrive at a specific location during their downstream or upstream migration. The locations could include, for example, a dam or an existing or proposed fishway.

Fishway – the suite of facilities, structures, devices, measures, and project operations that constitute and are essential to the success of an upstream or downstream fish passage system. The suite provides a water passage route around or through an obstruction that is designed to dissipate the energy in such a manner that enables fish to ascend the obstruction without undue stress (Clay 1995).

Fishway exit – the component of an upstream fish passage facility where flow from the forebay of the dam or barrier enters the fishway, and where fish exit the ladder and enter the forebay upstream of the dam.

Fishway weir – the partition that divides two pools in a fishway and passes flow between adjacent pools.

Flood frequency – the probable frequency that a streamflow will recur based on historical flow records. For example, a 100-year flood event refers to a flood flow magnitude that is likely to occur on average once every 100 years or has a 1% chance of being exceeded in any given year. Although calculating possible flood recurrence is often based on historical records, there is no guarantee that a 100-year flood will occur within the 100-year period, or not occur several times within that period.

Floodplain – the area adjacent to a stream that is inundated during periods of flow that exceed the channel capacity the stream has established over time.

Flow control structure – a structure in a water conveyance designed to maintain flow in a predictable fashion.

Flow duration exceedance curve – the plot of the relationship between the magnitude of daily flow and the percentage of time during a specific period that flow is likely to be equaled or exceeded. Flow exceedance curves may use flow data from an entire year or part of a year. For example, the 1% annual exceedance flow is the flow level exceeded 1% of the time within the entire year (i.e., 3.6 days on average), whereas the 1% exceedance flow for the fish migration window is the flow level exceeded 1% of the time during the fish passage season for a particular species and location. Exceedance values are usually derived using daily average flow data.

Freeboard – the height of a structure that extends above the maximum water surface elevation.

Functional design – an initial design concept based on the site conditions and biological needs of the species intended for passage. This is also sometimes referred to as preliminary design or conceptual design. Also, see the definition for conceptual design in this chapter. The functional design commonly includes the general layout, interior dimensions, and specifications covering the hydraulic features of the fishway (Clay 1995).

Hydraulic drop – the difference in total head between an upstream water surface and a downstream water surface. It includes the sums of the elevation head, pressure head, and velocity head at the upstream and downstream water surface locations. For fishway entrances and fishway weirs, the differences in velocity head and pressure head are usually negligible, and only water surface elevation differences are considered when estimating hydraulic drop across the structure.

Invert – the lowest inside surface of a culvert or flume.

Plunging flow – flow over a weir that falls into a receiving pool where the water surface elevation of the receiving pool is lower than that of the weir crest elevation. Surface flow in the receiving pool is typically in the upstream direction, downstream from the point of entry into the receiving pool. Also, see the definition for streaming flow in this chapter.

Preliminary design – an initial design concept based on the site conditions and biological needs of the species intended for passage. This is also sometimes referred to as a functional design or conceptual design. Also, see the definition for conceptual design in this chapter.

Redd – the nest a female salmonid excavates, deposits embryos into, and immediately buries with gravel substrate. Redds can be located in streams, rivers, or lake beaches. The locations selected vary with populations and species (Quinn 2005).

Scour – erosion of streambed material resulting in the temporary or permanent lowering of the streambed profile.

Soffit – the inside top of culvert or underside of a bridge.

Streaming flow – flow over a weir that falls into a receiving pool and where the water surface elevation of the receiving pool is above the weir crest elevation. In these situations, surface flow in the receiving pool is typically in the downstream direction and away from the point where flow enters the receiving pool.

Tailrace – the portion of the water channel below a dam that conveys turbine and spillway discharge downstream from the dam.

Tailwater – the body of water immediately downstream of a dam or other in-stream structure.

Thalweg – the streamflow path following the deepest parts (i.e., the lowest elevation) of a stream channel.

Upstream fish passage – fish passage relating to the upstream migration of adult and juvenile fish.

Upstream passage facility – a fishway system designed to pass fish upstream of a passage impediment, either by volitional passage (i.e., under their own swimming capability) or non-volitional passage (i.e., via a lift or transport vehicle).

Volitional passage – fish passage whereby fish transit a passage facility under their own swimming capability, using timing and behavior they choose, and under all naturally passable flows. Volitional passage means fish can enter, traverse, and exit a passage facility under their own power, instinct, and swimming capability. The fish pass through the facility without the aid of any apparatus, structure, or device (i.e., they are not trapped, mechanically lifted or pumped, or transported).

Weir – a low wall or dam built across the width of a river that pools water behind it while allowing water to flow steadily over the top of the structure.

3 Stream Crossings

3.1 Introduction

Chapter 3 contains criteria and guidelines for the design of stream crossings that provide upstream and downstream movement for all life stages of anadromous salmonids present at a site. These criteria and guidelines apply to bridges, culverts, and fords. For the purpose of fish passage, the distinction between a bridge, culvert, and low water crossing (also referred to as a ford) is less important than the effect the structure has on the form and function of the stream.

In addition to providing fish passage, any stream crossing design should maintain the ecological function of the stream, pass woody debris, pass flood flows and sediment, analyze the scour potential, and account for other species present at the site. The design team should collaborate with biologists and engineers familiar with the site to assess potential effects on species and life stages present and site geomorphology.

The criteria and guidelines presented in this chapter are general in nature. There may be cases where site constraints or unusual circumstances dictate a modification to one or more of these design elements. Conversely, where there is an opportunity to protect salmonids, additional site-specific criteria may be appropriate. Variances will be considered by NMFS on a project-specific basis. It is the responsibility of the applicant to formally request and provide compelling evidence in support of any modification of a guideline or criterion contained in this chapter. Requests must be submitted for approval early in the design process, well in advance of a proposed ESA consultation.

3.2 Preferred Alternatives for New, Replacement, or Retrofitted Stream Crossings

3.2.1 Description and purpose

Bridges, culverts, and fords have the potential to pass fish but some may facilitate better passage at a particular site. Based on the biological and ecological condition of an individual site, NMFS may require a specific road crossing design to restore or maintain critical fluvial processes and floodplain connectivity and morphology within the stream crossing-floodplain corridor.

3.2.2 Specific guidelines and criteria

NMFS prioritizes the following alternatives and types of structures in the order shown:

1. *No new crossing structure: realign the road to avoid crossing the stream.*
2. *Removal: Completely remove the crossing and restore the stream channel.*

3. *Bridge: Span the historically active floodplain or channel migration zone. This allows for long-term dynamic channel stability.*
4. *Stream Simulation Design: The following structures are prioritized in order of their ability to maintain stream simulation conditions over the life span of the project. methods:*
    a. *Bridge – Clear span*
    b. *Bridge – With mid-span piers*
    c. *Culvert*
        i. *Bottomless arch*
        ii. *Box culvert*
        iii. *Round pipe*
        iv. *Squash pipe*
    d. *Modified Stream Simulation Design – Requires NMFS approval.*
5. *Ford*
6. *Hydraulic design: This method may be accepted only when NMFS agrees that alternatives 1 through 5 (above) are unattainable or inappropriate. Hydraulic design styles include backwatered, embedded, baffled, and non-embedded culverts and culverts designed with a fishway.*

3.3 Stream Crossings in Spawning Areas

3.3.1 Description and purpose

The design team should work collaboratively with biologists familiar with the site to assess potential impacts on spawning, life stages requiring passage, and to assess bed stability. Bridges spanning the stream channel and floodplain provide better long-term dynamic channel stability, retention of existing spawning areas, maintenance of food (benthic invertebrate) production, and minimized risk of failure at spawning sites. Maintaining the stream bed at the natural grade and substrate material in as natural a condition as possible will reduce unnatural scour of spawning redds and promote population productivity through increased connectivity of the channel with the floodplain. These conditions can be facilitated better with bridge designs compared to culverts.

3.3.2 Specific criteria and guidelines

If a segment of stream channel where a crossing is proposed is in an active salmonid spawning area, then only Stream Simulation Design is recommended, and a bridge is the preferred structure for providing Stream Simulation.

It is important to maintain the bed at grade and substrate material in as natural a condition as possible. Bridges in particular, support population productivity by reducing scour of spawning redds through increased connectivity of the channel with the floodplain.

3.4 Crossing Alignment

Crossings which skew their alignment with the stream channel increase the probability of debris plugging (Furniss et al. 1998). A skewed crossing alignment may also affect scour and streambed instability through the crossing or large-scale loss of bed material exposing culvert bottoms or footings. Any of these outcomes can adversely affect upstream passage of adult and juvenile salmonids.

3.4.1 Specific criteria and guidelines

Stream crossing structures should be oriented to eliminate skew relative to the adjacent stream channel. Structures should be aligned to eliminate abrupt changes in flow direction upstream or downstream of the crossing.

Aligning the crossing structure so there are no abrupt changes in flow direction can often be accommodated by changing the road alignment, aligning a bridge's substructure components parallel to the stream flow, or by slightly elongating the culvert. Excessively elongating the culvert should be weighed against a better crossing alignment and modifying transition sections upstream and downstream of the crossing.

3.5 Culvert Length

3.5.1 Description and purpose

Culverts that are long compared to streambed width can reduce a stream's natural sinuosity and result in sediment transport problems even if the channel slope remains constant. Culvert length can also reduce the roughness, energy dissipation, channel planform, and promote unanticipated scour of the streambed through the culvert (Barnard et al. 2013). These impacts may lead to bed and bank instability through the culvert or large-scale loss of bed material exposing the culvert bottom or footings. Any of these outcomes can adversely affect upstream passage of adult and juvenile salmonids. Culvert length can also increase the risk of debris accumulation and plugging.

3.5.2 Specific criteria and guidelines

When the culvert length-to-span ratio is greater than 10 a bridge should be selected (Barnard et al. 2013). Stream crossings that are long compared to streambed width can reduce a stream's natural sinuosity and result in sediment transport problems even if the channel slope remains constant.

3.6 Flood Capacity

3.6.1 Description and purpose

Culvert failures in the Pacific Northwest occur primarily due to debris plugging, not insufficient hydraulic capacity (Furniss et al. 1998). Relative risk of culvert failure due to plugging is commonly assessed in the context of large wood. A deterministic presence or absence of large wood is the most often method of assessing this failure. Plugging risk is not a presence/absence determination and risk lies on a graded scale relative to site specific and watershed scale factors. Complicating assessing plugging risk is the fact that the plugging process can be initiated by relatively small pieces of wood and debris, not routinely identified as potentially troublesome (Flanagan 2004). Culvert failures due to plugging can lead to extensive damage of aquatic organism habitat which may persist over a long period of time (Love and Bates 2009). Culvert failures can also impair or impede fish passage. NMFS has provided risk pathway tables in the Improving Resilience document that may be of assistance for increases in debris plugging after fire events. Table 8 in that document covers risks that culverts may experience over a variety of facility element considerations.

3.6.2 Specific guidelines and criteria

All culverts should be designed to withstand the 100-year-recurrence peak flood flow without failure of the crossing. Stream crossings located in areas where there is significant risk of plugging by flood-borne debris should be designed to pass the 100-year peak flood with a minimum of 1 foot of freeboard (Barnard et al. 2013).

A number of culvert design manuals originating in the Pacific Northwest recommend culverts be designed to pass the 100-year flood (Barnard et al. 2013) (Love and Bates 2009) (Cafferata et al. 2017). This capacity should help reduce risk of crossing failure during flood flows.

3.7 Embedded Pipe Design Method

3.7.1 Description and purpose

Embedded Pipe Design Method represents a class of simplified culvert designs intended to size a culvert sufficiently wide, and embedded deep enough into the channel, to allow natural movement of bedload and formation of a stable streambed inside the culvert. Determination of the high and low fish passage design flows, water velocity, and water depth is not required for this method since the stream hydraulic characteristics within the culvert are intended to mimic the stream conditions upstream and downstream of the crossing. This design approach is predominantly for use in agricultural settings where irrigation canals or excavated channels contain fish and require crossing; and a landowner can perform the work of excavation and installation without the aid of surveying and engineering.

Embedded Pipe Methods cover several culvert designs originating in the Pacific Northwest, including: Active Channel method (NMFS 2001; CDFG 2002); No-Slope method (Barnard et al. 2013); Low Slope Stream Simulation Method (Love and Bates, (2009). These methods are similar in their design approach and differ predominately with the limitations on pipe length and slope of pipe installation. Price et al. (2010) concluded that as many as 45% of the designs using a No-Slope design approach failed to meet fish passage criteria based on post-construction evaluations. Most of the failure modes identified in Price et al. (2010) seem to be centered on conditions that arise from installing a pipe at 0% slope, regardless of channel gradient. To minimize failure of this method of culvert design, NMFS recommends installing Active Channel Method, No-Slope method, and Low Slope Stream Stimulation method pipes to the proposed average gradient of the project reach.

3.7.2 Specific criteria and guidelines

The following subsections provide specific design criteria and guidelines for Embedded Pipe Design Method crossings.

3.7.2.1 Culvert width

The minimum culvert width should be equal to, or greater than, 1.5 times the bankfull width.

3.7.2.2 Culvert diameter

Minimum diameter should be 6 feet.

3.7.2.3 Maximum stream slope

Average stream slopes should be 3% or less.

3.7.2.4 Invert depth

Inlet and outlet inverts of the culvert should be set at a minimum of 3 feet below the streambed.

3.7.2.5 Embedment

The inlet and outlet invert should be buried into the streambed not less than 30% of the culvert height at the outlet and not more than 50% of the culvert height at the inlet.

3.7.2.6 Fill Materials

Fill materials should be composed of natural or simulated streambed material.

3.8 Streambed Simulation Design Method

The Stream Simulation Design method (Forest Service Stream-Simulation Working Group, 2008; Barnard et al., 2013) is intended to mimic the natural stream processes through a stream crossing and produce a design where fish passage, sediment transport, and flood and debris conveyance function as they would in a natural channel. Determining high and low fish passage design flows, water velocity, and water depth are not required for Stream Simulation Design because the stream hydraulic characteristics within the crossing are designed to mimic natural stream conditions upstream and downstream of the crossing. This method requires additional information on hydrology and geomorphology (e.g., the topography of the stream channel) and a higher level of engineering expertise compared to Embedded Pipe Design Methods.

3.8.1 Description and Purpose

3.8.2 Specific Criteria and Guidelines

The following subsections provide specific design criteria and guidelines for Stream Simulation Design crossings.

3.8.2.1 Crossing width

The minimum crossing span should be 1.5 times the bankfull width.

3.8.2.2 Streambed slope

The slope of the reconstructed streambed within the crossing should maintain an average slope of 1.0 to 1.25 times the natural average slope of the adjacent upstream and downstream reaches.

3.8.2.3 Culvert slope

When a culvert is used, the culvert slope should approximate the slope of the stream through the reach in which it is being placed.

3.8.2.4 Channel vertical clearance

The minimum vertical clearance between the crossing bed and the culvert or bridge deck soffit elevation should be no less than 6 feet to allow access for debris removal.

3.8.2.5 Embedment

Inverts, abutments, footings, or other foundations types should be designed for the total anticipated scour depth. Minimum embedment depth of inverts, footings, and abutments should be 3 feet. Pipe inverts (inlet and outlet) should be buried into the streambed not less than 30% and not more than 50% of the culvert height.

3.8.2.6 Fill materials

Fill materials should be composed of materials of similar size composition to natural bed materials that form the natural stream channels adjacent to the road crossing.

The designer should demonstrate to NMFS that the streambed of the crossing will be stable over time. This can be accomplished by assessing hydraulic conditions through the passage corridor over the range of fish passage design flow and whether a sufficient amount of bed material will be transported through the crossing to maintain the integrity of the streambed over time. NMFS may agree that incorporating large fill material into the design would maintain grade and provide resting areas for migratory fish.

3.8.2.7 Scour prism

Maintain the scour prism as a clear, unobstructed opening (i.e. free of any embankment fill, bed retention sills, scour countermeasure, or structural material). The horizontal dimension of the scour prism is defined as 1.5 times the bankfull width, and the vertical dimension is defined as the total scour depth elevation or the criteria embedment depth as described in 3.8.2.5, whichever is greater. Banklines incorporating irregular sized rock (Forest Service Stream-Simulation Working Group 2008), "course band" rock designs (Barnard et al. 2013), or similar; can be within the scour prism. Engineered material used to create stable bank-lines or simulated floodplains at the high design flow within the crossing are allowed.

The scour prism for a bottomless arch culvert and an elliptical culvert are illustrated in Figure 3-1. The scour prism is a cross-sectional area of the stream channel applied through the entire length of the road crossing design.

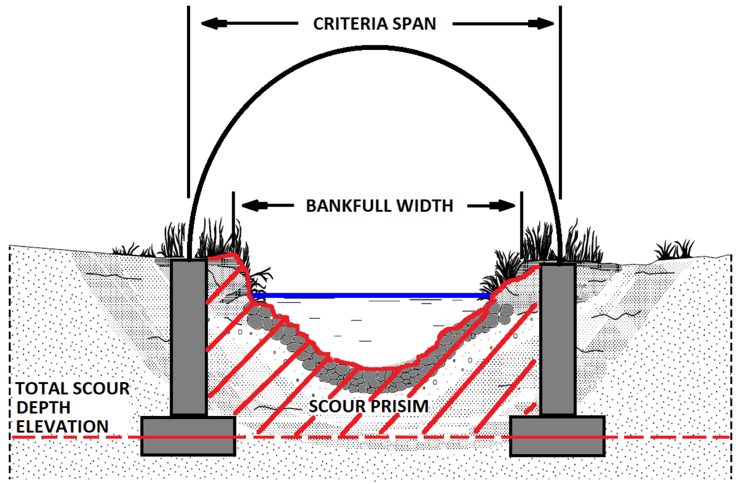
3.8.2.8 Bankline

Irregular banklines formed by lining rock of varying sizes along the culvert walls or by placing rock clusters at culvert walls, may improve channel complexity. Lack of channel complexity has been observed in stream simulation designs (Barnard et al. 2015) even though design methods are intended to mimic channel complexity of the reference reach. Creating banklines along the culvert walls may improve channel form complexity and habitat.

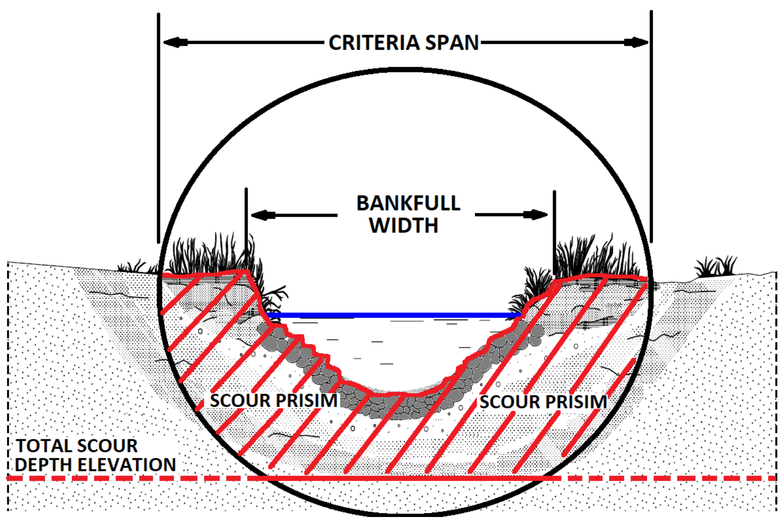
3.8.2.9 Simulated floodplain

Closed-bottom pipes less than 8 feet in diameter may pose challenges related to construction feasibility and long-term sustainability of a simulated floodplain. It is recommended that a simulated floodplain occupy no more than 30% of the criteria span.

Recommendations for the design of a simulated floodplain (i.e., bankfull bench) are still being developed. Forest Service Stream-Simulation Working Group (2008) states that sometimes a simulated floodplain can be constructed in a road crossing design but gives no detail on the design of such a structure. It has been shown via modeling (ESA Draft 2017) that there may be substantial benefits to the development of channel complexity and persistence of channel form and function through a road crossing when a pseudo floodplain is constructed. Barnard et al. (2015) observed a general lack of channel complexity in stream simulation designs even though mimicking the complexity and natural channel processes of the reference reach is a stated goal and intent of stream simulation design. Implementation of a simulated floodplain structure in road crossing designs may be critical to development and maintenance of long-term channel complexity and accompanying fluvial processes. Although no data supports any scale effects associated with construction of a simulated floodplain in closed pipes, it seems reasonable to be cautious of potential scale effects related to pipe size. Smaller pipes may reduce the potential benefits of constructing a simulated floodplain when compared to larger pipes. At some smaller pipe size simulated floodplains are not advisable. As the pipe diameter is reduced, pipe diameter and material sized to withstand a design flood may begin to converge on one another. This convergence may create channel stability issues or may functionally armor the crossing bed. Neither of these outcomes are desirable for fish passage.



(a) Scour prism in bottomless arch culvert (need modified image using "total" scour depth)



(b) Scour prism in elliptical culvert

Figure 3-1. Illustration of scour prism concept

3.9 Modifications to Stream Simulation Projects

Modification to stream simulation designs should be discussed with NMFS as part of the design process. Contact NMFS prior to consultation for project specific design input.

Stream simulation design was primarily developed for projects with a channel (1) that is alluvial, (2) possesses sediment transport characteristics which can replenish and maintain the simulated channel over the life expectancy of the road crossing, (3) can retain the average slope of the reference reach, and (4) the span of the crossing can incorporate the bankfull channel plus an appropriate degree of floodplain. On occasion geomorphic features such as the bankfull width cannot be confidently predicted by any means. This may occur at sites with:

- Moderately to heavily influenced by alluvial fans
- Backwater effects at confluences, estuaries, or impoundments
- Moderate to large natural breaks or discontinuities in stream channel slopes
- Channels with moderate to heavy bed or bank instability

Other conditions where stream simulation may not produce the intended results are identified by Barnard (2013) and Love and Bates (2009) and include the following:

- Projects exhibiting an extensive upstream wetland complex or pond
- Bedrock dominated systems or reaches
- Underfit channels: channel occupies a valley formed by glacial or fluvial processes far in excess of those present today
- Channelized or unnaturally confined systems or reaches
- Colluvial dominated systems or reaches
- Reference reach conditions predominately controlled by wood and debris
- Colluvial dominated systems or reaches

In these cases, modifying stream simulation design methods may be required. Design width of the crossing may need to exceed the stream simulation standard by some factor of safety, or a new width supported through hydraulic modeling. Boundary conditions for hydraulic models used to support modification of stream simulation design must adhere to the characteristics of stream simulation design outlined by Barnard (2013) below:

- Provide 100 year + flood conveyance with some freeboard
- Transport wood, debris, and sediment
- Similar sediment gradation and distribution as the reference reach
- Allow vertical adjustment of the streambed
- Provide bed mobility and stability
- Continuity of hydraulic conditions compared to the reference reach
- Mimic channel form, roughness, and gradient of reference reach
- Provide similar in-stream and margin habitat as the reference reach
- Ensure passage of fish and other aquatic organisms

3.10 Hydraulic Design Method

3.10.1 Description and Purpose

The Hydraulic Design Method is a design process that matches the hydraulic performance of a culvert with the swimming abilities of a target species and age class of fish. The Hydraulic Design method requires hydrologic data analysis; open channel flow hydraulic calculations; determinations of the high and low fish passage design flows, water velocity, and water depth; and information on the swimming ability and behavior of the target fish species and age classes.

The drawback of using the Hydraulic Design method is that it only targets the physiology of specific fish species and lacks the sediment transport and geomorphic processes critical to restoring and maintaining a healthy ecosystem. There are also significant errors associated with estimating hydrologic parameters and fish swimming speeds that should be resolved by making conservative assumptions during the design process.

3.10.2 Specific Criteria and Guidelines

The following subsections provide specific design criteria and guidelines for the Hydraulic Design method.

3.10.2.1 High fish passage design flow

The high design flow should be average daily flow exceeded 1% of the time during the time fish are expected to be present at the site. If flow duration data or methods necessary to compute the data are not available, then 50% of the 2-year flood recurrence interval flow may be used as an alternative.

3.10.2.2 Low fish passage design flow

For passage of adults, if flow duration data are available or can be synthesized, the average daily flow exceeded 50% of the time adults are expected to be present or 3 ft^3/s, whichever is greater, should be used as the low fish passage design flow. For juveniles, the 95% annual exceedance flow or 1 ft^3/s, whichever is greater, should be used.

The low design flow for fish passage is used to determine the minimum depth of water within a culvert. Hydraulic controls may be required to maintain depth at low flows.

3.10.2.3 Minimum water depth

Minimum water depth at the low fish passage design flow should be:

- *1 foot for adult steelhead and chinook, coho, and sockeye salmon;*
- *0.75 foot for pink and chum salmon; and*
- *0.5 foot for all species of juvenile salmonids as measured in the centerline of the culvert.*
- *The minimum depth within the culvert barrel should be calculated at fish passage design low flow.*

3.10.2.4 Maximum hydraulic drop

Hydraulic drops at, or adjacent to, the inlet, inside the culvert, or at the outlet do not provide good fish passage and should not be included in design.

3.10.2.5 Minimum culvert width

The minimum culvert width is 6 feet.

3.10.2.6 Minimum vertical clearance

The minimum vertical clearance between the culvert bed and the inside soffit of the culvert should be 6 feet.

This clearance provides access for debris removal. Smaller vertical clearances may work if a sufficient inspection and maintenance plan is provided with the design that ensures the culvert will be free of debris during the fish passage season.

3.10.2.7 Embedment

The bottom of the culvert should be buried into the streambed a minimum of 20% of the height of the culvert below the elevation of the tailwater control point downstream of the culvert, or 1 foot, whichever is greater.

3.10.2.8 Maximum culvert slope

Maximum slope should not exceed 0.5%.

3.10.2.9 Fish passage design velocity

Maximum velocity at the high fish passage design flow should be 1 ft/s.

3.11 Hydraulic Retrofit

3.11.1 Description and purpose

Culverts and bridges that impede passage may be temporarily enhanced through retrofitting efforts. Retrofitting is not a long-term passage solution, but it may be authorized for projects where passage barriers will not be removed or replaced in the immediate future. Fish passage may be improved using gradient control methods, baffles or weirs, and in some cases fish ladders. However, these retrofit actions are temporary and are not viewed as fish passage solutions that lead to the recovery of ESA-listed species.

3.11.2 Specific criteria and guidelines

The following subsections provide specific design criteria and guidelines for the Hydraulic Design Method.

3.11.2.1 Hydraulic controls

A change in water surface elevation of up to 1 foot through a culvert is acceptable for retrofitting culverts designed to pass adult salmonids, provided water depth and velocity in the *culvert meet other hydraulic guidelines. A jump pool at the culvert outlet should be provided that is at least 1.5 times the jump height, or a minimum of 2 feet deep, whichever is deeper.*

Hydraulic controls in the channel upstream and downstream of a culvert can be used to maintain a continuous low flow path through a culvert and stream reach. They can be used to facilitate fish passage by establishing the following desirable conditions: control depth and water velocity within a culvert, concentrate low flows, provide resting pools upstream and downstream of a culvert, and prevent erosion of bed and banks.

3.11.2.2 Backwatering

Retrofit designs maximize backwatering of the crossing invert to the maximum extent possible. If baffles are installed, the downstream hydraulic control should backwater the first two baffles at the culvert outlet at the low fish passage design flow.

3.11.2.3 Baffles

Baffles, and similar internal weirs, should only be considered when all other retrofit alternatives are deemed infeasible. This is because many baffle designs are untested for anadromous salmonid passage, and baffles reduce the hydraulic capacity of culverts and have the potential to accumulate debris. NMFS may agree to baffled culverts on a site-specific basis if compelling evidence of successful passage at other sites using a similar design is provided and a suitable monitoring and maintenance plan developed and followed.

Baffles may provide incremental fish passage improvement in culverts with excess hydraulic capacity that cannot be made passable by other means. However, baffles may also increase clogging and debris accumulation within the culvert and require special design considerations specific to the baffle type. Culverts that are too long or too high in gradient require resting pools or other forms of velocity refuge spaced at increments along the culvert length. Baffles should only be installed after approval by NMFS on a site-specific basis, and typically are only approved if the baffles will be used on an interim basis until a permanent passage solution is implemented. In addition, if baffles are installed, a suitable inspection and maintenance plan should be provided. For example, the plan could call for the baffles to be inspected prior to each passage season and after any flood event greater than a 2-year exceedance flow and subsequent debris removal after the inspection, if needed. The baffle design configuration should demonstrate that it can provide successful fish passage over the range of fish passage design flows. If an inspection and maintenance plan is implemented and fish passage standards are met, NMFS may approve the use of baffles in a permanent installation.

Retrofitting culverts can involve the following baffle alternatives and structure types. NMFS prefers to retrofit culverts using baffles or internal weirs over fishways.

Fishways (Chapter 5 in *NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual 2022*) are generally not recommended for retrofitting culverts, but they may be useful in limited situations. Fishways require a specialized site-specific design for each installation, for which NMFS should be contacted prior to ESA consultation.

3.12 Additional Design Criteria for Road Crossings

3.12.1 Specific criteria and guidelines

The following subsections provide the additional design criteria for road crossings.

3.12.2 Trash Racks and Livestock Fences

Trash racks and livestock fences should not be installed near culvert inlets because debris accumulations on the structures may severely restrict fish passage and potentially may injure fish.

Where fencing cannot be avoided, it should be removed during adult salmon upstream migration periods. Otherwise, a minimum of 9 inches of clear spacing between pickets should be provided up to the high flow water surface. Timely clearing of debris is also important, even if flow is getting around the fencing. Cattle fences that rise with increasing flow are highly recommended.

Where trash racks cannot be avoided, the rack should only be installed above the water surface level indicated by bankfull flow. Clear spacing between the vertical components of the trash rack should be a minimum of 9 inches. If trash racks are used, a long-term maintenance plan should be provided along with the design describing how the timely clearing of debris will be addressed.

3.12.3 Lighting

Natural or artificial supplemental lighting should be provided in new and replacement culverts that are more than 150 feet in length. Where supplemental lighting is provided, the spacing between light sources should not exceed 75 feet.

NMFS should be contacted if a culvert greater than 150 feet in length is under consideration for lighting.

3.12.4 In-Stream Work Windows

NMFS has established in-stream work windows for each watershed that correspond to times of the year when salmonid presence is minimized. Work in the active stream channel should be performed within the work window. Temporary crossings placed in salmonid streams for water diversion during construction activities should meet all the guidelines in this document. However, if it can be shown that the location of a temporary crossing in the stream network is not a fish passage concern at the time of the project, then the construction activity only needs to minimize erosion, sediment delivery, and impacts to surrounding riparian vegetation.

NMFS and state resource agencies establish instream work windows for major watersheds.

3.12.5 Installation

Crossings should only be installed when a site is de-watered and for which sediment control and flow routing plans have been developed, reviewed, and are agreed to by NMFS. Upon completion of construction the work area and riparian corridor should be fully restored with a mix of native locally adapted riparian vegetation. Use of species that grow extensive root networks quickly should be emphasized. Sterile non-native hybrids may be used for erosion control in the short term if planted in conjunction with native species.

3.12.6 Construction Disturbances

Disturbances to the installation site during construction should be minimized and the construction activity should not adversely impact fish migration or spawning. If salmon are likely to be present fish clearing or salvage operations should be conducted by qualified personnel prior to construction. If the fish are listed as threatened or endangered under the federal or state ESA NMFS should be consulted prior to initiating salvage operations. During salvage care should be taken to ensure fish are not chased under banks or logs that will be removed or dislocated by construction and stranded fish should be returned to a suitable location in a nearby stream by a method that does not require handling of the fish and as specified in the ESA take permit, if applicable. Construction disturbance to the riparian area should be minimized and the activity should not adversely impact fish migration or spawning.

3.12.7 Pumps

If pumps are used to temporarily divert a stream to facilitate construction a compliant fish screen should be used to prevent entrainment or impingement of small fish (Section 8.7 in NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual 2022).

3.12.8 Wastewater

Wastewater associated with project activities should be disposed of upland in a location that will not drain directly into any stream channel.

3.12.9 Other Hydraulic Considerations

Water surface elevations in the stream reach should exhibit gradual flow transitions both upstream and downstream of the road crossing. Abrupt changes in water surface and velocity should be avoided with no hydraulic jumps, turbulence, or drawdown at the entrance. A continuous low flow channel should be maintained throughout the stream reach.

3.12.10 Post-Construction Evaluation and Long-Term Maintenance and Assessment

A post-construction evaluation should be conducted to ensure the intended results of the design are accomplished and that mistakes are not repeated elsewhere. The post-construction evaluation consists of the following three elements:

1. *Verify the culvert is installed in accordance with proper design and construction procedures.*

2. *Measure hydraulic conditions to ensure these guidelines are met.*
3. *Perform a biological assessment to confirm the hydraulic conditions are resulting in successful fish passage.*

NMFS may assist in developing an evaluation plan to fit site-specific conditions and species. The goal of the evaluation plan is to generate feedback about techniques that are working well as well as those requiring future modification. The evaluations are not intended to cause extensive retrofits of a project unless the as-built installation does not conform to the design guidelines or an obvious fish passage problem persists. Over time, NMFS anticipates that the second and third elements of these evaluations will be abbreviated as clear trends in the data emerge.

All culverts should be inspected at least once annually over the life of the culvert to ensure proper functioning, any stream crossing failures or deficiencies discovered should be corrected promptly. A summary report of the inspection and corrections should be completed and submitted to the resource agencies. A less frequent reporting schedule may be agreed upon for proven stream crossings.

Any physical structure will continue to serve its intended use only if it is properly maintained. During the storm season timely inspection and removal of debris is necessary for culverts to continue to move water, fish, sediment, and debris.

4 Grade Control

In the context of this document's sole focus on fish passage designs, Grade Control are structures that control the grade and longitudinal profile of rivers, streams, and other engineered channels, which must also provide passage routes for fish. This chapter describes some of the design challenges and associated variables relevant to each type of Grade Control project and its ability to pass fish. It also seeks to provide insights into critical variables and potential solutions to some of the challenges they pose to fish passage.

In addition to providing fish passage, any Grade Control design should include consideration for maintaining the ecological function of the stream, passing woody debris, flood flows and sediment, scour potential, and other species present at the site. The design team should collaborate with biologists and engineers familiar with the site to assess potential effects on species and life stages present and site geomorphology.

The criteria and guidelines presented in this chapter are general in nature. There may be cases where site constraints or unusual circumstances dictate a modification to one or more of these design elements. Also, where there is an opportunity to protect salmonids, additional site-specific criteria may be appropriate. Deviations from this criteria will be considered by NMFS on a project-specific basis. It is the responsibility of the applicant to formally request and provide compelling evidence in support of any modification of a guideline or criterion contained in this chapter. Requests should be submitted for approval early in the design process, well in advance of a proposed ESA consultation.

4.1 Introduction

Grade Control structures in rivers and streams often span the entire channel. They can be used for road crossings; reach restoration after dam removal, improving habitat; and modifications to water diversion structures. They are designed to pass the stream's full hydrograph, sediment load, and debris through the structure. Often, the goal of design should be to reconnect the channel to its floodplain and simulate natural channel geomorphology, roughness, and vegetation objectives.

This chapter discusses four types of Grade Control:

- Constructed Channel
- Rigid weirs
- Boulder weirs
- Channel-spanning fish ladders

An extensive literature search was conducted to identify studies which could inform regulatory guidance on Grade Control as a fishway structure. However, very few studies were found which informed the topics covered in this chapter. This chapter covers design elements that NMFS feels are critical to the success of Grade Control projects used to pass fish, yet are not well represented within the current body of literature directly. Some material presented in this chapter is derived from NMFS experience, for which there are no direct references. This chapter should not be viewed or applied as a standalone set of instructions for engineering Grade Control for fish passage projects; such application is beyond the scope of this document. Rather, a user should consult one of the referenced design manuals and ensure specific design elements are consistent with the requirements of this chapter.

4.2 Specific Design Guidelines

Key considerations in the design and implementation of individual types of Grade Control projects are provided in Section 4.2.

4.2.1 Constructed Channels

Designers should select engineering methods for Constructed Channels that have a track record of success at a similar scale, and within similar geomorphic conditions, as the proposed design. Prior to selecting a Constructed Channel design approach for your project, contact NMFS to discuss how potential structure instability may affect ESA consultation of the project.

NMFS is using the term Constructed Channel to describe a large group of designs which go by different industry names. Constructed Channels cover structures termed as nature-like fishways, engineered riffles, roughened channel, and rock ramps, to name a few.

Constructed Channels are designed to mimic or simulate, to varying degrees, the hydraulic conditions by replicating the geomorphic form and complexity of natural channels. They may be used to facilitate the passage of a wide assemblage of fish and other aquatic species over a wide range of flows.

NMFS does not recommend strictly replicating local natural bed and bank material as the means of providing structure stability, especially in over steepened channels. Balancing the structural stability and geomorphic form of Constructed Channels is a complex engineering task. The goal is to ensure that the design provides adequate fish passage conditions, through hydraulic complexity and long-term stability of hydraulic conditions over the life of the project. It is critical for designers to select engineering methods that have a track record of success at the same scale—and within the same geomorphic conditions—as the proposed design. It has been observed that successful projects developed for small streams, do not always produce that same results at larger scales. The effect of scale on project success has been documented in different types of in-stream structures (Frissell and Nawa 1992).

A few points related to structure stability and project failure of Constructed Channels are worth discussion. Project failure is defined as the inability of the structure to meet the stated passage goals or expectations. Structure stability is defined as the ability of the structure to maintain its form over time. From a fish passage perspective, within the class of Constructed Channel designs, structure instability is not always associated with project failure. When other civil works are adjacent or associated with a Constructed Channel, such as a bridge apron, irrigation dam, culvert, or pipes (e.g., gas, sewer, or water) structure instability can be directly correlated (i.e., structure instability leads to project failure). In projects where there are no civil works within the hydraulic influence of the Constructed Channel, structure instability may not be directly correlated with project failure (i.e., structure instability has no adverse effect on passage conditions).

Additional information on Constructed Channels is available in the following publications: Newbury and Gaboury (1993), Mooney et al. (2007), Love and Bates (2009), Barnard et al. (2013), U.S. Bureau of Reclamation (BOR) and USACE (2015), BOR (2016), Castro and Beavers (2016), and Newbury (2016).

4.2.1.1 Design slope

NMFS recommends the design slope be restricted to no more than 4% greater than the average slope of the upstream and downstream reaches. For example, where the average slope of the upstream and downstream reach is 4%, the maximum design slope is 8% (4% + 4% = 8%). The design slope is the overall slope of the proposed section of the channel and not the discrete ramps, riffles or cascades segments within the project.

Design slopes more than 4% greater than the average slope of the project reach may experience structure instability. According to Castro and Beavers (2016), large discontinuities in slope may prevent desired hydraulic conditions of a Constructed Channel from being maintained throughout the life of the structure. These instabilities occur for a wide range of reasons. Improper installation of rock, inadequate rock size or distribution of rock sizes, lack of adequate hydraulic roughness, and insufficient energy dissipation throughout the structure, to name a few.

Structure instability can, although not always, cause fish passage to be blocked or delayed. Risk of creating a fish passage barrier is reduced as the slope of the Constructed Channel more closely resembles the project reach averaged slope. Calculating the average slope of both the upstream and downstream reaches should capture enough of the natural channel profile to provide a reliable baseline for calculating the natural slope of the project reach. Upstream and downstream surveys should capture a minimum length of channel equal to the length of the project. For example, if the project length is 100-feet, the survey should extend 100-feet upstream and 100-feet downstream of the project. Calculating the slopes of the natural channel should be done separately for the upstream and downstream reaches and considered individually, not as a composite value.

4.2.2 Rigid Weirs

Rigid weirs have the advantage of being able to remain in place over long periods while maintaining environmentally sensitive or specific hydraulic conditions. Rigid weirs, which are static, non-deformable structures, can be constructed from concrete, logs, or sheet pile material (Barnard et al. 2013). Due to corrosion and decomposition, rigid weirs made of wood and steel may fail over time.

4.2.2.1 Footing embedment

Designers should show that embedment of footings is placed deep enough to resist scour failure over the life span of the project by providing the hydraulic analysis performed to determine the placement depth.

Rigid weirs commonly fail when weir embedment is insufficient to resist scour. Weirs designed for larger systems with greater hydraulic energy may require additional embedment to maintain structural integrity of the design. Factors of safety applied to scour calculations should be identified with supporting justification.

4.2.2.2 Crest shape

Weir crests should be sloped across the width of the weir to produce a shallow "V" shaped crest that focuses flow toward the middle of the channel and away from banks. The side slope should be no steeper than 5H:1V.

The shape of the crest can aggravate upstream backwater effects and downstream scour of the bed and banks. Straight crested weir should be avoided as they increase the wetted width of the channel and induce erosion and scour of the banks. Weirs that are v-shaped, with sloped sides focus flow and reduce erosion and scour along the banks and margins of the channel. Side slopes exceeding 5H:1V may initiate excessive scour of the bed and banks. In relatively large channels, side slopes should be less than 5H:1V (Love and Bates 2009).

4.2.2.3 Concentrating low flows

In streams with base flows that routinely are less than 10 ft^3/s, weirs and notches should be sized to provide a concentrated, plunging flow of at least 1 ft^3/s.

Low-flow conditions require additional considerations when designing the geometry and function of a low-flow notch. To ensure adequate water depth at the lowest flows, the notch is sized and shaped to create a plunging flow regime at 1 ft^3/s. For projects where additional flow concentration is beneficial or required, the entire notch may be designed as a V-notch or the design could incorporate V-shaped geometry.

4.2.2.4 Weir spacing

Weir spacing may vary according to the erodibility of the bed and banks. As erosion and scour risk increase weirs are placed farther apart. Weir spacing is typically a function of the bankfull width. Common widths range between 0.5 and 2 times the bankfull width (Love and Bates 2009) (Barnard 2013). Weirs should be spaced a sufficient distance apart to maintain sediment presence along the upstream face of each individual weir. Spacing and associated project roughness should provide adequate resting and holding areas for migrating fish. Resting areas are designed as locations where the stream velocity is 2fps or less at the high fish passage flow.

Correct weir spacing is closely associated with site topography, channel and bed composition, and project passage goals. Please contact NMFS to discuss project specific weir spacing.

4.2.3 Boulder Weirs

Boulder weirs are low-elevation structures that span the entire width of a channel. They are designed to develop an abrupt drop in channel bed and water surface elevation and are used to stabilize stream grade, improve fish passage, and reduce erosion. Boulder weirs have been used to simulate natural, step-type drop structures in streams.

4.2.3.1 Design approach

Boulder weirs should be designed using guidance provided in Chapter 7 of BOR (2016). Boulder weirs are most appropriately used in systems with a step-pool morphology where the bed and banks of the stream channel are naturally armored. At a minimum, boulder weir designs require two rows of header rock and footer rock. Headers and footers are backfilled with scour-resistant rock along the upstream face of the headers and downstream face of the footers. The boulder weir structure as a whole should be constructed to be non-porous using material that is well graded which easily entrains the natural bedload transported in the channel.

Traditional boulder weir designs typically consist of two rows of rock: one header row and one footer row (Rosgen 1996). However, this design is highly prone to failure (Mooney et al. 2007) and is not recommended for use where sustaining specific streambed or water surface elevation is critical (Barnard et al. 2013). Drop heights mandated by hydraulic fish passage criteria more commonly govern this design approach than do natural geomorphic relationships. The traditional method of designing boulder weirs lacks sufficient consideration of geomorphic context.

The BOR (2016) boulder weir design approach was developed over the last decade and was informed through extensive monitoring of hundreds of project sites and hydraulic modeling.

The BOR design approach eliminates many of the failure modes routinely observed in traditional boulder weir designs.

4.2.4 Channel-Spanning Fish Ladders

Channel-spanning fish ladders are applications of more traditional fishway designs through which all streamflow and debris pass. Applications include retrofit designs, which are most commonly found at culverts and occasionally at bridges, control of large headcuts, and grade control associated with other channel instabilities. This class of grade control requires additional monitoring and maintenance challenges compared to traditional fish ladder applications. A channel spanning ladder may not be the appropriate fish passage approach in situations where large volumes of bed load or debris are transported through the project reach. The presence of sediment and debris may degrade the performance of the fishway for fish passage.

4.2.4.1 Fishway type

Due to the hydraulics of pool-and-chute designs they may perform better than other fish ladder types for channel spanning applications where passing bedload is and debris is required. Vertical-slot fishways, Ice Harbor-style fishways, Denils, and pool-and-weir designs are not recommended for channel-spanning applications due to the adverse effect entrained debris and sediment have on passage conditions.

Additional information regarding pool-and-chute fishway design can be found in Chapter 5 in *NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual 2022*.

4.2.4.2 Fishway width

Minimum fishway width for a channel-spanning technical fishway should be the bankfull width of the stream channel. NMFS should be contacted for project-specific recommendations.

Narrowing or widening the channel upstream of the fishway may cause adverse hydraulic effects in the fishway due to constriction and expansion. Either of these conditions should be avoided. Flow lines at the fishway exit should be as hydraulically smooth as possible.

4.2.4.3 Project gradient

Channel-spanning fish ladders are best suited for sites where project gradients exceed 5%.

Lower gradients increase the risk of sediment accumulating and impacting fish passage conditions and are better suited for Constructed Channels or rigid weirs, which do not depend on maintaining sediment-free pools to successfully pass fish.

4.2.4.4 Hydraulic criteria

All associated hydraulic criteria for fish ladder design contained in Chapter 5 in NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual 2022, should be met. NMFS should be contacted when modification of criteria is proposed.

4.3 General Design Guidelines

Key considerations in the design and implementation of all Grade Control structures required to pass fish are provided in Section 4.3.

4.3.1 Hydraulic Diversity

All Grade Control projects should be designed to mimic the hydraulic diversity found in natural channels.

Fish passage at a Grade Control structure is partially a function of hydraulic diversity. Grade Control structures that exhibit homogenous (i.e., uniform) hydraulics may limit passage compared to more hydraulically diverse structures. Smaller and weaker fish species may be able to pass in the shallower, lower velocity water found at the margins of a properly tapered Grade Control structure. Wilcox and Wohl (2007) found that due to three-dimensional flow patterns in step-pool channels approximately 35% of the flow in not oriented in the downstream direction, hence fish, especially smaller weaker individual, may use complex flow patterns found along hydraulically diverse banklines to assist their upstream migration. Figure 4-1 demonstrates how hydraulic diversity may be effectively incorporated into a Grade Control design using the following features:

- A rigid weir that incorporates large rock and wood to provide hydraulic diversity
- Concrete weirs that are spaced close together and function as sediment retaining structures while providing pool habitat at low flows
- Large roughness elements (i.e., large wood and rock elements) to provide the energy dissipation and velocity reduction necessary for passage at higher flows and retain and sort sediment in depositional zones throughout the structure

Figure 4-1. Example of hydraulic diversity in a Grade Control project

4.3.2 Geomorphic Assessment

All project designs should include appropriately scoped geomorphic assessments at the watershed scale, reach scale, and project site. The assessments should consider the geology, hydrology, morphology, sediment transport, vegetation, and potential for channel adjustment.

Conducting appropriate geomorphic assessments is the most critical aspect of designing successful Grade Control project. These assessments are used to determine a suitable design method and the scale and scope of its implementation. Each assessment should be commensurate with the relative risk of structural or biological failure of the project. Table 4-1 provides a sampling of geomorphic information and data collected for these assessments.

Table 4-1. Geomorphic Assessment

Category	Type of Data
Basic Characteristics	• Current and future climate conditions • Land use and development
Hydrology	• Ephemeral, intermittent, or perennial hydrology • Stream gage summary • Flood frequency analysis • Historical changes and potential future changes in streamflow • Peak flow response to land use changes.
Morphology	• Channel classification • Morphologic dimensions of planform, floodplain, and channel • Long profile • Channel migration zone • Bed and bank adjustment potential • Channel adjustment potential • Presence/absence of armor layers • Erosion/depositional features • Lateral and vertical channel floodplain and channel constraints • Channel evolution phase and trajectory • Dynamic equilibrium • Long profile stability • Historical channel changes/instability • Bank angle, height, layering, material size, sorting, cohesiveness, tension cracks, slumping, bare banks, and root exposure
Sediment Transport	• Sediment inputs/origins • Bed material: size, uniformity, packing, and sand fraction • Sediment transport characteristics • Sediment slug material and dimensions • Predicted sediment pulse characteristics
Vegetation	• Riparian composition and condition • Wood debris characteristics: maturity, species, collection points, form, and function

Geomorphic assessments should be properly scoped, focusing on the watershed and reach scales and project site under consideration. For instance, smaller, low-energy streams in confined and moderately confined channels possessing a highly armored bed and banks may not benefit from extensive geomorphic assessments. Whereas other projects may require more extensive assessments—regardless of stream size—because they release stored sediments, require connecting to floodplains, have incised channels, lack an armored bed and banks, possess highly migratory or response-driven channels, or are characterized as being unstable.

4.3.3 Fish Passage Design Flows

Design flows for grade control structures are determined using the process found in Chapter 4 of NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual 2022.

Designers should diligently investigate any and all flows that might destabilize the structure. The assumption that that 100-year flood event is the destabilizing flow may be false. Hydraulic jump or instabilities which may fail the structure can occur at flows substantially less than the 100-year flood event. Flows where hydraulic jumps and drops occur may produce more destabilizing forces than the 100-year flood event. Destabilizing hydraulic conditions can also become barriers to fish passage. Hydrologic and hydraulic analyses should be comprehensive enough to identify all potential critical flows essential to stability over its intended life span.

4.3.4 Structural Rock Placement and Spacing

The location, orientation, and spacing of the largest structural elements in a Grade Control project are critical to the structural stability and should be called out in exact detail in engineering and construction documents.

Intentionally placing structural rock, compared to dumping, may significantly improve its stability to resist hydraulic forces (Jafarnejad et al. 2014; Hiller et al. 2018a). This highlights the increased stability that Grade Control designs can achieve if structural rock locations, orientation, and spacing are calculated, specified, and implemented according to the design, compared to being randomly dumped or placed. Purposeful placement requires that greater detail and quality control procedures be identified in project specification documents

4.3.5 Particle Size Distribution of Engineered Streambed Material

Particle size distribution of engineered bed and bank material should be well-graded up to the D84 size class.

NMFS experience has shown that the particle size distribution is a critical component of Grade Control project stability and porosity. Failure to design a well-graded mix of engineered bed and bank material may lead to an unacceptable degree of structure deformation, which can result in a channel avulsion or flanking through the scour and displacement of larger structural rock.

4.3.6 Channel Form and Function

Designers should provide a detailed description of how the form and function of the Grade Control project will change over time. The description should explain the strategies that will be incorporated into the design and maintenance of the Grade Control project that can mitigate these changes over time, without adversely affecting fish passage or critical stream processes. This explanation should include the long-term effects that bed load movement and sediment transport will have on channel stability, porosity, and evolution at the project and reach scales.

Grade Control projects inevitably adjust over time, regardless of the design approach used. Some Grade Control projects are designed as threshold channels, where the movement of the boundary material is negligible during the design flow (NRCS 2007). Even when considerable factors of safety are used, significant bed and bank adjustment with Grade Control projects occurs after construction. NMFS recommends using design methods that increase the number of components within the design to enhance channel stability and form, rather than relying solely on conservative rock sizing to increase channel stability.

4.3.7 Channel Roughness

This criterion applies to Constructed Channels, Rigid Weirs, and Boulder Weirs. Designers should provide NMFS with detailed specifications showing how passage roughness will be physically represented in the design. Passage roughness consists of individual elements (such as rock or wood elements) that project into the water column 0.5 to 1.0 times the bankfull depth at the bankfull discharge. NMFS recommends an area of at least 30% of bankfull wetted channel be occupied by this size of roughness element.

Modeling requires the use of roughness values to estimate the effects of boundary roughness on water depth and velocity in channel design. NMFS has observed there can be large discrepancies between modeled roughness values and the actual roughness physical expressed in the design post-construction. These discrepancies are typical expressed as higher velocities, increased turbulence, unanticipated scour and erosion, and a fewer holding and resting areas than were expected. Individually and in aggregate these issues can adversely affect fish passage. It is expected that documentation of the methods, assumptions, and specifications used to detail and explain the roughness design process will result in fewer projects failing to meet passage requirements.

Channel roughness providing the bulk of fish passage benefits are best described and specified comparing the size of the elements to the depth of water at the high fish passage design flow. Large roughness elements will possess an exposed dimension above the thalweg that is analogous to the high fish passage design depth. Meaning once stable, the element should have a portion exposed to the air, or nearly exposed, at the high fish passage design flow. This relationship between water depth and roughness size is critical to providing the necessary energy dissipation and velocity reduction for fish to rest and move in higher gradient channels. Channels with low relative roughness (uniformly sized bed and bank material), are characterized as hydraulically smooth. Hydraulically smooth channels at high gradients provide little to no resting or holding areas for fish. Hydraulically smooth channels commonly fail to meet fish passage velocity criteria.

This criterion was developed based on the relationship between natural D84 and D90 class material and bankfull depth for streams in Washington State with slopes greater than 2% (Barnard et al. 2013). Barnard et al. measured stream discharge and bed roughness, observing that the rock providing the bulk of velocity reduction and hydraulic diversity were those elements which had a dimension analogous to the bankfull depth of the channel. Over a diverse range of project sizes, NMFS has also observed that velocity conditions are most often passable when somewhere in the range of 20%-40% of the project surface area is occupied by roughness elements extending significantly into the water column at the bankfull discharge.

4.3.8 Maximum average channel velocity

This criterion applies to Constructed Channels, Rigid Weirs, and Boulder Weirs. Maximum average channel velocity at the high fish passage flow should be no greater than 5 ft/s, *regardless of channel slope. The relationship between channel roughness and channel slope should be carefully engineered to ensure this criterion is not exceeded. Channel Spanning Fish Ladders maintain specific ladder velocity outlined in NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual.*

Barnard et al. (2013) indicates that at the 10% exceedance flow, high gradient streams in Washington State exhibit similar average channel velocities, regardless of channel slope, in the range of 4 ft/s. The velocity criterion in the section is presented to help designers express a more realistic relationship between channel slope and roughness in nature-like fishway designs. When channel slope and roughness have the proper relationship to maintain a 5 ft/s average channel velocity at the 5% exceedance flow, energy dissipation and turbulence are much more likely to be within the range observed in natural high gradient streams of similar slope and roughness. This criterion also simplifies and improves design and monitoring by providing a simple value to compare against hydraulic models and field measurements. An in-depth discussion on turbulence in higher gradient natural channels in contained in CH 6 of Barnard et al. (2013).

The origin of the 4ft/s criterion used the 10% exceedance flow to back calculate the energy dissipation factor (EDF) in high gradient natural channels in Washington (Barnard et al. 2013). When using a 5% exceedance flow it seems reasonable to increase the maximum average channel velocity to 5 ft/s. When using a 1% exceedance flow, it seems reasonable to use a maximum average channel velocity of 6 ft/s. These assumptions are supported by data from Castro and Jackson (2001) which indicates the average bankfull channel velocity in the Pacific Northwest can be well represented as an average of 6 ft/s. Work by Love and Lang (2014) reported that annual exceedance values associated with a discharge equal to 50% of the 2-year return interval ranged between 0.2% and 1.8%. Together these data indicate that annual exceedance flows between 10% and 1% exceedance are likely well represented by a range of average channel velocities between 4ft/s and 6ft/s.

4.3.9 Energy Dissipation

Energy dissipation structures or measures should be incorporated into the design at intervals that will ensure the average channel velocity remains no greater than 5 fps at the 5% exceedance flow, throughout the length of the project.

Channel roughness alone may not provide the energy dissipation needed to ensure velocity criteria are met. Energy dissipation pools may be needed to provide passage and improve structure stability and longevity. Pools can enhance fish passage by continuing to provide holding and resting areas for fish at flows higher than the fish passage design flow. Energy dissipation pools can also reduce destabilizing hydraulic forces acting on the structure. Bates (2009) recommend an energy dissipation pool for every 3 feet of vertical channel displacement. The minimum length of energy dissipation pools typically ranges between 1 to 1.5 times the bankfull width. Roughness element size appropriate for fish passage and energy dissipation is covered in section 4.3.7. NMFS will consider other pool geometries and pool frequency criterion if those methods can be supported by project specific or hydraulic modeling examples..

4.3.10 Bank Transitions

The natural channel and the fish passage design should exhibit gradual hydraulic transition of flow characteristics moving into (fish exit) and out of (fish entrance) the fishway. Designs should taper the upstream banks at the exit so there is a gradual hydraulic transition into the Grade Control project reach from the channel upstream. The transition area should also be armored so that the upstream channel does not outflank the fishway. The geomorphic assessment is critical in developing the scope and scale of flanking countermeasures.

Projects with significant channel confinement and skew have exhibited unintended and unmitigated scour, which has led to structural failure and passage barriers. These conditions may result in structural failure and development of a passage barrier. The presence of abutments, aprons, weirs, and other in-stream or adjacent structures that may affect near-field hydraulic drops and jumps should be modeled to determine an appropriate design approach for promoting smooth hydraulic transitions at the exit and entrance of the Grade Control project.

4.3.11 Slope Transitions

In situations where a channel-spanning fish ladder or rigid weirs are used, the three most upstream weirs (located at the fishway exit) should be set to gradually transition the slope of the water surface into the fishway exit. This is accomplished by limiting the vertical drop to no more than 3 to 4 inches between each.

Where discrete hydraulic drops are absent (i.e., riffles, cascades, or chutes) the upstream transition section begins at the uppermost end (exit) of the fishway. The length of the transition section extends upstream 1.5 times the bankfull width. The average slope of this section is half the design slope. For example, where the design slope is 4%, the average slope of the upstream transition section is 2%.

The purpose of this criteria is to promote a gradual hydraulic transition between the natural channel and the project reach. Abrupt changes in hydraulic conditions at these transition points has been observed to promote unintended scour which can result in development of a passage barrier. NMFS will consider other mitigation measures as meeting this criterion if those measures can be supported by project specific or hydraulic modeling examples.

4.3.12 Quality Control

Quality control methods for ensuring correct material, volume, condition, size, location, and distribution of rock and wood material used in Grade Control designs should be submitted with project plans and specifications to NMFS for review and comment.

NMFS has observed that the size, quantity, and quality of rock and wood material incorporated into Grade Control structures significantly affects the ability of the project to meet fish passage goals and criteria. A common observation when projects fail to achieve fish passage standards is that quality control during construction was not implemented, or the methods were poorly executed. This commonly results in a gap grade streambed or an inadequately engineered bed that is mobile at flows much less than designed for. The 12 inch minus fraction of rock has been seen to move with great mobility at flows much lower than anticipated when projects are gap graded between 12 inch and 24 inch class material. Quality control efforts should include ensuring the fraction of the engineered bed material between 18-24 inches are in the correct quantities and meet the specified size. This 18-24inch fraction of material seems to be critical to locking in the smaller fractions of the design particle distribution. Construction methods also play a role in project success. Project success also seems to be positively correlated to having an engineer on sight during installation of the project.

4.3.13 Washing and Sealing Bed and Banks

Engineered bed and bank material should be sealed during construction by washing, or flooding. NMFS engineers have observed that installing bed and bank material simultaneously with copious amounts of water seems to produce a better seal than periodically introducing water to the bed and banks at discrete points in the installation process. Sealing must prevent loss of surface flow in completed projects.

A sufficient flow of water through the Grade Control project should be provided to accumulate and compact fine sediments into any voids (i.e., flooding, washing). Sealing bed and bank material is critical for maintaining low-flow fish passage conditions; it should be conducted simultaneously with the bed and bank installation. Washing should be frequent, preferably continuous, throughout construction of the bed and banks.

Observation of Grade Control construction, and discussions with contractors installing Grade Control structures, indicates the term "jetting" has several connotations which introduce increased risk of a project bed failing to be sealed properly. Jetting seems to connotate that the force of water used which is the primary desirable water characteristic when sealing a bed. This can lead to the understanding that the project needs a high-pressure hose and less thought or concern about the amount of water a project will require. A high-pressure wash of engineered streambed material provides no guarantee the streambed will seal properly. Water velocity is not a substitute for water volume when sealing beds and banks properly. Turbid runoff should be treated to meet regional water quality standards before re-entering the channel downstream if necessary.

Periodic observations should be made to determine if bed and bank material is sealing properly during placement. Sections of channel that are not sealed should be brought into compliance by one or more of the following methods.

- Application of additional selected streambed gravel and washing
- Mechanical agitation using approved methods
- Removal and replacement of engineered bed and bank material

Projects that lose surface water as a result of an inadequately sealed bed run the risk of having to excavate significant portions of the project bed to properly seal the bed. Natural bed load transport of the stream and time may never fix conditions leading to subsurface water losses. Assuming the channel will repair itself is a faulty conclusion.

4.3.14 Maintenance and Monitoring

A NMFS-approved maintenance and monitoring plan is recommended. It should contain adaptive management triggers and measures that address how morphology and passage hydraulics will be monitored and modified if necessary. Monitoring should be conducted after the first bankfull event after construction. Additional monitoring should occur at the next 5-year flow event. If passage is achieved as designed at these first two events, future monitoring should occur following 10-year, 25-year, and 50-year events.

The following components should be included in the maintenance and monitoring plan:

- Fish Passage Assessment – Depending on project-specific considerations, monitoring may include an assessment of passage efficiency via NMFS-approved means of biological evaluation. This monitoring requirement is specific to each project and will be identified by NMFS on a project-specific basis.
- Channel Velocity – Channel velocity will be verified through monitoring. When average channel velocity exceeds velocity criteria, NMFS will evaluate the passage conditions of the fishway. Repairs or adaptive management actions, if warranted, will be identified by NMFS and carried out by the maintaining entity.

Due to the diversity of Grade Control designs and the variable nature of channel roughness, monitoring requirements are specific to each project and will be identified by NMFS on a project-specific basis. Repairs, if warranted, will be identified by NMFS and designed and carried out by the maintaining entity.

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Refer to NMFS No.:
NWR-2013-10221

December 3, 2013

Paul Henson, State Supervisor
U.S. Fish and Wildlife Service
Oregon State Office
2600 SE 98th Avenue, Suite 100
Portland, Oregon 97266

Kate Benkert, Deputy Manager
U.S. Fish and Wildlife Service
Oregon State Office
2600 S.E. 98th Ave, Ste 100
Portland, Oregon 97266

Jennifer A. Steger, Northwest & Alaska Regional Supervisor
NOAA Restoration Center
7600 Sandpoint Way NE
Seattle, Washington 98115-6349

Re: Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) by the U.S. Fish and Wildlife Service Using the Partners for Fish and Wildlife, Fisheries, Coastal, and Recovery Programs and NOAA Restoration Center Using the Damage Assessment, Remediation and Restoration Program (DARRP), and Community-Based Restoration Program (CRP) in the States of Oregon, Washington, and Idaho

Dear Mr. Henson, Ms. Benkert and Ms. Steger:

The enclosed document contains a joint programmatic conference and biological opinion (opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7(a) (2) of the Endangered Species Act (ESA) on consultation on the effects of implementing aquatic restoration actions proposed to be funded or carried out by the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration Restoration Center (NOAA RC) in the States of Oregon, Washington, and Idaho.

USFWS funds or carries out projects under the Partners for Fish and Wildlife, Fisheries, Coastal, and Recovery programs. These actions fulfill natural resource responsibilities assigned to USFWS under the Fish and Wildlife Coordination Act, Endangered Species Act, and the Partners for Fish and Wildlife Act. NOAA RC funds or carries out projects under the Damage Assessment, Remediation and Restoration Program and the Community Based Restoration Program under the auspices of the Clean Water Act, the Superfund Act, the Oil Pollution Act of 1990, the National Marine Sanctuaries Act, and the Fish and Wildlife Coordination Act.

Actions covered in this opinion, which will occur in Oregon, Washington, and Idaho, combine and modify actions described in programmatic biological opinions previously issued to USFWS and to NOAA RC, as summarized in the consultation history section of the opinion.

During this consultation, NMFS concluded that the proposed action is not likely to adversely affect southern distinct population segment (DPS) green sturgeon *(Acipenser medirostris)*, and southern resident killer whales *(Orcinus orca),* and their designated critical habitat. NMFS also concluded that the proposed action is not likely to adversely affect the Puget Sound/Georgia Basin DPSs of yelloweye rockfish (*Sebastes ruberrimus*), canary rockfish (*Sebastes pinniger*), and bocaccio rockfish (*Sebastes paucispinis*) (and their critical habitat where it has been designated).

NMFS also concluded that the proposed action is not likely to jeopardize the continued existence of the following 20 species, or result in the destruction or adverse modification of their designated or proposed critical habitats (critical habitat for LCR coho salmon has been proposed, but not yet designated). However, NMFS' conclusion for LCR coho salmon critical habitat will not be effective until that designation is final and NMFS has adopted the conference opinion.

1. Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*)
2. Upper Willamette River (UWR) spring-run Chinook salmon
3. Upper Columbia River (UCR) spring-run Chinook salmon
4. Snake River (SR) spring/summer-run Chinook salmon
5. SR fall-run Chinook salmon
6. Puget Sound (PS) Chinook salmon
7. Columbia River chum salmon (*O. keta*)
8. Hood Canal chum salmon
9. LCR coho salmon (*O. kisutch*)
10. Oregon Coast (OC) coho salmon
11. Southern Oregon/Northern California Coasts (SONCC) coho salmon
12. Lake Ozette sockeye salmon (*O. nerka*)
13. SR sockeye salmon
14. LCR steelhead (*O. mykiss*)
15. UWR steelhead
16. Middle Columbia River (MCR) steelhead
17. UCR steelhead
18. Snake River Basin (SRB) steelhead
19. PS steelhead
20. Southern distinct population segment eulachon *(Thaleichthys pacificus*).

As required by section 7 of the ESA, NMFS is providing an incidental take statement (ITS) with the opinion. The ITS describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this program. The ITS also sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal action agency must comply with to carry out the reasonable and prudent measures.

Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of the listed species considered in this opinion, except eulachon because NMFS has not yet promulgated an ESA section 4(d) rule prohibiting take of threatened eulachon. However, anticipating that such a rule may be issued in the future, we have included terms and conditions to minimize take of eulachon. These terms and conditions are identical to the terms and conditions required to minimize take of listed salmon and steelhead. Therefore, we expect the USFWS and NOAA RC will follow these terms and conditions regardless of whether take of eulachon is prohibited. The take exemption for eulachon will take effect on the effective date of any future 4(d) rule prohibiting take of eulachon.

This document also includes the results of our analysis of the program's likely effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes three conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. Section 305(b)(4)(B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations.

If the response is inconsistent with the recommendations, the action agency must explain why the recommendations will not be followed, including the justification for any disagreements over the effects of the action and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the agency. Therefore, we request that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

If you have any questions regarding this opinion, please contact Clayton Hawkes in the Interior Columbia Basin Office at 503-230-5406.

Sincerely,

William W. Stelle, Jr.
Regional Administrator

cc: Megan Callahan-Grant, PNWRC
Dennis Mackey, USFWS
CalLee Davenport, USFWS
Rich Carlson, USFWS
Kathleen Hendricks, USFWS

bcc: F/NWR – CHRON File
F/NWR4 – File copy; J. Fisher (electronic pdf), K. Kratz (electronic pdf), M. Tehan (electronic pdf), M. Liverman (electronic pdf), J. Lockwood (electronic pdf), K. Phippen (electronic pdf), N. Munn (electronic pdf), D. Bambrick (electronic pdf)

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File No.: 0055-HCO2013

addressee(s) email:

Jennifer Steger
jennifer.steger@noaa.gov

Paul Henson
Paul_Henson@fws.gov

Kate Benkert
Kate_Benkert@fws.gov

Dennis Mackey
Dennis_Mackey@fws.gov

cc(s) email:

Megan Callahan-Grant
megan.callahan-grant@noaa.gov

CalLee Davenport
CalLee_Davenport@fws.gov

Rich Carlson
rich_carlson@fws.gov

Kathleen Hendricks
kathleen_hendricks@fws.gov

Endangered Species Act - Section 7 Programmatic Conference and Biological Opinion
and
Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

for

Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services
(PROJECTS)
by the
U.S. Fish and Wildlife Service
Using the Partners for Fish and Wildlife, Fisheries,
Coastal, and Recovery Programs
and
NOAA Restoration Center
Using the Damage Assessment, Remediation and Restoration Program (DARRP), and
Community-Based Restoration Program (CRP)
in
the States of Oregon, Washington, and Idaho

NMFS Consultation Number: NWR-2013-10221

Federal Action Agencies: U.S. Fish and Wildlife Service
Oregon, Washington, and Idaho State Offices

National Marine Fisheries Service,
NOAA Restoration Center

Affected Species and Determinations:

ESA-Listed Species	**ESA Status**	**Is the action likely to adversely affect this species or its critical habitat?**	**Is the action likely to jeopardize this species?**	**Is the action likely to destroy or adversely modify critical habitat for this species?**
Lower Columbia River Chinook salmon	T	Yes	No	No
Upper Willamette River Chinook salmon	T	Yes	No	No
Upper Columbia River spring-run Chinook salmon	E	Yes	No	No
Snake River spring/summer run Chinook salmon	T	Yes	No	No
Snake River fall-run Chinook salmon	T	Yes	No	No
Puget Sound Chinook salmon	T	Yes	No	No
Columbia River chum salmon	T	Yes	No	No
Hood Canal summer-run chum salmon	T	Yes	No	No
Lower Columbia River coho salmon	T	Yes	No	No*

Oregon Coast coho salmon	T	Yes	No	No
Southern Oregon/Northern California coasts coho salmon	T	Yes	No	No
Snake River sockeye salmon	E	Yes	No	No
Lake Ozette sockeye salmon	T	Yes	No	No
Lower Columbia River steelhead	T	Yes	No	No
Upper Willamette River steelhead	T	Yes	No	No
Middle Columbia River steelhead	T	Yes	No	No
Upper Columbia River steelhead	T	Yes	No	No
Snake River Basin steelhead	T	Yes	No	No
Puget Sound steelhead	T	Yes	No	No
Puget Sound/Georgia Basin bocaccio	E	No	No	No
Puget Sound/Georgia Basin canary rockfish	T	No	No	No
Puget Sound/Georgia Basin yelloweye rockfish	T	No	No	No
Southern green sturgeon	T	No	No	No
Southern Eulachon	T	Yes	No	No
Southern Resident killer whale	T	No	No	No

*Critical habitat has been proposed for LCR coho salmon.

Fishery Management Plan that Describes EFH in the Action Area	Would the action adversely affect EFH?	Are EFH conservation recommendations provided?
Coastal Pelagic Species	Yes	Yes
Pacific Coast Groundfish	Yes	Yes
Pacific Coast Salmon	Yes	Yes

Consultation
Conducted By: National Marine Fisheries Service
West Coast Region

Issued by: ______________________
William W. Stelle, Jr.
Regional Administrator

Date Issued: December 3, 2013

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1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the conference and biological opinion (opinion) and incidental take statement portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, *et seq*.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801, *et seq*.) and implementing regulations at 50 CFR 600.

The opinion, incidental take statement, and EFH conservation recommendations are each in compliance with Data Quality Act (44 U.S.C. 3504(d)(1) *et seq.*) and they underwent pre-dissemination review.

1.2 Consultation History

Actions covered in this opinion combine and modify actions described in programmatic biological opinions previously issued to USFWS on June 25, 2004[1] and October 21, 2009[2] and to NOAA RC on July 12, 2004[3] and October 22, 2009[4].

On June 11, 2013, USFWS and NOAA RC requested to combine and revise the programmatic consultations completed separately on October 21 and 22, 2009, respectively. During pre-consultation NMFS, USFWS, and NOAA RC agreed on draft restoration categories that will be covered and project design criteria (PDC) for their implementation. In the 2009 opinions, USFWS restoration actions were funded or carried out in Oregon and Southwest Washington and NOAA RC's were funded or carried out in Oregon, Washington, and Idaho.

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[1] Endangered Species Act Section 7 Consultation: Programmatic Biological and Conference Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Oregon Restoration Programs: Coastal, Greenspaces, Jobs in the Woods, and Partners for Fish and Wildlife, June 25, 2004 (Refer to NMFS No.: 2004/00155).

[2] Programmatic biological and conference opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat consultation for restoration actions funded or carried out by the U.S. Fish and Wildlife Service in Oregon and Southwest Washington using the Partners for Fish and Wildlife, Coastal, and Recovery Programs (October 21, 2009) (Refer to NMFS No.:2008/03791).

[3] Endangered Species Act Section 7 consultation: programmatic biological and conference opinion and Magnuson-Stevens Fishery Conservation and Management Act essential fish habitat consultation for NOAA Restoration Center programs, July 12, 2004 (Refer to NMFS No.: 2002/01967).

[4] Programmatic biological and conference opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat consultation for restoration actions funded or carried out by the NOAA Restoration Center in the Pacific Northwest using the Damage Assessment, Remediation and Restoration Program and the Community-based Restoration Program (October 22, 2009) (Refer to NMFS No.: 2007/09078).

This joint opinion will cover programs for both agencies in all three states. Submittal of a biological assessment (BA) was deemed unnecessary to reinitiate because similar BAs and opinions were recently completed with the Bonneville Power Administration (BPA; HIP III) (NMFS 2013b) and U.S. Forest Service/Bureau of Land Management/Bureau of Indian Affairs (ARBO II) (NMFS 2013c).

USFWS' projects are implemented under the Partners for Fish and Wildlife, Fisheries, Coastal, and Recovery programs. These programs address the restoration needs of a wide range of fish and wildlife trust species, primarily on private or Tribal lands. Actions covered in this revision are pursuant to the Fish and Wildlife Coordination Act, Partners for Fish and Wildlife Act, and the Endangered Species Act. Depending on the action, other cooperating entities may include Federal agencies, states, Tribes, local governments, non-governmental and nonprofit organizations, businesses, schools, and private landowners.

Funding for NOAA RC's actions is provided by the Damage Assessment, Remediation and Restoration Program (DARRP) and the Community-Based Restoration Program (CRP), often in combination with resources provided by U.S. Fish and Wildlife programs, including the Partners for Fish and Wildlife Program and Coastal and Recovery Program. DARRP is cooperatively implemented by the NOAA Restoration Center, NOAA's National Ocean Service's Office of Response and Restoration, and the Office of General Counsel. These programs are authorized by the Comprehensive Environmental Response, Compensation, and Liability Act (also known as CERCLA or Superfund), the Oil Pollution Act, the Clean Water Act, and the Marine Protection, Research and Sanctuaries Act. The CRP, which involves communities in the restoration of local marine and estuarine habitats, is authorized by the Fish and Wildlife Coordination Act. Depending on the action, other cooperating entities may include Federal agencies, states, tribes, local governments, non-governmental and nonprofit organizations, businesses, schools, and private landowners.

During consultation, USFWS and NOAA RC concluded that categories of activities, as proposed, will likely adversely affect 20 species listed under the ESA and their proposed or designated critical habitat (Table 1), but are not likely to adversely affect southern distinct population segment (DPS) green sturgeon (*Acipenser medirostris)*, southern resident killer whales *(Orcinus orca)*, and Puget Sound/Georgia Basin (PS/GB) DPSs of yelloweye rockfish (*Sebastes ruberrimus*), canary rockfish (*Sebastes pinniger*), and bocaccio rockfish (*Sebastes paucispinis*), and their critical habitat where it has been designated. The full analysis for these species is found in the "Not Likely to Adversely Affect" Determination section (2.11). The action will adversely affect areas designated by the Pacific Fisheries Management Council as EFH for groundfish (PFMC 2005) and coastal pelagic species (PFMC 1998); and Chinook salmon, coho salmon, and Puget Sound pink salmon (PFMC 1999). Estuarine areas designated as Habitat Areas of Particular Concern (HAPC) will also be adversely affected.

Table 1. Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register (FR) decision notices for ESA-listed species considered in this opinion. Listing status: 'T' means listed as threatened; 'E' means listed as endangered; 'P' means proposed for listing or designation.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon *(Oncorhynchus tshawytscha)*			
Lower Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River spring-run	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River spring-run	E 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	ESA section 9 applies
Snake River spring/summer-run	T 6/28/05; 70 FR 37160	10/25/99; 64 FR 57399	6/28/05; 70 FR 37160
Snake River fall-run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160
Puget Sound	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Chum salmon *(O. keta)*			
Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Hood Canal summer-run	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Coho salmon *(O. kisutch)*			
Lower Columbia River	T 6/28/05; 70 FR 37160	P 1/14/13; 78 FR 2726	6/28/05; 70 FR 37160
Oregon Coast	T 6/20/11; 76 FR 35755	2/11/08; 73 FR 7816	2/11/08; 73 FR 7816
Southern Oregon/Northern California Coasts	T 6/28/05; 70 FR 37160	5/5/99; 64 FR 24049	6/28/05; 70 FR 37160
Sockeye salmon *(O. nerka)*			
Lake Ozette	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Snake River	E 8/15/11; 70 FR 37160	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Lower Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Middle Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	2/1/06; 71 FR 5178
Snake River Basin	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Puget Sound	T 5/11/07; 72 FR 26722	P 1/14/13; 78 FR 2726	P 2/7/07; 72 FR 5648
Eulachon *(Thaleichthys pacificus)*			
Southern DPS	T 3/18/10; 75 FR 13012	10/20/11; 76 FR 65324	Not applicable

Since 2010, USFWS (Oregon and Southwest Washington) and NOAA RC (Oregon, Washington, and Idaho) have reported on 18 to 25 ($\bar{x}$ = 21) restoration actions per year using the October 21 and 22, 2009, opinions. Those actions were distributed as follows: Puget Sound (PS) 5%, Willamette/Lower Columbia (WLC) 11%, Interior Columbia (IC) 49%, Oregon Coast (OC) 33%, and Southern Oregon/Northern California Coasts (SONCC) 2% (Table 2). Most projects (95%) occurred in Oregon, no projects were in Idaho. Over half of all the actions reported involved fish passage restoration (Table 3), and often secondary actions such as instream wood or streambank restoration.

Table 2. USFWS and NOAA RC aquatic restoration actions in the Puget Sound (PS), Willamette/Lower Columbia (WLC), Interior Columbia (IC), Oregon Coast (OC), and Southern Oregon/Northern California Coasts (SONCC) recovery domains per year, 2010 to 2012. Data for this period only includes NOAA RC and USFWS in Oregon.

year	PS	WLC	IC	OC	SONCC
2010	1	3	5	11	0
2011	0	3	9	5	1
2012	2	1	17	5	0
Total	3	7	31	21	1

Table 3. USFWS and NOAA RC actions per category per year, 2010 to 2012, in Oregon and the Northwest, respectively.

Year	Fish Passage	Stream Channel Restoration	Streambank Restoration	Water Structure Removal	Floodplain Wetland, & Riparian	Estuary & Nearshore
2010	10	3	0	2	5	0
2011	9	5	0	3	1	0
2012	14	5	3	1	1	1
Total	33	13	3	6	7	1

In the recent past, the USFWS Idaho Partners Program has worked on very few aquatic restoration projects, but may be better prepared to increase its output under this opinion. The USFWS Washington Partners Program likely completes as many aquatic restoration projects as Oregon. Their Partners Program budgets are fairly similar. Over a 7-year period (FY 2006-2012) most of Washington Partners projects were in the PS recovery domain. About 23,325 feet of "instream habitat" was treated with projects that included the placement of instream structures such as large wood (LW) and engineered log jams (ELJ), culvert and bridge replacement, side- and off-channel habitat improvement, livestock fencing and watering facilities, fish ladders, and dike removal. In the IC domain, USFWS treated 300 feet of instream habitat in the Wenatchee River watershed. We estimate that the combined number of Partners Program aquatic restoration projects for the three-state region will nearly double under this opinion.

The docket for this consultation is on file at the Oregon Washington Coastal Area Office in Portland, Oregon.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

USFWS and NOAA RC propose to fund or carry out 18 categories of aquatic restoration actions under the Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) program. The 18 project categories of action include:

Project Categories

1. Fish Passage Restoration (Stream Simulation Culvert and Bridge Projects; Headcut and Grade Stabilization; Fish Ladders; Irrigation Diversion Replacement/Relocation and Screen Installation/Replacement)
2. Large Wood (LW), Boulder, and Gravel Placement; Engineered Logjams (ELJ); Constructed Riffles, Porous Boulder Step Structures and Vanes; Gravel Augmentation; Tree Removal for LW Projects
3. Dam and Legacy Structure Removal
4. Fluvial Channel Reconstruction/Relocation
5. Off- and Side-Channel Habitat Restoration
6. Streambank Restoration
7. Set-Back or Removal of Existing Berms, Dikes, and Levees
8. Reduction/Relocation of Recreation Impacts
9. Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering
10. Piling and other Structure Removal
11. Shellfish Bed/Nearshore Habitat Restoration
12. In-channel Nutrient Enhancement
13. Road and Trail Erosion Control and Decommissioning
14. Juniper Removal
15. Bull Trout Protection
16. Beaver Habitat Restoration
17. Wetland Restoration
18. Tide/Flood Gate Removal, Replacement, or Retrofit

1.3.1 Proposed Design Criteria

USFWS and NOAA RC propose to apply the following PDC, in relevant part, to every action authorized under this opinion. Measures described under “Administration” apply to the USFWS and NMFS as they manage the PROJECTS program. PDC described under “General Construction” apply to actions that involve construction. PDC described under “Types of Action” are measures that apply to specific types of actions.

1.3.1.1 Program Administration

1. **Initial Rollout.** USFWS, NOAA RC, and NMFS will provide an initial rollout of this opinion for restoration program staff to ensure that these conditions are considered at the onset of each project, incorporated into all phases of project design, and that any constraints, such as the need for fish passage or hydraulic engineering, are resolved early on.
2. **Failure to Report May Trigger Reinitiation.** NMFS may recommend reinitiation of this consultation if USFWS or NOAA RC fails to provide full reports or host the joint-annual coordination meeting (See 11 and 12 below).
3. **Full Implementation Required.** Failure to comply with all applicable conditions for a specific project may invalidate protective coverage of ESA section 7(o)(2) regarding "take" of listed species, and may lead NMFS to a different conclusion regarding the effects of that project.
4. **Integration of PDC, Conservation Measures, and Terms and Conditions into Project Design and Contract Language.** The USFWS and NOAA RC shall incorporate appropriate aquatic and terrestrial conservation measures and PDC, along with any terms and conditions, into contract language, force-account implementation plans, cooperative agreements, or other agency-specific means of ensuring compliance.
5. **Restoration Review Team (RRT).** The following types of projects require RRT review prior to submission to NMFS for approval:
    a. Dam Removal
    b. Fluvial Channel Reconstruction/Relocation, which includes side channel projects when the proposed side channel will contain greater than 20% of the bankfull flow
    c. Tide/Flood Gate Replacement/Retrofit
    d. Precedent or policy setting actions, such as the application of new technology.

    The RRT will be comprised of a core group, including program managers from the USFWS Partners for Fish and Wildlife, Coastal, Fisheries, and Recovery programs, and the NOAA RC, plus a representative from NMFS Habitat Conservation Division, and a NMFS fish passage engineer. Additional technical experts (highly-skilled fisheries biologists, hydrologists, geomorphologists, soil scientists, or engineers) from these agencies will be recruited depending on the project to be reviewed.

    The reviews will help ensure that projects: 1) Meet the obligations set forth in this opinion; 2) are consistent with similar projects; 3) maximize ecological benefits of restoration and recovery projects; and 4) ensure consistent use and implementation of this opinion throughout the action area. RRT review may be delayed if an incomplete or substandard design is submitted for review and significant revision is necessary.[5]

[5] NMFS completed the effects analysis for this opinion based on the actions as described in this section, with the application of all relevant general and activity-specific conservation measures, and on our review of the best available scientific information, and our past experience with similar types of actions. We did not assume the RRT review process would result in a further reduction of the short-term adverse effects of any particular project.

The RRT will keep a record of opinion clarifications and changes approved by NMFS. The RRT does not replace any existing review process, nor shall it slow down project implementation unless significant technical, policy, or program concerns with a particular restoration approach are identified. NMFS will not approve a project for inclusion under this programmatic unless the RRT has reviewed its design.

6. **Review and Approval.** Various levels of review and approval are required for projects covered under this opinion.
    a. USFWS and NOAA RC project managers will review each project to be covered under this opinion prior to submission of an action notification form to NMFS to ensure that project are:
        i. Within the present or historic range of an ESA-listed salmon, steelhead, or eulachon, or designated critical habitat.
        ii. May affect one of the 20 endangered or threatened species considered in this opinion, or their designated critical habitat.
        iii. The effects are likely to be within the range of effects considered in this opinion.
        iv. Activities <u>not</u> covered by this opinion include the following actions:
            1. Use of pesticide-treated wood, including pilings.
            2. Installation of a new tide gate.
            3. Conducting in-water work in the Willamette River downstream of Willamette Falls between Dec 1 and Jan 31.
            4. Any action that requires an environmental impact statement (EIS) under the National Environmental Policy Act (NEPA) if the EIS evaluates alternatives affecting listed species.
            5. Require any earthwork at an U.S. Environmental Protection Agency (EPA)-designated Superfund Site, a state-designated clean-up area, or in the likely impact zone of a significant contaminant source, as identified by historical information or best professional judgment.
    b. NMFS engineering will review and approve any project with any of the following elements, including any additional conservation measures necessary to ensure that the effects of those projects are within range of effects considered in this opinion:
        i. Modifications or variances of any PROJECTS requirement (PDC 7)
        ii. Fish screen for pump intake(s) to dewater at rate >3 cfs (PDC 27)
        iii. Installation of pilings (PDC 30)
        iv. Culverts and bridges that do not meet width standards (PDC 33c)
        v. Grade control, stream stability, or headcut countermeasures (PDC 33d.ii)
        vi. Fish ladders and channel-spanning non-porous structures (PDC 33e)
        vii. Irrigation diversion replacement/relocation (PDC 33f)
        viii. Fish screen installation/replacement (PDC 33f)
        ix. ELJs that occupy >25% of the bankfull area (PDC 34b)
        x. Constructed or engineered riffles (PDC 34c)
        xi. Dam removal projects (PDC 35a)
        xii. Fluvial channel reconstruction/relocation (PDC 36)
        xiii. Off- and side-channel reconstruction >20% of the bankfull flow (PDC 37)

xiv. Alluvium placement that occupies >25% of the channel bed or >25% of the bank full cross sectional area (PDC 38d)
xv. LW placement that occupies >25% of the bankfull cross section (PDC 38e)
xvi. Beach nourishment projects (PDC 43c)
xvii. Tide/flood gate removal, replacement or retrofit projects (PDC 50)

c. Projects that follow PDC in this opinion do not require NMFS approval, including:
   i. Culverts and bridges that meet width standards (PDC 33a-c)
   ii. LW, boulder, and gravel placement projects (PDC 34a&e)
   iii. ELJs that occupy less than 25% of the bankfull area (PDC 34b)
   iv. Porous boulder step structures and vanes (PDC 34d)
   v. Tree removal for LW projects (PDC 34f)
   vi. Removal of legacy structures (PDC 35b)
   vii. Off and side channel reconstruction projects when the proposed side channel will contain less than 20% of the bankfull flow (PDC 37)
   viii. Streambank restoration (PDC 38)
   ix. Set-back or removal of existing berms, dikes, and levees (PDC 39)
   x. Estuary restoration (PDC 39b)
   xi. Reduction/relocation of recreation impacts (PDC 40)
   xii. Livestock fencing, stream crossings and off-channel livestock watering facilities (PDC 41)
   xiii. Piling and other structure removal (PDC 42)
   xiv. Shellfish bed restoration (PDC 43a)
   xv. Replacing shoreline armoring (PDC 43b)
   xvi. In-channel nutrient enhancement (PDC 44)
   xvii. Road and trail erosion control and decommissioning (PDC 45)
   xviii. Juniper tree removal (PDC 46)
   xix. Bull trout protection measures (47)
   xx. Beaver in-channel structures and habitat restoration (PDC 48)
   xxi. Wetland restoration (PDC 49)
   xxii. Tide/flood gate removal (PDC 50)

7. **Minor Variance Process.** Because of the wide range of proposed activities and the natural variability within and between stream systems, some projects may necessitate minor variations from criteria specified herein. NMFS Branch Chiefs may grant minor variances, including exceptions to inwater work windows, when there is a clear conservation benefit or there are no additional adverse effects beyond those covered by this opinion. Minor variances may be requested as part of the above notification process and will:
   a. Cite the opinion identifying number
   b. Cite the relevant criterion by page number
   c. Define the requested variance
   d. Explain why the variance is necessary
   e. Provide a rationale why the variance will either provide a conservation benefit or, at a minimum, not cause additional adverse effects
   f. Include as attachments any necessary approvals by state agencies

8. **Site Access.** USFWS and NOAA RC will retain the right of reasonable access to each project site to monitor the use and effectiveness of these conditions.

9. **On-Site Documentation.** The following documentation will be posted at the project site or accessible in the area of work if not feasible to post:
    a. Name(s), phone number(s), and address(es) of the person(s) responsible for oversight will be posted at the work site.
    b. A description of hazardous materials that will be used, including inventory, storage, and handling procedures will be available on-site.
    c. Procedures to contain and control a spill of any hazardous material generated, used or stored on-site, including notification of proper authorities, will be readily available on-site.
    d. A standing order to cease work in the event of high flows (above those addressed in the design and implementation plans) or exceedance of water quality limits will be posted on-site.

10. **Monitoring and Reporting.** USFWS and NOAA RC will ensure that the following notifications and reports (Appendix A) are submitted to NMFS for each project to be completed under this opinion.
    All project notifications and reports are to be submitted electronically to NMFS at usfws.biop.nwr@noaa.gov or noaarc.biop.nwr@noaa.gov, including:
    a. Project notification 30-days or more before start of construction (Part 1).
    b. Project completion within 60-days of end of construction (Part 1 with Part 2 completed).
    c. Fish salvage within 60-days of work area isolation with fish capture (Part 1 with Part 3 completed).

11. **Annual Program Report.** USFWS and NOAA RC will each submit monitoring reports to NMFS by February 15 each year that describe efforts to carry out this opinion. The reports will include assessments of overall PROJECTS program activity, maps showing the locations and types of actions authorized and carried out under this opinion, and any other data or analyses the USFWS and NOAA RC deem necessary or helpful to assess habitat trends as a result of actions authorized under this opinion. USFWS and NOAA RC will each submit reports to NMFS by email at this address: usfws.biop.nwr@noaa.gov or noaarc.biop.nwr@noaa.gov, respectively. USFWS and NOAA RC will review the tracking information for all projects implemented in a given year to ensure the accuracy and completeness of the tracking record within 60 days of provision by NMFS. USFWS and NOAA RC will also provide a record of the addendum to this opinion for the previous year, including a summary of RRT Quarterly and Annual meetings.

12. **Annual Coordination Meeting.** USFWS and NOAA RC will attend a joint annual coordination meeting with NMFS by March 31 each year to discuss annual reports and any actions that can improve conservation under this opinion, or make the PROJECTS program more efficient or accountable.

1.3.1.2 Project Design Criteria - General Construction Measures

13. Project Design

a. Use the best available scientific information regarding the likely effects of climate change on resources in the project area, including projections of local stream flow and water temperature, to ensure that the project will be adaptable to those changes.

b. Obtain all applicable regulatory permits and official project authorizations before beginning construction.

c. Minimize the extent and duration of earthwork, *e.g.*, compacting, dredging, drilling, excavation, and filling.

   i. Avoid use of heavy equipment, vehicles or power tools below bankfull elevation unless project specialists determine such work is necessary, or will result in less risk of sedimentation or other ecological damage than work above that elevation.

   ii. Complete earthwork in wetlands, riparian areas, and stream channels as quickly as possible.

d. Cease project operations when high flows may inundate the project area, except for efforts to avoid or minimize resource damage.

14. Site Contamination Assessment

a. The level of detail and resources committed to such an assessment will be commensurate with the level and type of past or current development at the site. Assessments may include the following:

   i. Review available records, such as former site use, building plans, and records of any prior contamination events.

   ii. If the project site was used for industrial processes (*i.e.*, mining or manufacturing with chemicals), inspect to determine the environmental condition of the property.

   iii. Interview people who are knowledgeable about the site, *e.g.*, site owners, operators, and occupants, neighbors, or local government officials.

b. Retain contaminant survey information in the project file. Consult with NMFS if ground disturbance to accomplish the proposed project will potentially release contaminants to aquatic habitat that supports listed fish species.

15. Site Layout and Flagging

a. Before any significant ground disturbance or entry of mechanized equipment or vehicles into the construction area, clearly mark with flagging or survey marking paint the following areas:

   i. Sensitive areas, *e.g.*, wetlands, water bodies, ordinary high water, spawning areas

   ii. Equipment entry and exit points

   iii. Road and stream crossing alignments

   iv. Staging, storage, and stockpile areas

b. Before the use of herbicides, clearly flag no-application buffer zones.

16. Staging, Storage, and Stockpile Areas

a. Designate and use staging areas to store hazardous materials, or to store, fuel, or service heavy equipment, vehicles and other power equipment with tanks larger than 5 gallons, that are at least 150 feet from any natural water body or wetland, or on an established paved area, such that sediment and other contaminants from the staging area cannot be deposited in the floodplain or stream.

b. Natural materials that are displaced by construction and reserved for restoration, *e.g.*, LW, gravel, and boulders, may be stockpiled within the 100-year floodplain.
c. Dispose of any material not used in restoration and not native to the floodplain outside of the functional floodplain.
d. After construction is complete, obliterate all staging, storage, or stockpile areas, stabilize the soil, and revegetate the area.[6]

17. Erosion Control

a. Use site planning and site erosion control measures commensurate with the scope of the project to prevent erosion and sediment discharge from the project site.
b. Before significant earthwork begins, install appropriate, temporary erosion controls downslope to prevent sediment deposition in the riparian area, wetlands, or water body.
c. During construction, if eroded sediment appears likely to be deposited in the stream during construction, install additional sediment barriers as necessary.
d. Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabric.
e. Soil stabilization utilizing wood fiber mulch and tackifier (hydro-applied) may be used to reduce erosion of bare soil if the materials are noxious weed free and nontoxic to aquatic and terrestrial animals, soil microorganisms, and vegetation.
f. Remove sediment from erosion controls if it reaches 1/3 of the exposed height of the control.
g. Whenever surface water is present, maintain a supply of sediment control materials and an oil-absorbing floating boom at the project site.
h. Stabilize all disturbed soils following any break in work unless construction will resume within four days.
i. Remove temporary erosion controls after construction is complete and the site is fully stabilized.

18. Hazardous Material Spill Prevention and Control

a. At the project site:
   i. Post written procedures for notifying environmental response agencies, including an inventory and description of all hazardous materials present, and the storage and handling procedures for their use.
   ii. Maintain a spill containment kit, with supplies and instructions for cleanup and disposal, adequate for the types and quantity of hazardous materials present.
   iii. Train workers in spill containment procedures, including the location and use of the spill containment kits.
b. Temporarily contain any waste liquids generated under an impervious cover, such as a tarpaulin, in the staging area until the wastes can be properly transported to, and disposed of, at an approved receiving facility.

[6] Road and path obliteration refers to the most comprehensive degree of decommissioning and involves decompacting the surface and ditch, pulling the fill material onto the running surface, and reshaping to match the original contour.

19. Equipment, Vehicles, and Power Tools

a. Select, operate and maintain all heavy equipment, vehicles, and power tools to minimize adverse effects on the environment, *e.g.*, low pressure tires, minimal hard-turn paths for track vehicles, use of temporary mats or plates to protect wet soils.
b. Before entering wetlands or working within 150 feet of a waterbody, replace all petroleum-based hydraulic fluids with biodegradable products.[7]
c. Invasive species prevention and control.
    i. Before entering the project site, power wash all heavy equipment, vehicles and power tools, allow them to fully dry, and inspect them to make certain no plants, soil, or other organic material is adhering to their surface.
    ii. Before entering the water, inspect any watercraft, waders, boots, or other gear to be used in or near water and remove any plants, soil, or other organic material adhering to the surface.
d. Inspect all equipment, vehicles, and power tools for fluid leaks before they leave the staging area.
e. Before operation within 150 feet of any waterbody, and as often as necessary during operation, thoroughly clean all equipment, vehicles, and power tools to keep them free of external fluids and grease and to prevent leaks and spills from entering the water.
f. Generators, cranes or other stationary heavy equipment operated within 150 feet of any waterbody will be maintained and protected as necessary to prevent leaks and spills from entering the water.

20. Temporary Access Roads and Paths

a. Whenever reasonable, use existing access roads and paths preferentially.
b. Minimize the number and length of temporary access roads and paths through riparian areas and floodplains.
c. Minimize removal of riparian vegetation.
d. When it is necessary to remove vegetation, cut at ground level (no grubbing).
e. Do not build temporary access roads or paths where grade, soil, or other features suggest slope instability.
f. Any road on a slope steeper than 30% will be designed by a civil engineer with experience in steep road design.
g. After construction is complete, obliterate all temporary access roads and paths, stabilize the soil, and revegetate the area.
h. Temporary roads and paths in wet areas or areas prone to flooding will be obliterated by the end of the in-water work window. Decompact road surfaces and drainage areas, pull fill material onto the running surface, and reshape to match the original contours.

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[7] For additional information and suppliers of biodegradable hydraulic fluids, motor oil, lubricant, or grease, see Environmentally Acceptable Lubricants by the U.S. EPA (2011); *e.g.*, mineral oil, polyglycol, vegetable oil, synthetic ester; Mobil® biodegradable hydraulic oils, Total® hydraulic fluid, Terresolve Technologies Ltd.® bio-based biodegradable lubricants, Cougar Lubrication® 2XT Bio engine oil, Series 4300 Synthetic Bio-degradable Hydraulic Oil, 8060-2 Synthetic Bio-Degradable Grease No. 2, *etc*. The use of trade, firm, or corporation names in this opinion is for the information and convenience of the action agency and applicants and does not constitute an official endorsement or approval by the U.S. Department of Commerce or NMFS of any product or service to the exclusion of others that may be suitable.

21. Dust Abatement

a. Employ dust abatement measures commensurate with soil type, equipment use, wind conditions, and the effects of other erosion control measures.
b. Sequence and schedule work to reduce the exposure of bare soil to wind erosion.
c. Maintain spill containment supplies on-site whenever dust abatement chemicals are applied.
d. Do not use petroleum-based products.
e. Do not apply dust-abatement chemicals, *e.g.*, magnesium chloride, calcium chloride salts, ligninsulfonate, within 25 feet of a water body, or in other areas where they may runoff into a wetland or water body.
f. Do not apply ligninsulfonate at rates exceeding 0.5 gallons per square yard of road surface, assuming a 50:50 solution of ligninsulfonate to water.

22. Temporary Stream Crossings

a. No stream crossing may occur at active spawning sites, when holding adult listed fish are present, or when eggs or alevins are in the gravel.
b. Do not place temporary crossings in areas that may increase the risk of channel re-routing or avulsion, or in potential spawning habitat, *e.g.*, pools and pool tailouts.
c. Minimize the number of temporary stream crossings; use existing stream crossings whenever reasonable.
d. Install temporary bridges and culverts to allow for equipment and vehicle crossing over perennial streams to access construction areas.
e. Wherever possible, vehicles and machinery will cross streams at right angles to the main channel.
f. Equipment and vehicles may cross the stream in the wet only where the streambed is bedrock where the streambed is naturally stable, or where mats or off-site logs are placed in the stream and used as a crossing.
g. Obliterate all temporary stream crossings as soon as they are no longer needed, and restore any damage to affected stream banks or channel.

23. Surface Water Withdrawal and Construction Discharge Water

a. Surface water may be diverted to meet construction needs, but only if developed sources are unavailable or inadequate.
b. Diversions may not exceed 10% of the available flow and will have a juvenile fish exclusion device that is consistent with NMFS' criteria (NMFS 2011a).[8]
c. Treat all construction discharge water using best management practices to remove debris, sediment, petroleum products, and any other pollutants likely to be present (*e.g.*, green concrete, contaminated water, silt, welding slag, sandblasting abrasive, grout cured less than 24 hours, drilling fluids), to ensure that no pollutants are discharged to any perennial or intermittent waterbody.

24. Fish Passage

a. Provide fish passage for any adult or juvenile ESA-listed fish likely to be present in the action area during construction, unless passage did not exist before construction, stream isolation and dewatering is required during project implementation, or the stream is naturally impassable at the time of construction.

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[8] National Marine Fisheries Service. 2011. Anadromous salmonid passage facility design. Northwest Region.

b. After construction, provide fish passage that meets NMFS' fish passage criteria for any adult or juvenile ESA-listed fish (NMFS 2011a), for the life of the action.

25. Timing of In-Water Work

a. The inwater work window will be identified as the limit to inwater construction specified in the project notification form. The construction schedule will conform to the windows established in Oregon, Washington, and Idaho by the Oregon Department of Fish and Wildlife (ODFW 2008), Washington Department of Fish and Wildlife (WDFW 2010), and Idaho Department of Fish and Game, respectively. Any exceptions to in-water work windows recommended by ODFW, WDFW, or IDFG will be approved by NMFS. In the Willamette River below Willamette Falls, the winter work window (December 1 – January 31) is not approved for actions under this opinion.

b. Hydraulic and topographic measurements and placement of LW, boulders, or gravel may be completed anytime, provided the affected area is not occupied by adult fish congregating for spawning, or in an area where redds are occupied by eggs or pre-emergent alevins.

26. Fisheries, Hydrology, Geomorphology, Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration include assessments and monitoring projects that are associated with planning, implementation, and monitoring of aquatic restoration projects covered by this opinion. Such support projects may include surveys to document the following aquatic and riparian attributes: fish habitat, hydrology, channel geomorphology, water quality, fish spawning, fish presence[9], macroinvertebrates, riparian vegetation, wildlife, and cultural resources (including excavating test pits less than 1 m^2 in size). This also includes effectiveness monitoring associated with projects implemented under this opinion, provided the effectiveness monitoring is limited to the same survey techniques described in this section.

a. Train personnel in survey methods to prevent or minimize disturbance of fish. Contract specifications should include these methods where appropriate.

b. Avoid impacts to fish redds. When possible, avoid sampling during spawning periods.

c. Coordinate with other local agencies to prevent redundant surveys.

d. Locate excavated material from cultural resource test pits away from stream channels. Replace all material in test pits when survey is completed and stabilize the surface.

e. Does not include research projects that have or should obtain a permit pursuant to section 10(a) of the ESA.

27. Work Area Isolation

a. Isolate any work area within the wetted channel from the active stream whenever ESA-listed fish are reasonably certain to be present, or if the work area is less than 300 feet upstream from known spawning habitats. However, work area isolation may not always be necessary or practical in certain settings; *i.e.,* dry streambeds and tidal zones, respectively.

b. Engineering design plans for work area isolation will include all isolation elements.

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[9] Capture or enumeration by non-lethal techniques, *i.e.,* snorkel, minnow trapping; not hooking or electrofishing.

c. Dewater the shortest linear extent of work area practicable, unless wetted in-stream work is deemed to be minimally harmful to fish, and is beneficial to other aquatic species.[10]
    i. Use a coffer dam and a by-pass culvert or pipe, or a lined, non-erodible diversion ditch to divert flow around the dewatered area. Dissipate flow energy to prevent damage to riparian vegetation or stream channel and provide for safe downstream reentry for fish, preferably into pool habitat with cover.
    ii. Where gravity feed is not possible, pump water from the work site to avoid rewatering. Maintain a fish screen on the pump intake to avoid juvenile fish entrainment (NMFS 2011a).
    iii. Pump seepage water to a temporary storage and treatment site, or into upland areas, to allow water to percolate through soil or to filter through vegetation before reentering the stream channel with a treatment system comprised of either a hay bale basin or other sediment control device.
    iv. Monitor below the construction site to prevent stranding of aquatic organisms.
    v. When construction is complete, re-water the construction site slowly to prevent loss of surface flow downstream, and to prevent a release of suspended sediment.

d. Whenever a pump is used to dewater the isolation area and ESA-listed fish may be present, a fish screen will be used that meets the most current version of NMFS' fish screen criteria (NMFS 2011a). NMFS approval is required for pumping that exceeds 3 cfs.

28. Fish Capture and Release

a. If practicable, allow listed fish species to migrate out of the work area or remove fish before dewatering; otherwise remove fish from an exclusion area as it is slowly dewatered with methods such as hand or dip-nets, seining, or trapping with minnow traps (or gee-minnow traps).

b. Fish capture will be supervised by a qualified fisheries biologist, with experience in work area isolation and competent to ensure the safe handling of fish.

c. Conduct fish capture activities during periods of the day with the coolest air and water temperatures possible, normally early in the morning to minimize stress and injury of species present.

d. Monitor the nets frequently enough to ensure they stay secured to the banks and free of organic accumulation.

e. Electrofishing will be used during the coolest time of day, and only after other means of fish capture are determined to be not feasible or ineffective.
    i. Follow the most recent version of NMFS (2000) electrofishing guidelines.
    ii. Do not electrofish when the water appears turbid, *e.g.*, when objects are not visible at depth of 12 inches.
    iii. Do not intentionally contact fish with the anode.
    iv. Use direct current (DC) or pulsed direct current within the following ranges:

[10] For instructions on how to dewater areas occupied by lamprey, see *Best management practices to minimize adverse effects to Pacific lamprey* (*Entosphenus tridentatus*) (USFWS 2010).

1. If conductivity is less than 100 µs, use 900 to 1100 volts.
2. If conductivity is between 100 and 300 µs, use 500 to 800 volts.
3. If conductivity greater than 300 µs, use less than 400 volts.

v. Begin electrofishing with a minimum pulse width and recommended voltage, then gradually increase to the point where fish are immobilized.

vi. Immediately discontinue electrofishing if fish are killed or injured, *i.e.*, dark bands visible on the body, spinal deformations, significant de-scaling, torpid or inability to maintain upright attitude after sufficient recovery time. Recheck machine settings, water temperature and conductivity, and adjust or postpone procedures as necessary to reduce injuries.

f. If buckets are used to transport fish:

i. Minimize the time fish are in a transport bucket.

ii. Keep buckets in shaded areas or, if no shade is available, covered by a canopy.

iii. Limit the number of fish within a bucket; fish will be of relatively comparable size to minimize predation.

iv. Use aerators or replace the water in the buckets at least every 15 minutes with cold clear water.

v. Release fish in an area upstream with adequate cover and flow refuge; downstream is acceptable provided the release site is below the influence of construction.

vi. Be careful to avoid mortality counting errors.

g. Monitor and record fish presence, handling, and injury during all phases of fish capture and submit a fish salvage report (Appendix A) to NMFS within 60 days of capture that documents date, time of day, fish handling procedures, air and water temperatures, and total numbers of each salmon, steelhead and eulachon handled, and numbers of ESA-listed fish injured or killed.

29. Invasive and non-native plant control

a. ***Non-herbicide methods.*** Limit vegetation removal and soil disturbance within the riparian zone by limiting the number of workers there to the minimum necessary to complete manual, mechanical, or hydro-mechanical plant control (*e.g.*, hand pulling, bending[11], clipping, stabbing, digging, brush-cutting, mulching, radiant heat, portable flame burner, super-heated steam, pressurized hot water, or hot foam (Arsenault *et al.* 2008; Donohoe *et al.* 2010))[12]. Do not allow cut, mowed, or pulled vegetation to enter waterways.

b. ***Herbicide Label.*** Herbicide applicators will comply with all label instructions.

c. ***Power equipment.*** Refuel gas-powered equipment with tanks larger than 5 gallons in a vehicle staging area placed 150-feet or more from any natural waterbody, or in an isolated hazard zone such as a paved parking lot.

d. ***Maximum herbicide treatment area.*** Do not exceed treating 10% of the acres of riparian habitat within a 6th-field HUC with herbicides per year.

e. ***Herbicide applicator qualifications.*** Herbicides may only be applied by an appropriately licensed applicator, or under the direct supervision of a licensed

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[11] Knotweed treatment pre-treatment; See Nickelson (2013).

[12] See http://ahmct.ucdavis.edu/limtask/equipmentdetails.html

applicator, using an herbicide specifically targeted for a particular plant species that will cause the least impact. The applicator will be responsible for preparing and carrying out the herbicide transportation and safely plan, as follows.

f. ***Herbicide transportation and safety plan.*** The applicator will prepare and carry out an herbicide safety/spill response plan to reduce the likelihood of spills or misapplication, to take remedial actions in the event of spills, and to fully report the event. Most knotweed (*Polygonum cuspidatum*, *P. sachalinense*, *P. polystachyum* and hybrids) patches are expected to have overland access. However, some sites may be reached only by water travel, either by wading or inflatable raft or kayak. The following measures will be used to reduce the risk of a spill during water transport: (a) No more than 2.5 gallons of glyphosate will be transported per person or raft, and typically it will be one gallon or less; (b) glyphosate will be carried in 1 gallon or smaller plastic containers. The containers will be wrapped in plastic bags and then sealed in a dry-bag. If transported by raft, the dry-bag will be secured to the watercraft.

g. ***Herbicides.*** The only herbicides allowed for use under this opinion are (some common trade names are shown in parentheses):[13]

    i. aquatic imazapyr (*e.g*., Habitat)
    ii. aquatic glyphosate (*e.g*., AquaMaster, AquaPro, Rodeo)
    iii. aquatic triclopyr-TEA (*e.g*., Renovate 3)
    iv. chlorsulfuron (*e.g*., Telar, Glean, Corsair)
    v. clopyralid (*e.g*., Transline)
    vi. imazapic (*e.g*., Plateau)
    vii. imazapyr (*e.g*., Arsenal, Chopper)
    viii. metsulfuron-methyl (*e.g*., Escort)
    ix. picloram (*e.g*., Tordon)
    x. sethoxydim (*e.g*., Poast, Vantage)
    xi. sulfometuron-methyl (*e.g*., Oust, Oust XP)

h. ***Herbicide adjuvants.*** When recommended by the label, an approved aquatic surfactant or drift retardant can be used to improve herbicidal activity or application characteristics. Adjuvants that contain alky amine etholoxylates, *i.e.*, polyethoxylated tallow amine (POEA), alkylphenol ethoxylate (including alkyl phenol ethoxylate phosphate esters), or herbicides that contain these compounds are **not** covered by this opinion. The following product names are covered by this opinion:

    i. Agri-Dex
    ii. AquaSurf
    iii. Bond
    iv. Bronc Max
    v. Bronc Plus Dry-EDT
    vi. Class Act NG
    vii. Competitor
    viii. Cut Rate
    ix. Cygnet Plus
    x. Destiny HC
    xi. Exciter
    xii. Fraction
    xiii. InterLock
    xiv. Kinetic

[13] The use of trade, firm, or corporation names in this opinion is for the information and convenience of the action agency and applicants and does not constitute an official endorsement or approval by the U.S. Department of Commerce or NMFS of any product or service to the exclusion of others that may be suitable.

xv.	Level 7	xvi.	Liberate
xvii.	Magnify	xviii.	One-AP XL
xix.	Pro AMS Plus	xx.	Spray-Rite
xxi.	Superb HC	xxii.	Tactic
xxiii.	Tronic		

i. ***Herbicide carriers.*** Herbicide carriers (solvents) are limited to water or specifically labeled vegetable oil. Use of diesel oil as an herbicide carrier is not covered by this opinion.

j. ***Dyes.*** Use a non-hazardous indicator dye (*e.g.*, Hi-Light or Dynamark) with herbicides within 100-feet of water. The presence of dye makes it easier to see where the herbicide has been applied and where or whether it has dripped, spilled, or leaked. Dye also makes it easier to detect missed spots, avoid spraying a plant or area more than once, and minimize over-spraying (SERA 1997).

k. ***Herbicide mixing.*** Mix herbicides and adjuvants, carriers, and/or dyes more than 150-feet from any perennial or intermittent waterbody to minimize the risk of an accidental discharge.

l. ***Tank Mixtures.*** The potential interactive relationships that exist among most active ingredient combinations have not been defined and are uncertain. Therefore, combinations of herbicides in a tank mix are not covered by this opinion.

m. ***Spill Cleanup Kit.*** Provide a spill cleanup kit whenever herbicides are used, transported, or stored. At a minimum, cleanup kits will include Material Safety Data Sheets, the herbicide label, emergency phone numbers, and absorbent material such as cat litter to contain spills.

n. ***Herbicide application rates.*** Apply herbicides at the lowest effective label rates.

o. ***Herbicide application methods.*** Apply liquid or granular forms of herbicides as follows:

    i. Broadcast spraying – hand held nozzles attached to back pack tanks or vehicles, or by using vehicle mounted booms.
    ii. Spot spraying – hand held nozzles attached to back pack tanks or vehicles, hand-pumped spray, or squirt bottles to spray herbicide directly onto small patches or individual plants.
    iii. Hand/selective – wicking and wiping, basal bark, fill (“hack and squirt”), stem injection, cut-stump.
    iv. Triclopyr – will not be applied by broadcast spraying.
    v. Keep the spray nozzle within four feet of the ground when applying herbicide. If spot or patch spraying tall vegetation more than 15 feet away from the high water mark (HWM), keep the spray nozzle within 6 feet of the ground.
    vi. Apply spray in swaths parallel towards the project area, away from the creek and desirable vegetation, *i.e.*, the person applying the spray will generally have their back to the creek or other sensitive resource.
    vii. Avoid unnecessary run off during cut surface, basal bark, and hack-squirt/injection applications.

p. ***Washing spray tanks.*** Wash spray tanks 300-feet or more away from any surface water.
q. ***Minimization of herbicide drift and leaching.*** Minimize herbicide drift and leaching as follows:
   i. Do not spray when wind speeds exceed 10 miles per hour, or are less than 2 miles per hour.
   ii. Be aware of wind directions and potential for herbicides to affect aquatic habitat area downwind.
   iii. Keep boom or spray as low as possible to reduce wind effects.
   iv. Increase spray droplet size whenever possible by decreasing spray pressure, using high flow rate nozzles, using water diluents instead of oil, and adding thickening agents.
   v. Do not apply herbicides during temperature inversions, or when air temperature exceeds 80 degrees Fahrenheit.
   vi. Wind and other weather data will be monitored and reported for all broadcast applications.
r. ***Rain.*** Do not apply herbicides when the soil is saturated or when a precipitation event likely to produce direct runoff to salmon bearing waters from the treated area is forecasted by the NOAA National Weather Service or other similar forecasting service within 48 hours following application. Soil-activated herbicides may follow label instructions. Do not conduct hack-squirt/injection applications during periods of heavy rainfall.
s. ***Herbicide buffer distances.*** Observe the following no-application buffer-widths, measured in feet, as map distance perpendicular to the bankfull elevation for streams, the upland boundary for wetlands, or the upper bank for roadside ditches. Widths are based on herbicide formula, stream type, and application method, during herbicide applications (Table 4). Before herbicide application begins, flag or mark the upland boundary of each applicable herbicide buffer to ensure that all buffers are in place and functional during treatment.

Table 4. Herbicide buffer distances by herbicide formula, stream type, and application method.

Herbicide	No Application Buffer Width (feet)					
	Streams and Roadside Ditches with flowing or standing water present and Wetlands			Dry Streams, Roadside Ditches, and Wetlands		
	Broadcast Spraying	Spot Spraying	Hand Selective	Broadcast Spraying	Spot Spraying	Hand Selective
Labeled for Aquatic Use						
Aquatic Glyphosate	100	waterline	waterline	50	None	none
Aquatic Imazapyr	100	15	waterline	50	None	none
Aquatic Triclopyr-TEA	**Not Allowed**	15	waterline	**Not Allowed**	None	none
Low Risk to Aquatic Organisms						
Imazapic	100	15	bankfull elevation	50	None	none
Clopyralid	100	15	bankfull elevation	50	None	none
Metsulfuron-methyl	100	15	bankfull elevation	50	None	none
Moderate Risk to Aquatic Organisms						
Imazapyr	100	50	bankfull elevation	50	15	bankfull elevation
Sulfometuron-methyl	100	50	5	50	15	bankfull elevation
Chlorsulfuron	100	50	bankfull elevation	50	15	bankfull elevation
High Risk to Aquatic Organisms						
Picloram	100	50	50	100	50	50
Sethoxydim	100	50	50	100	50	50

30. Piling Installation

a. Pilings may be placed with concrete, or steel round pile 24 inches in diameter or smaller, steel H-pile designated as HP24 or smaller, or untreated wood.[14]
b. When possible, use a vibratory hammer for piling installation.
c. When using an impact hammer to drive or proof steel piles, one of the following sound attenuation methods will be used to effectively dampen sound pressure waves in all areas to a single strike peak threshold of 206 decibels and, for cumulative strikes, a 187 decibel sound exposure level (SEL) in areas and times where fish are larger than 2 grams and a 183 decibel SEL in areas and times when fish are smaller than 2 grams:
    i. Completely isolate the pile from flowing water by dewatering the area around the pile.
    ii. If water velocity is 1.6 feet per second or less, surround the piling being driven by a confined or unconfined bubble curtain that will distribute

[14] An individual consultation and site-specific risk assessment are required for actions that propose the use of pilings made of treated wood, including chromated copper arsenate (CCA), ammoniacal copper zinc arsenate (ACZA), alkaline copper quaternary (ACQ-B and ACQ-D), ammoniacal copper citrate (CC), copper azole (CBA-A), copper dimethyldithiocarbamate (CDDC), borate preservatives, and oil-type wood preservatives, such as creosote, pentachlorophenol, and copper naphthenate.

small air bubbles around 100% of the piling perimeter for the full depth of the water column, as described in NMFS and USFWS (2006).[15]

iii. If water velocity is greater than 1.6 feet per second, surround the piling being driven by a confined bubble curtain (*e.g.,* a bubble ring surrounded by a fabric or non-metallic sleeve) that will distribute air bubbles around 100% of the piling perimeter for the full depth of the water column.

iv. **NMFS fish passage review and approval.** Provide NMFS information regarding the timing of in-water work, the number of impact hammer strikes per pile and the estimated time required to drive piles, hours per day pile driving will occur, depth of water, and type of substrate, hydroacoustic assumptions, and the pile type, diameter, and spacing of the piles.

31. Site Restoration

a. Restore any significant disturbance of riparian vegetation, soils, stream banks or stream channel.
b. Remove all project related waste; *e.g.*, pick up trash, sweep roadways in the project area to avoid runoff-containing sediment, *etc.*
c. Obliterate all temporary access roads, crossings, and staging areas.
d. Loosen soil in compacted areas when necessary for revegetation or infiltration.
e. Although no single criterion is sufficient to measure restoration success, the intent is that the following features should be present in the upland parts of the project area, within reasonable limits of natural and management variation:
   i. Human and livestock disturbance, if any, are confined to small areas necessary for access or other special management situations.
   ii. Areas with signs of significant past erosion are completely stabilized and healed, bare soil spaces are small and well-dispersed.
   iii. Soil movement, such as active rills and soil deposition around plants or in small basins, is absent or slight and local.
   iv. Native woody and herbaceous vegetation, and germination microsites, are present and well distributed across the site; invasive plants are minimal or absent.
   v. Plants have normal, vigorous growth form, and a high probability of remaining vigorous, healthy and dominant over undesired competing vegetation.
   vi. Plant litter is well distributed and effective in protecting the soil with little or no litter accumulated against vegetation as a result of active sheet erosion ("litter dams").
   vii. A continuous corridor of shrubs and trees appropriate to the site are present to provide shade and other habitat functions for the entire streambank/shoreline.

32. Revegetation

a. Plant and seed disturbed areas before or at the beginning of the first growing season after construction.

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[15] See also Wursig *et al*. (2000) and Longmuir and Lively (2001) for additional information on how to deploy an effective, economical bubble curtain.

b. Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous species. Vegetation, such as willow, sedge and rush mats, may be gathered from abandoned floodplains, stream channels, *etc.* When feasible, use vegetation salvaged from local areas scheduled for clearing due to development.
c. Use species that will achieve shade and erosion control objectives, including forb, grass, shrub, or tree species that are appropriate for the site and native to the project area or region.
d. Short-term stabilization measures may include use of non-native sterile seed mix if native seeds are not available, weed-free certified straw, jute matting, and similar methods.
e. Do not apply surface fertilizer within 50 feet of any wetland or water body.
f. Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.
g. Do not use invasive or non-native species for site restoration.
h. Conduct post-construction monitoring and treatment to remove or control invasive plants until native plant species are well-established.

1.3.1.3 Project Design Criteria – Types of Restoration Actions

Projects within the 18 aquatic restoration activity categories will be designed and implemented to help restore watershed and coastal processes. These projects are designed to improve channel dimensions and stability, sediment transport and deposition, and riparian, wetland, floodplain and hydrologic functions, as well as water quality.

As such, these improvements may help address limiting factors related to spawning, rearing, and migration of ESA-listed fish species. Aquatic habitat restoration and enhancement projects are conducted within stream channels, adjacent riparian/floodplain areas, wetlands, nearshore coastal habitats, and uplands.

33. **Fish Passage Restoration** includes the following: total removal, replacement, or resetting of culverts or bridges; stabilizing headcuts and other channel instabilities; removing, relocating, constructing, repairing, or maintaining fish ladders; and replacing, relocating, or constructing fish screens and irrigation diversions. Such projects will take place where fish passage has been partially or completely eliminated.

a. **Stream simulation culvert and bridge projects.** All road-stream crossing structures shall adhere to the most recent version of NMFS fish passage criteria (NMFS 2011a) located at: http://www.nwr.noaa.gov/publications/hydropower/ferc/fish-passage-design.pdf NMFS engineering review, if required, shall occur at the conceptual, post-modeling, and final design phases, which is approximated by 30%, 60%, and 90% designs.
b. All road-stream crossing structures shall simulate stream channel conditions per industry design standards found in any one of the following:
    i. *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service

2008) or the most recent version, located at: http://stream.fs.fed.us/fishxing/aop_pdfs.html

ii. *Part XII Fish Passage Design and Implementation, Salmonid Stream Habitat Restoration Manual* (California Department of Fish and Game 2009) or the most recent version, located at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=12512

iii. *Water Crossings Design Guidelines* (Barnard *et al.* 2013) or the most recent version), located at: http://wdfw.wa.gov/publications/01501/

c. **General road-stream crossing criteria**

i. Span

1. Span is determined by the crossing width at the proposed streambed grade.
2. Single span structures will maintain a clear, unobstructed opening above the general scour elevation that is at least as wide as 1.5 times the active channel width.
3. Multi-span structures will maintain clear, unobstructed openings above the general scour elevation (except for piers or interior bents) that are at least as wide as 2.2 times the active channel width.
4. Entrenched streams: If a stream is entrenched (entrenchment ratio of less than 1.4), the crossing width will accommodate the floodprone width. Floodprone width is the channel width measured at twice the maximum bankfull depth (Rosgen 1996).
5. Minimum structure span is 6ft.

ii. Scour Prism

1. Designs shall maintain the general scour prism, as a clear, unobstructed opening (*i.e.,* free of any fill, embankment, scour countermeasure, or structural material to include abutments, footings, and culvert inverts). No scour or stream stability countermeasure may be applied above the general scour elevation.
2. When bridge abutments are set back beyond the applicable criteria span they may be located above the general scour elevation.

iii. Embedment

1. All culvert footings and inverts shall be placed below the thalweg at a depth of 3 feet, or the Lower Vertical Adjustment Potential (LVAP) line, whichever is deeper.
    a. LVAP, as calculated in *Stream Simulation: An ecological approach to providing passage for aquatic organisms at road crossings* (USDA-Forest Service 2008)
2. In addition to embedment depth, embedment of closed bottom culverts shall be between 30% and 50% of the culvert rise.

iv. Bridges

1. Primary bridge structural elements will be concrete, metal, fiberglass, or untreated timber. The use of treated wood for bridge construction or replacement is not allowed under this opinion. Old railroad cars, which are commonly used as bridges, may have

treated wood decking. Sample for the presence of treatment chemicals and replace treated elements with untreated wood.

2. All concrete will be poured in the dry, or within confined waters not connected to surface waters, and will be allowed to cure a minimum of 7 days before contact with surface water as recommended by Washington State Department of Transportation (2010).
3. Riprap will not be placed within the bankfull width of the stream. Riprap may only be placed below bankfull height when necessary for protection of abutments and pilings. The amount and placement of riprap will not constrict the bankfull flow.
4. Temporary work bridges will also meet NMFS (2011a) (or the latest version).

v. **NMFS fish passage review and approval.** NMFS will review crossing structure designs if the span width is determined to be less than the criteria established above or if the design is inconsistent with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011a).

d. **Headcut and grade stabilization.** Headcuts (vertical off-sets in the streambed) often occur in meadow areas, where floodplain soils are fine textured. Headcuts may develop because of channel straightening, channel avulsion, or loss of riparian vegetation.

i. Methods

1. In streams with current or historical fish presence, provide fish passage over a stabilized headcut through use of morphologically appropriate grade control. This includes constructed riffles for riffle-pool morphologies, rough constructed riffles/ramps for plane bed morphologies, wood jams, rock bands, and boulder weirs for step-pool morphologies, and roughened channels for cascade morphologies as described in part ii below.
2. Grade control materials can include both rock and LW. Material shall not in any part consist of gabion baskets, sheet piles, concrete, articulated concrete blocks, or cable anchors.
3. Rock for structures shall be durable and of suitable quality to assure permanence in the climate in which it is to be used. Gravel sizing depends on the size of the stream, maximum depth of flow, planform, entrenchment, and ice and debris loading.
4. Short-term headcut stabilization (including emergency stabilization projects) may occur without associated fish passage measures. However, fish passage will be incorporated into the final headcut stabilization action and be completed during the first subsequent in-water work period.

ii. Grade Stabilization to Promote Fish Passage

1. **NMFS fish passage review and approval.** NMFS will review all projects containing grade control, stream stability, or headcut countermeasures that are proposed to promote fish passage.

2. Provide fish passage over grade control structures through use of constructed riffles for pool/riffle streams or a series of log or rock structures for step/pool channels. If LW and boulder placement is used for headcut stabilization, refer to Large Wood, Boulder, and Gravel Placement (PDC 34) below.
3. Construct structures in a 'V' or 'U' shape, oriented with the apex upstream, lower in the center to direct flows to the middle of channel.
4. Key structures into the stream bed to minimize structure undermining due to scour, preferably at least 2.5 times their exposure height. The structures should also be keyed into both banks—if feasible greater than 8 feet.
5. If several structures will be used in series, space them at the appropriate distances to promote fish passage of all life stages of native fish. Incorporate NMFS (2011a) fish passage criteria (jump height, pool depth, *etc.*) in the design of step structures. Recommended spacing should be no closer than the net drop divided by the channel slope (for example, a one-foot high step structure in a stream with a two-percent gradient will have a minimum spacing of 50-feet [1/0.02]).
6. Include gradated (cobble to fine) material in the rock structure material mix to help seal the structure/channel bed, thereby preventing subsurface flow and ensuring fish passage immediately following construction if natural flows are sufficient.
7. If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

e. **Fish Ladders**

i. **NMFS fish passage review and approval.** NMFS will review fishways designs for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011a).

ii. Design preference is based on project type, level of maintenance, and required monitoring essential for reliable fish passage.
Typical fishway designs include: (a) roughened channels/boulder step structures, (b) channel spanning concrete sills, (c) pool and chute, and (d) pool and weir fishways. Roughened channel and boulder step structure fishways consist of a graded mix of rock and sediment in an open channel that creates enough roughness and diversity to facilitate fish passage. NMFS' review will include any appurtenant facilities (*i.e.*, fish counting equipment, pit tag detectors, lighting, trash racks, attraction water) that may be included with the fish ladder design. See the most recent version of *Anadromous Salmonid Passage Facility Design* (NMFS 2011a) for guidelines and PDC.

iii. If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

f. **Irrigation diversion replacement/relocation and screen installation/ replacement**

   i. **NMFS fish passage review and approval.** NMFS will review irrigation diversion replacement/relocation and screen installation/ replacement projects for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011a).
   ii. Diversion structures—associated with points of diversion and future fish screens—will pass all life stages of threatened and endangered aquatic species that historically used the affected aquatic habitat.
   iii. Water diversion intake and return points will be designed (to the greatest degree possible) to prevent all native fish life stages from swimming or being entrained into the diversion.
   iv. NMFS fish screen criteria (NMFS 2011a) applies to Federally listed salmonid species under their jurisdiction. This includes screens in temporary and permanent pump intakes.
   v. All fish screens will be sized to match the irrigator's state water right or estimated historical water use, whichever is less.
   vi. Size of bypass structure should be big enough to pass steelhead kelt into the stream.
   vii. Abandoned ditches and other similar structures will be plugged or backfilled, as appropriate, to prevent fish from swimming or being entrained into them.
   viii. When making improvements to pressurized diversions, install a totalizing flow meter capable of measuring rate and duty of water use. For non-pressurized systems, install a staff gage or other measuring device capable of measuring instantaneous rate of water flow.
   ix. Conversion of instream diversions to groundwater wells will only be used in circumstances where there is an agreement to ensure that any surface water made available for instream flows is protected from surface withdrawal by another water user.
   x. For the removal of diversion structures constructed of local rock and dirt, the project sponsor will dispose of the removed material in the following manner:
      1. Material more than 60% silt or clay will be disposed in uplands, outside of the active floodplain.
      2. Material with more than 40% gravel will be deposited within the active floodplain, but not in wetlands.
      3. Material with more than 50% gravel and less than 30% fines (silt or clay) may be deposited below the OHW mark.

34. **Large Wood (LW), Boulder, and Gravel Placement** includes LW and boulder placement, ELJs, constructed riffles, porous boulder structures and vanes, gravel placement, and tree removal for LW projects. Such activities will occur in areas where channel structure is lacking due to past stream cleaning (LW removal), riparian timber harvest, and in areas where natural gravel supplies are low due to anthropogenic disruptions. These projects will occur in stream channels and adjacent floodplains to increase channel stability, rearing habitat, pool formation, spawning gravel deposition, channel complexity, hiding cover, low velocity areas, and floodplain function.

a. **Large wood and boulder projects**
   i. Place LW and boulders in areas where they would naturally occur and in a manner that closely mimics natural accumulations for that particular stream type. For example, boulder placement may not be appropriate in low-gradient meadow streams.
   ii. Structure types shall simulate disturbance events to the greatest degree possible and include, but are not limited to, log jams, debris flows, wind-throw, and tree breakage.
   iii. No limits are to be placed on the size or shape of structures as long as such structures are within the range of natural variability of a given location and do not block fish passage.
   iv. Projects can include grade control and streambank stabilization structures, while size and configuration of such structures will be commensurate with scale of project site and hydraulic forces.
   v. The partial burial of LW and boulders is permitted and may constitute the dominant means of placement. This applies to all stream systems but more so for larger stream systems where use of adjacent riparian trees or channel features is not feasible or does not provide the full stability desired.
   vi. LW includes whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates. When available, trees with rootwads should be a minimum of 1.5x bankfull channel width, while logs without rootwads should be a minimum of 2.0 x bankfull widths.
   vii. Structures may partially or completely span stream channels or be positioned along stream banks.
   viii. Stabilizing or key pieces of LW will be intact, hard, with little decay, and if possible have root wads (untrimmed) to provide functional refugia habitat for fish. Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.
   ix. Anchoring LW – Anchoring alternatives may be used in preferential order:
      1. Use of adequate sized wood sufficient for stability
      2. Orient and place wood in such a way that movement is limited
      3. Ballast (gravel or rock) to increase the mass of the structure to resist movement
      4. Use of large boulders as anchor points for the LW
      5. Pin LW with rebar to large rock to increase its weight. For streams that are entrenched (Rosgen F, G, A, and potentially B) or for other streams with very low width to depth ratios (less than 12) an additional 60% ballast weight may be necessary due to greater flow depths and higher velocities.
      6. Anchoring LW by cable is not allowed under this opinion.

b. **Engineered Logjams (ELJs)** are structures designed to redirect flow and change scour and deposition patterns.[16] While providing valuable fish and wildlife habitat, they are also designed to redirect flow and can provide stability to a streambank or downstream gravel bar. To the extent practical, ELJs are designed to simulate stable natural log jams and can be either naturally stable due to LW size and/or stream width or anchored in place using rebar, rock, or piles (driven into a dewatered area or the streambank, but not in water). They are also designed to create a hydraulic shadow, a low-velocity zone downstream that allows sediment to settle out and scour holes adjacent to the structure.

   i. **NMFS fish passage review and approval.** For ELJs that occupy greater than 25% of the bankfull area, NMFS will review the action for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011a).
   ii. ELJs will be patterned, to the greatest degree possible, after stable natural log jams.
   iii. Grade control ELJs are designed to arrest channel down-cutting or incision by providing a grade control that retains sediment, lowers stream energy, and increases water elevations to reconnect floodplain habitat and diffuse downstream flood peaks.
   iv. Stabilizing or key pieces of LW that will be relied on to provide streambank stability or redirect flows will be intact and solid (little decay). If possible, acquire LW with untrimmed rootwads to provide functional refugia habitat for fish.
   v. When available, trees with rootwads attached should be a minimum length of 1.5 times the bankfull channel width, while logs without rootwads should be a minimum of 2.0 times the bankfull width.
   vi. The partial burial of LW and boulders may constitute the dominant means of placement, and key boulders (footings) or LW can be buried into the streambank or channel.
   vii. Angle and offset – The LW portions of ELJ structures should be oriented such that the force of water upon the LW increases stability. If a rootwad is left exposed to the flow, the bole placed into the streambank should be oriented downstream parallel to the flow direction so the pressure on the rootwad pushes the bole into the streambank and bed.
   Wood members that are oriented parallel to flow are more stable than members oriented at 45 or 90 degrees to the flow.
   viii. If LW anchoring is required, a variety of methods may be used. These include buttressing the wood between riparian trees, or the use of manila, sisal, or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, rebar pinning or bolted connections may be used. Rock may be used for ballast but is limited to that needed to anchor the LW.

[16] ELJs are defined as structures composed of LW with at least three key members incorporating the use of an anchoring system as defined in PDC 33.a.ix.

c. **Constructed riffles**

   i. **NMFS fish passage review and approval.** NMFS will review all constructed or engineered riffles for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011a).

   ii. Constructed riffles are to be constructed to allow upstream and downstream passage of all native fish species and life stages that occur in the stream. A low flow notch shall be constructed to concentrate flows in channels where minimum flows may restrict fish passage.

   iii. Constructed riffles will be constructed out of a well-graded gravel mix, including the appropriate level of fines, to allow for compaction for stability and sealing to ensure minimal loss of surface flow through the newly placed material.

   iv. Gravel sizing depends on the size of the stream, maximum depth of flow, planform, entrenchment, and ice and debris loading.

   v. The project designer or an inspector experienced in these structures should be present during installation.

   vi. To ensure that the structure is adequately sealed, surface flow must be present before equipment leaves the site.

d. **Porous boulder step structures and vanes**

   i. Full channel spanning boulder structures are to be installed only in highly uniform, incised, bedrock-dominated channels to enhance or provide fish habitat in stream reaches where log placements are not practicable due to channel conditions (not feasible to place logs of sufficient length, bedrock dominated channels, deeply incised channels, artificially constrained reaches, *etc.*), where damage to infrastructure on public or private lands is of concern, or where private landowners will not allow log placements due to concerns about damage to their streambanks or property.

   ii. Install boulder structures low in relation to channel dimensions so that they are completely overtopped during channel-forming flow events (approximately a 1.0- to 1.5-year flow event).

   iii. Boulder step structures are to be placed diagonally across the channel or in more traditional upstream pointing “V” or “U” configurations with the apex oriented upstream.

   iv. Boulder step structures are to be constructed to allow upstream and downstream passage of all native fish species and life stages that occur in the stream. Plunges shall be kept less than 6 inches in height.

   v. The use of gabions, cable, or other means to prevent the movement of individual boulders in a boulder step structure is not allowed.

   vi. Rock for boulder step structures shall be durable and of suitable quality to assure long-term stability in the climate in which it is to be used. Rock sizing depends on the size of the stream, maximum depth of flow, planform, entrenchment, and ice and debris loading.

   vii. The project designer or an inspector experienced in these structures should be present during installation.

viii. Full spanning boulder step structure placement should be coupled with measures to improve habitat complexity and protection of riparian areas to provide long-term inputs of LW.

e. **Gravel augmentation**

i. Gravel can be placed directly into the stream channel, at tributary junctions, or other areas in a manner that mimics natural debris flows and erosion.

ii. Augmentation will only occur in areas where the natural supply has been eliminated, significantly reduced through anthropogenic disruptions, or used to initiate gravel accumulations in conjunction with other projects, such as simulated log jams and debris flows.

iii. Gravel to be placed in streams shall be a properly sized gradation for that stream, clean alluvium with similar angularity as the natural bed material. When possible use gravel of the same lithology as found in the watershed. Reference *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organism*s *at Road-Stream Crossings* (USDA-Forest Service 2008) to determine gravel sizes appropriate for the stream.

iv. Gravel can be mined from the floodplain at elevations above bankfull, but not in a manner that will cause stranding during future flood events.

v. Crushed rock is not permitted.

vi. After gravel placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material.

vii. Do not place gravel directly on bars and riffles that are known spawning areas, which may cause fish to spawn on the unsorted and unstable gravel, thus potentially resulting in redd destruction.

viii. Imported gravel will be free of invasive species and non-native seeds. If necessary, wash gravel prior to placement.

f. **Tree removal for LW projects**

i. Live conifers and other trees can be felled or pulled/pushed over for in-channel LW placement only when riparian zone tree stands are fully stocked[17] or over-stocked.[18] Tree felling shall not create excessive streambank erosion or increase the likelihood of channel avulsion during high flows.

ii. Danger trees and trees killed through fire, insects, disease, blow-down and other means can be felled and used for in-channel placement regardless of live-tree stocking levels.

iii. Trees may be removed by cable, ground-based equipment, horses or helicopters.

iv. Trees may be felled or pushed/pulled directly into a stream or floodplain.

v. Trees may be stock piled for future instream restoration projects.

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[17] Fully stocked stands – Stands in which all the growing space is effectively occupied but which still have ample room for development of the crop trees.

[18] Overstocked stands – Stands in which the growing space is so completely utilized that growth has slowed down and many trees, including dominants, are being suppressed.

vi. The project manager for an aquatic restoration action will coordinate with an USFWS wildlife biologist in tree-removal planning efforts.

35. **Dam and Legacy Structure Removal** includes removal of dams, channel-spanning weirs, legacy habitat structures, earthen embankments, subsurface drainage features, spillway systems, outfalls, pipes, instream flow redirection structures (*e.g.,* drop structure, gabion, groin), or similar devices used to control, discharge, or maintain water levels. Legacy structures include past projects, such as LW, boulder, rock gabions, and other in-channel and floodplain structures. Removal projects will be implemented to reconnect stream corridors, floodplains, and estuaries, reestablish wetlands, improve aquatic organism passage, and restore more natural channel and flow conditions. Instream water control structures that impound contaminated sediment are not covered by this opinion.

a. **Dam removal**

i. Design Review

1. **NMFS fish passage review and approval.** NMFS will review the action for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011a).
2. **Restoration Review Team (RRT).** The action will be reviewed by the RRT prior to submission to NMFS for approval.

ii. Project Documentation – At a minimum, the following information will be necessary for review:

1. A longitudinal profile of the stream channel thalweg for 20 channel widths downstream of the structure and 20 channel widths upstream of the reservoir area (outside of the influence of the structure) shall be used to determine the potential for channel degradation.
2. A minimum of three cross-sections – one downstream of the structure, one through the reservoir area upstream of the structure, and one upstream of the reservoir area (outside of the influence of the structure) to characterize the channel morphology and quantify the stored sediment.
3. Sediment characterization to determine the proportion of coarse sediment (greater than 2 mm) in the reservoir area.
4. A survey of any downstream spawning areas that may be affected by sediment released by removal of the water control structure or dam. Reservoirs with a d35 greater than 2 mm (*i.e.,* 65% of the sediment by weight exceeds 2 mm in diameter) may be removed without excavation of stored material, if the sediment contains no contaminants; reservoirs with a d35 less than 2 mm (*i.e.,* 65% of the sediment by weight is less than 2 mm in diameter) will require partial removal of the fine sediment to create a pilot channel, in conjunction with stabilization of the newly exposed streambanks with native vegetation.

iii. Design Guidance – If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

iv. Monitoring – Dams greater than 10-feet in height (measured at the upstream side of the structure at the approximate centerline of the stream) require a long-term monitoring and adaptive management plan that will be developed between the NMFS and the USFWS or NOAA RC.

b. **Removal of legacy structures**

i. Remove material not typically found within the stream or floodplain at project sites (*i.e.*, LW, boulders, concrete, *etc.*) from the 100-year floodplain.

ii. Materials (*i.e.*, LW and boulders.) typically found within the stream or floodplain at that site can be reused to implement habitat improvements described under the <u>Large Wood, Boulder, and Gravel Placement</u> (PDC 34) activity category in this opinion.

iii. If the structure being removed is keyed into the bank, fill in "key" holes with native materials to restore contours of streambank and floodplain. Compact the fill material adequately to prevent washing out of the soil during over-bank flooding. Do not mine material from the stream channel bed to fill in "key" holes.

iv. When removal of buried log structures may result in significant disruption to riparian vegetation or the floodplain, consider using a chainsaw to extract the portion of log within the channel and leaving the buried sections within the streambank.

v. If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

vi. If the legacy structures (log, rock, or gabion weirs) were placed to provide grade control, evaluate the site for potential headcutting and incision due to structure removal. If headcutting and channel incision are likely to occur due to structure removal, additional measures will be taken to reduce these impacts.

vii. If the structure is being removed because it has caused an over-widening of the channel, consider implementing other restoration categories to decrease the width to depth ratio of the stream to a level commensurate with the geomorphic setting.

36. **Fluvial Channel Reconstruction/Relocation** projects include reconstruction of existing stream channels through excavation and structure placement (LW and boulders) or relocation (rerouting of flow) into historical or newly constructed channels that are typically more sinuous and complex. This proposed action applies to stream systems that have been straightened, channelized, dredged, or otherwise modified for the purpose of flood control, increasing arable land, realignment, or other land use management goals, or for streams that are incised or otherwise disconnected from their floodplains due to watershed disturbances. For tidal wetland and estuarine projects, refer to PDCs 39.b and 49.

a. **General project design criteria**
   i. Design Review
      1. **NMFS fish passage review and approval.** NMFS will review the action for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011a).
      2. **Restoration Review Team (RRT).** The action will be individually reviewed by the RRT prior to submission to NMFS for approval.
   ii. Design Guidance
      1. Construct geomorphically appropriate stream channels and floodplains within a watershed and reach context.
      2. Design actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that will naturally occur at that stream and valley type.
      3. To the greatest degree possible, remove nonnative fill material from the channel and floodplain to an upland site.
      4. When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain where appropriate to support the project goals and objectives.
      5. Structural elements shall fit within the geomorphic context of the stream system. For bed stabilization and hydraulic control structures, constructed riffles shall be preferentially used in pool-riffle stream types, while roughened channels and boulder step structures shall be preferentially used in step-pool and cascade stream types.
      6. Material selection (LW, rock, gravel) shall also mimic natural stream system materials.
      7. Construction of the streambed should be based on Stream Simulation Design principles as described in section 6.2 of *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008) or other appropriate design guidance documents (see PDC 33b).

b. **Project documentation.** Provide NMFS and the RRT with the following documentation:
   i. Background and problem statement
      1. Site history
      2. Environmental baseline
      3. Problem description
      4. Cause of problem
   ii. Project description
      1. Goals/objectives
      2. Project elements
      3. Sequencing, implementation

4. Recovery trajectory: how does it develop and evolve?

iii. Design analysis
   1. Technical analyses
   2. Computations relating design to analysis
   3. References

iv. River Restoration Analysis Tool. The River Restoration Analysis Tool (restorationreview.com) was created to assist with design and monitoring of aquatic restoration projects. The following questions taken from the tool will be addressed in the project documentation:
   1. Problem Identification
      a. Is the problem identified?
      b. Are causes identified at appropriate scales?
   2. Project Context
      a. Is the project identified as part of a plan, such as a watershed action plan or recovery plan?
      b. Does the project consider ecological, geomorphic, and socioeconomic context?
   3. Goals & Objectives
      a. Do goals and objectives address problem, causes, and context?
      b. Are objectives measurable?
   4. Alternatives/Options Evaluation
      a. Were alternatives/options considered?
      b. Are uncertainties and risk associated with selected alternative acceptable?
   5. Project Design
      a. Do project elements collectively support project objectives?
      b. Are PDC defined for all project elements?
      c. Do project elements work with stream processes to create and maintain habitat?
      d. Is the technical basis of design sound for each project element?
   6. Implementation
      a. Are plans and specifications sufficient in scope and detail to execute the project?
      b. Does plan address potential implementation impacts and risks?
   7. Monitoring & Management
      a. Does monitoring plan address project compliance?
      b. Does monitoring plan directly measure project effectiveness?

c. **Monitoring**. Develop a monitoring and adaptive plan that has been reviewed and approved by the RRT and NMFS 30 days prior to the planned start of construction. The plan will include the following:
   i. Introduction
   ii. Existing Monitoring Protocols

iii. Project Effectiveness Monitoring Plan
   1. Immediately upon completion of the new channel construction, the contractor shall survey the project and provide as-built monitoring data, which will be supplied to NMFS and the RRT for review. This survey will compare as-built metrics to proposed design metrics on channel length, substrate size, residual pool depth, pieces of LW, *etc.*

iv. Project Review Team Triggers
v. Monitoring Frequency, Timing, and Duration
vi. Monitoring Technique Protocols
vii. Data Storage and Analysis
viii. Monitoring Quality Assurance Plan
ix. Literature cited

37. **Off- and Side-Channel Habitat Restoration** projects will be implemented to reconnect historical side-channels with floodplains by removing off-channel fill and plugs. Furthermore, new side-channels and alcoves can be constructed in geomorphic settings that will accommodate such features. This activity category typically applies to areas where side channels, alcoves, and other backwater habitats have been filled or blocked from the main channel, disconnecting them from most if not all flow events.
   a. **NMFS fish passage review and approval.** When a proposed side channel will contain greater than 20% of the bankfull flow,[19] the action will be reviewed by the RRT and reviewed and approved by NMFS for consistency with NMFS (2011a) *Anadromous Salmonid Passage Facility Design* criteria.
   b. **Data requirements.** Data requirements and analysis for off- and side-channel habitat restoration include evidence of historical channel location, such as land use surveys, historical photographs, topographic maps, remote sensing information, or personal observation.
   c. **Allowable excavation.** Off- and side-channel improvements can include minor excavation (less than or equal to 10% of volume) of naturally accumulated sediment within historical channels, *i.e.,* based on the OHW level as the elevation datum. The calculation of the 10% excavation volume does not include manually placed fill, such as dikes, berms, or earthen plugs (see PDC 39). There is no limit as to the amount of excavation of anthropogenic fill within historical side channels as long as such channels can be clearly identified through field or aerial photographs. Excavation depth will not exceed the maximum thalweg depth in the main channel. Excavated material removed from off- or side-channels shall be hauled to an upland site or spread across the adjacent floodplain in a manner that does not restrict floodplain capacity.

38. **Streambank Restoration**
   a. The following streambank stabilization methods may be used individually or in combination:
      i. Alluvium placement
      ii. LW placement
      iii. Roughened toe

[19] Large side channels projects are essentially channel construction projects if they contain more than 20% of flow.

iv. Woody plantings
v. Herbaceous cover, in areas where the native vegetation does not include trees or shrubs
vi. Bank reshaping and slope grading
vii. Coir logs
viii. Deformable soil reinforcement
ix. Engineered log jams (ELJ)
x. Floodplain flow spreaders
xi. Floodplain roughness

b. For more information on the above methods see Federal Emergency Management Agency (2009)[20] or Cramer *et al.* (2003).[21] Other than those methods relying solely upon woody and herbaceous plantings, streambank stabilization projects should be designed by a qualified engineer that is appropriately registered in the state where the work is performed.
c. Rock will not be used for streambank restoration, except as ballast to stabilize LW. Stream barbs and full-spanning weirs are not allowed for stream bank stabilization under this opinion.
d. **Alluvium Placement** can be used as a method for providing bank stabilization using imported gravel/cobble/boulder-sized material of the same composition and size as that in the channel bed and banks to halt or attenuate streambank erosion, stabilize riffles, and provide critical spawning substrate for native fish. This method is predominantly for use in small to moderately sized channels and is not appropriate for application in mainstem systems. These structures are designed to provide roughness, redirect flow, and provide stability to adjacent streambed and banks or downstream reaches, while providing valuable fish and wildlife habitat.
   i. **NMFS fish passage review and approval.** NMFS will review alluvium placement projects that occupy more than 25% of the channel bed or more than 25% of the bankfull cross sectional area.
   ii. This design method is only approved in those areas where the natural sediment supply has been eliminated, significantly reduced through anthropogenic disruptions, or used to initiate or simulate sediment accumulations in conjunction with other structures, such as LW placements and ELJs.
   iii. Material used to construct the toe should be placed in a manner that mimics attached longitudinal bars or point bars.
   iv. Size distribution of toe material will be diverse and predominately comprised of D_{84} to D_{max} size class material.
   v. Spawning gravels will constitute at least one-third of the total alluvial material used in the design.
   vi. Spawning gravels are to be placed at or below an elevation consistent with the water surface elevation of a bankfull event.

[20] http://www.fema.gov/pdf/about/regions/regionx/Engineering_With_Nature_Web.pdf
[21] http://wdfw.wa.gov/publications/00046/wdfw00046.pdf

vii. Spawning size gravel can be used to fill the voids within toe and bank material and placed directly onto stream banks in a manner that mimics natural debris flows and erosion.
viii. All material will be clean alluvium with similar angularity as the natural bed material. When possible use material of the same lithology as found in the watershed. Reference *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008) to determine gravel sizes appropriate for the stream.
ix. Material can be mined from the floodplain at elevations above bankfull, but not in a manner that will cause stranding during future flood events.
x. Crushed rock is not permitted.
xi. After placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material.
xii. Do not place material directly on bars and riffles that are known spawning areas, which may cause fish to spawn on the unsorted and unstable gravel, thus potentially resulting in redd destruction.
xiii. Imported material will be free of invasive species and non-native seeds. If necessary, wash prior to placement.

e. **Large Wood Placements** are defined as structures composed of LW that do not use mechanical methods as the means of providing structure stability (*i.e.,* large rock, rebar, rope, cable, *etc*.). The use of native soil, run of alluvium, wood, or buttressing with adjacent trees as methods for providing structure stability are authorized. This method is predominantly for use in small to moderately sized channels and is not appropriate for application in mainstem systems. These structures are designed to provide roughness, redirect flow, and provide stability to adjacent streambed and banks or downstream reaches, while providing valuable fish and wildlife habitat.

i. **NMFS Review and Approval.** NMFS will review LW placement projects that would occupy greater than 25% of the bankfull cross section area.
ii. Structure shall simulate disturbance events to the greatest degree possible and include, but not be limited to, log jams, debris flows, wind-throw, and tree breakage.
iii. Structures may partially or completely span stream channels or be positioned along stream banks.
iv. Where structures partially or completely span the stream channel LW should be comprised of whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates.
v. Structures will incorporate a diverse size (diameter and length) distribution of rootwad or non-rootwad, trimmed or untrimmed, whole trees, logs, snags, slash, *etc*.
vi. For individual logs that are completely exposed, or embedded less than half their length, logs with rootwads should be a minimum of 1.5 times bankfull channel width, while logs without rootwads should be a minimum of 2.0 times bankfull width.

vii. Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.

f. Roughened toe

i. Minimum amount of wood incorporated into the treated area, for mitigation of riprap, is equal to the number of whole trees whose cumulative summation of rootwad diameters is equal to 80% of linear-feet of treated streambank.

g. Engineered log jams

i. See PDC 34b.

h. If LW mechanical anchoring is required, a variety of methods may be used. These include large angular rock, buttressing the wood between adjacent trees, or the use of manila, sisal or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, rebar pinning or bolted connections may be used. Use of cable is not covered by this opinion.

i. When a hole in the channel bed caused by local scour will be filled with rock to prevent damage to a culvert, road, or bridge foundation, the amount of rock will be limited to the minimum necessary to protect the integrity of the structure.

j. When a footing, facing, head wall, or other protection will be constructed with rock to prevent scouring or down-cutting of, or fill slope erosion or failure at, an existing culvert or bridge, the amount of rock used will be limited to the minimum necessary to protect the integrity of the structure. Whenever feasible, include soil and woody vegetation as a covering and throughout the structure.

k. Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous species. Vegetation, such as willow, sedge and rush mats, may be gathered from abandoned floodplains, stream channels, *etc.*

l. Do not apply surface fertilizer within 50 feet of any stream channel.

m. Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.

n. Conduct post-construction monitoring and treatment or removal of invasive plants until native plant species are well established.

39. **Set-Back or Removal of Existing Berms, Dikes, and Levees** will be conducted to reconnect historical fresh-water deltas to inundation, stream channels with floodplains, and historical estuaries to tidal influence. Such projects will take place where estuaries and floodplains have been disconnected from adjacent rivers through drain pipes and anthropogenic fill.

a. **Floodplains and freshwater deltas**

i. Design actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type.

ii. Remove drain pipes, fences, and other capital projects to the extent possible.

iii. To the extent possible, remove nonnative fill material from the floodplain to an upland site.

iv. Where it is not possible to remove or set-back all portions of dikes and berms, or in areas where existing berms, dikes, and levees support abundant riparian vegetation, openings will be created with breaches. Breaches shall be equal to or greater than the active channel width to reduce the potential for channel avulsion during flood events. In addition to other breaches, the berm, dike, or levee shall always be breached at the downstream end of the project or at the lowest elevation of the floodplain to ensure the flows will naturally recede back into the main channel, thus minimizing fish entrapment.

v. When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain to create set-back dikes and fill anthropogenic holes provided that floodplain function is not impeded.

b. **Estuary restoration**

i. Project implementation shall be conducted in a sequence that will not preclude repairing or restoring estuary functions once dikes/levees are breached and the project area is flooded.

ii. Culverts and tide gates will be removed using the PDC and conservation measures, where appropriate, as described in Work Area Isolation (PDC 27), Surface Water Withdrawals (PDC 23), and Fish Capture and Release (PDC 28) and Fish Passage Restoration (PDC 33) above.

iii. Temporary roads within the project area should be removed to allow free flow of water. Material either will be placed in a stable area above the ordinary high water line or highest measured tide or be used to restore topographic variation in wetlands.

iv. To the extent possible, remove segmented drain tiles placed to drain wetlands. Fill generated by drain tile removal will be compacted back into the ditch created by removal of the drain tile.

v. Channel construction may be done to recreate channel morphology based on aerial photograph interpretation, literature, topographic surveys, and nearby undisturbed channels. Channel dimensions (width and depth) are based on measurements of similar types of channels and the drainage area. In some instances, channel construction is simply breaching the levee. For these sites, further channel development will occur through natural processes.

vi. Fill ditches constructed and maintained to drain wetlands. Some points in an open ditch may be over-filled, while other points may be left as low spots to enhance topography and encourage sinuosity of the developing channel.

40. **Reduction/Relocation of Recreation Impacts** is intended to close, better control, or relocate recreation infrastructure and use along streams/shorelines/estuaries and within riparian areas. This includes removal, improvement, or relocation of infrastructure associated with designated campgrounds, dispersed camp sites, day-use sites, foot trails, and off-road vehicle roads/trails in riparian areas.

a. Design remedial actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type.
b. To the extent possible, non-native fill material shall be removed from the floodplain to an upland site.
c. Overburden or fill comprised of native materials, which originated from the project area, can be used to reshape the floodplain, placed in small mounds on the floodplain, used to fill anthropogenic holes, buried on site, or disposed into upland areas.
d. For recreation relocation projects—such as campgrounds, horse corrals, off-road vehicle trails—move current facilities out of the riparian area or as far away from the stream/shoreline as possible.
e. Consider de-compaction of soils and vegetation planting once overburden material is removed.
f. Place barriers—boulders, fences, gates, *etc.*—outside of the bankfull width and across traffic routes to prevent off-road vehicle access into and across streams.
g. For work conducted on off-road vehicle roads and trails, follow relevant PDC in Road and Trail Erosion Control and Decommissioning (PDC 45) below.

41. **Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering Facility** projects will be implemented by constructing fences to exclude riparian grazing, providing controlled access for walkways that livestock use to transit across streams and through riparian areas, and reducing livestock use in riparian areas and stream channels by providing upslope water facilities.

a. **Livestock fencing**
    i. To the extent possible, fences will be placed outside the channel migration zone and allow for lateral stream movement.
    ii. Minimize vegetation removal, especially potential LW recruitment sources, when constructing fence lines.
    iii. Where appropriate, construct fences at water gaps in a manner that allows passage of LW and other debris.

b. **Livestock stream crossings**
    i. The number of crossings will be minimized.
    ii. Locate crossings or water gaps where streambanks are naturally low. Livestock crossings or water gaps will not be located in areas where compaction or other damage can occur to sensitive soils and vegetation (*e.g.*, wetlands) due to congregating livestock.
    iii. To the extent possible, crossings will not be placed in areas where ESA-listed species spawn or are suspected of spawning (*e.g.*, pool tailouts where spawning may occur), or within 300-feet upstream of such areas.
    iv. Existing access roads and stream crossings will be used whenever possible, unless new construction will result in less habitat disturbance and the old trail or crossing is retired.
    v. Access roads or trails will be provided with a vegetated buffer that is adequate to avoid or minimize runoff of sediment and other pollutants to surface waters.

vi. Essential crossings will be designed and constructed or improved to handle reasonably foreseeable flood risks, including associated bedload and debris, and to prevent the diversion of streamflow out of the channel and down the trail if the crossing fails.

vii. If necessary, the streambank and approach lanes can be stabilized with native vegetation or angular rock to reduce chronic sedimentation. The stream crossing or water gap should be armored with sufficient sized rock (*e.g.*, cobble-size rock) and use angular rock if natural substrate is not of adequate size.

viii. Livestock crossings will not create barriers to the passage of adult and juvenile fish. Whenever a culvert or bridge—including bridges constructed from flatbed railroad cars, boxcars, or truck flatbeds—is used to create the crossing, the structure width will tier to project design criteria listed for Stream Simulation Culvert and Bridge Projects under Fish Passage Restoration (PDC 33).

ix. Stream crossings and water gaps will be designed and constructed to a width of 10 to 15 feet in the upstream-downstream direction to minimize the time livestock will spend in the crossing or riparian area.

x. When using pressure treated lumber for fence posts, complete all cutting/drilling offsite (to the extent possible) so that treated wood chips and debris do not enter water or flood prone areas.

xi. Riparian fencing is not to be used to create livestock handling facilities.

c. **Off-channel livestock watering facilities**

i. The development of a spring is not allowed if the spring is occupied by ESA-listed species.

ii. Water withdrawals will not dewater habitats or cause low stream flow conditions that could affect ESA-listed fish. Withdrawals may not exceed 10% of the available flow.

iii. Troughs or tanks fed from a stream or river will have an existing valid water right. Surface water intakes will be screened to meet the most recent version of NMFS fish screen criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011a), be self-cleaning, or regularly maintained by removing debris buildup. A responsible party will be designated to conduct regular inspection and as-needed maintenance to ensure pumps and screens are properly functioning.

iv. Place troughs far enough from a stream or surround with a protective surface to prevent mud and sediment delivery to the stream. Avoid steep slopes and areas where compaction or damage could occur to sensitive soils, slopes, or vegetation due to congregating livestock.

v. Ensure that each livestock water development has a float valve or similar device, a return flow system, a fenced overflow area, or similar means to minimize water withdrawal and potential runoff and erosion.

vi. Minimize removal of vegetation around springs and wet areas.

vii. When necessary, construct a fence around the spring development to prevent livestock damage.

42. **Piling and Other Structure Removal** includes the removal of untreated and chemically treated wood pilings, piers, vessels, boat docks, derelict fishing gear, as well as similar structures comprised of plastic, concrete, and other material. Pilings and other structures occur in estuaries, lakes, floodplains, and rivers, and are typically used in association with boat docks, structures, and other facilities.

a. **When removing an intact pile**

i. Install a floating surface boom to capture floating surface debris.

ii. To the extent possible, keep all equipment (*e.g.*, bucket, steel cable, vibratory hammer) out of the water, grip piles above the waterline, and complete all work during low water and low current conditions.

iii. Dislodge the piling with a vibratory hammer, whenever feasible. Never intentionally break a pile by twisting or bending.

iv. Slowly lift piles from the sediment and through the water column.

v. Place chemically-treated piles in a containment basin on a barge deck, pier, or shoreline without attempting to clean or remove any adhering sediment. A containment basin for the removed piles and any adhering sediment may be constructed of durable plastic sheeting with sidewalls supported by hay bales or another support structure to contain all sediment and return flow which may otherwise be directed back to the waterway.

vi. After piling removal, fill the holes left with clean, native sediments from the project area.

vii. Dispose of all removed piles, floating surface debris, any sediment spilled on work surfaces, and all containment supplies at a permitted upland disposal site.

b. **When removing a broken pile**

i. If a pile breaks above the surface of uncontaminated sediment, or less than 2 feet below the surface, make every attempt short of excavation to remove it entirely. If the pile cannot be removed without excavation, drive the pile deeper if possible.

ii. If dredging is likely in the area of piling removal, use a GPS (global positioning device) to note the location of all broken piles for future use in site debris characterization.

43. **Shellfish Bed/Nearshore Habitat Restoration** may involve shellfish bed restoration, replacing shore line armoring, and providing beach nourishment. An example of a sustainable restoration action might include restoration of sediment input to a nearshore by removing bulkheads at historical feeder bluff sites, thereby allowing gradual and ongoing erosion/mass wasting of bluffs and LW recruitment, instead of one-time beach nourishment. This opinion does not cover projects where the sole objective is to protect upland property or to cap contaminants.

a. **Shellfish bed restoration**

i. Shell or other substance used for substrate enhancement will be procured from clean sources that do not deplete the existing supply of shell bottom. Shells should be steam cleaned, left on dry land for a minimum of one month, or both, before placement in the aquatic environment. Shells from the local area should be used whenever possible.

ii. When placing shell substrate, juveniles, adults, or spat-on-shell in areas occupied by submerged aquatic vegetation, there will be an implementation plan submitted, detailing existing condition, density, and spatial extent of eelgrass; and proposed planting density and anticipated effects on eelgrass density and long-term viability. The implementation plan will provide reasonable assurances that submerged aquatic vegetation (SAV) will not be significantly affected, that there will be a net environmental benefit resulting from the action, or both.
iii. Molluscan shellfish and any co-planted submerged aquatic vegetation used for restoration will be species native to the project area.

b. **Replacing shoreline armoring** with more ecological designs to protect property, instead of riprap and traditional bulkheads. Project selection will require accurate assessment of existing conditions, erosion risks, and patterns of future degradation.
   i. Conduct a site assessment describing the conditions that created the need for the project and the mechanisms that underlie it. Site assessments also describe the natural resources and the human infrastructure within the project area and their respective risks. Effective project plans also will consider how the project fits in a broader geomorphologic and ecosystem context, the process unit. Alternatives to "hard armor" might include:
      1. Restoration of original shore geometry (bulkhead removal or setback)
      2. Beach nourishment (gravel beach design) when the goal of importing sediment is to reduce wave energy to the upper beach
      3. Grade control/slope support with large wood and/or rock
      4. Wood revetment or wood/rock revetment
      5. Biotechnical slope support (vegetated geogrids, soil pillows, *etc*.).[22]
   ii. Restrict plantings to native vegetation.

c. **Beach nourishment.** Projects may use sediment harvested during already permitted dredging activities and/or gravel from upland sources. Sediment is either trucked or barged in and placed in the high tide zone of the beach. There it is likely to be subsequently reworked and redistributed by wave action. Sustainable restoration efforts restore processes, not just specific elements or site characteristics that cannot be replenished naturally. The goal is to use indigenous materials to mimic natural processes, with the expectation that the nourished beach will perform much as a natural one. Consider extant wave exposure, supply and types of natural sources of sediment, net alongshore sediment transport, predicted sea level rise and the size of sediment. For example: if the goal is to restore historical surf smelt spawning habitat, sediment placement should include a sand/pea gravel mix, with the bulk in the 1-7 mm diameter range within the uppermost one-third of the tidal range (approximately +7 feet upward) (Penttila 2007).

[22] See *Alternative bank protection methods for Puget Sound shorelines* (Zelo *et al.* 2000) for examples of a variety of erosion control techniques, including bioengineering, gravel beach nourishment, and the active use of logs and woody debris.

i. **NMFS review and approval.** NMFS will review beach nourishment project plans to minimize potential adverse impacts to critical habitat/EFH such as eelgrass or other SAV, sea lion haulouts, and other resources that may be present. NMFS will also review monitoring reports.

ii. **Conduct topographic and bathymetric profile surveys** of the beach and offshore within the project and control areas. Pre- and post-construction surveys shall be conducted no more than 90 days before construction commences and no more than 60 days after construction ends.

iii. **Develop post-project monitoring plan.** The frequency and duration of monitoring should be commensurate with the scale and complexity of the project. Comparisons will be made between conditions at the project site after construction and those that were present before construction, or which exist on an adjacent reference beach similar in form to the constructed beach. (For very large projects performance monitoring of beach restoration projects often continue for 10 (biological performance) to 20 (physical performance) years.)

1. Physical monitoring surveys shall be conducted in years 1, 2, 3, 5, and 10, and during interim years as needed to investigate the functioning of the new beach. Beach/depth profile transect surveys shall be conducted during a spring or summer month and repeated as close as practicable during that same month of the year. Detailed maps of sampling locations shall be presented as needed.
2. Biological monitoring shall be conducted in years 2, 5, and 10 after completion of construction. Biological evaluation of the restored beach may include comparing pre-post project differences in the density of epibenthic zooplankton, numbers and length frequency of juvenile salmonids, and forage fish spawning. Detailed maps of sampling locations shall be presented as needed.

44. **In-Channel Nutrient Enhancement** includes the placement of salmon carcasses, salmon carcass analogs (SCA), or inorganic fertilizers in stream channels to help return stream nutrient levels back to historical levels. This action helps restore marine-derived nutrients to aquatic systems, thereby adding an element to the food chain that is important for growth of macroinvertebrates, juvenile salmonids, and riparian vegetation. Application and distribution of nutrients throughout a stream corridor can occur from bridges, stream banks, boats, or helicopter.

a. In Oregon, follow guidelines for the placement of carcasses in the Oregon Watershed Enhancement Board's (1999) Oregon Aquatic Habitat Restoration and Enhancement Guide. Projects are permitted through Oregon Department of Environmental Quality, which regulates the placement of carcasses instream as a discharge. Use carcasses from the treated watershed or those that are certified disease free by an Oregon Department of Fish and Wildlife (ODFW) pathologist.

b. In Washington, follow WDFW's *Protocols and Guidelines for Distributing Salmonid Carcasses, Salmon Carcass Analogs, and Delayed Release Fertilizers to Enhance Stream Productivity in Washington State* (Cramer 2012) or the most recent edition.

c. Ensure that the relevant streams have the capacity to capture and store placed carcasses.
d. Carcasses should be of species native to the watershed and placed during the normal migration and spawning times that would naturally occur in the watershed.
e. Do not supplement nutrients in eutrophic or naturally oligotrophic systems.

45. **Road and Trail Erosion Control and Decommissioning** includes hydrologically closing or decommissioning roads and trails, including culvert removal in perennial and intermittent streams; removing, installing or upgrading cross-drainage culverts; upgrading culverts on non-fish-bearing steams; constructing water bars and dips; reshaping road prisms; vegetating fill and cut slopes; removing and stabilizing of side-cast materials; grading or resurfacing roads that have been improved for aquatic restoration with gravel, bark chips, or other permeable materials; contour shaping of the road or trail base; removing road fill to native soils; and soil stabilization and tilling compacted surfaces to reestablish native vegetation. Such actions will target priority roads that contribute sediment to streams, block fish passage, or disrupt floodplain and riparian functions.

a. **Road decommissioning and stormproofing**
   i. For road decommissioning and hydrologic closure projects within riparian areas, recontour the affected area to mimic natural floodplain contours and gradient to the extent possible.
   ii. When obliterating or removing segments immediately adjacent to a stream, use sediment control barriers between the project and stream.
   iii. Dispose of slide and waste material in stable sites out of the flood-prone area. Native material may be used to restore natural or near-natural contours.
   iv. Drainage features used for stormproofing and treatment projects should be spaced as to hydrologically disconnect road surface runoff from stream channels. If grading and resurfacing is required, use gravel, bark, or other permeable materials for resurfacing.
   v. Minimize disturbance of existing vegetation in ditches and at stream crossings.
   vi. Conduct activities during dry-field conditions (generally May 15 to October 15) when the soil is more resistant to compaction and soil moisture is low.
   vii. When removing a culvert from a first or second order, non-fishing bearing stream, project specialists shall determine if culvert removal should include stream isolation and rerouting in project design. Culvert removal on fish bearing streams shall adhere to the measures described in Fish Passage Restoration (PDC 33).
   viii. For culvert removal projects, restore natural drainage patterns and channel morphology. Evaluate channel incision risk and construct in-channel grade control structures when necessary.

b. **Road relocation**
   i. When a road is decommissioned in a floodplain and future vehicle access through the area is still required, relocate the road as far as practical away from the stream.

ii. The relocation will not increase the drainage network and will be constructed to hydrologically disconnect it from the stream network to the extent practical. New cross drains shall discharge to stable areas where the outflow will quickly infiltrate the soil and not develop a channel to a stream.

iii. This consultation does not cover new road construction (not associated with road relocation) or routine maintenance within riparian areas.

46. **Juniper Tree Removal** will be conducted in riparian areas and adjoining uplands to help restore plant species composition and structure that would occur under natural fire regimes. Juniper removal will occur in those areas where juniper have encroached into riparian areas as a result of fire exclusion, thereby replacing more desired riparian plant species such as willow, cottonwood, aspen, alder, sedge, and rush. The following measures will apply:

a. Remove juniper to natural stocking levels where juniper trees are expanding into neighboring plant communities to the detriment of other native riparian vegetation, soils, or streamflow.

b. Do not cut old-growth juniper, which typically has several of the following features: sparse limbs, dead limbed or spiked-tops, deeply furrowed and fibrous bark, branches covered with bright-green arboreal lichens, noticeable decay of cambium layer at base of tree, and limited terminal leader growth in upper branches, as described by Miller *et al.* (2005).

c. Felled trees may be left in place, lower limbs may be cut and scattered, or all or part of the trees may be used for streambank or wetland restoration (*e.g.*, manipulated as necessary to protect riparian or wetland shrubs from grazing by livestock or wildlife or otherwise restore ecological function in floodplain, riparian, and wetland habitats).

d. Where appropriate, cut juniper may be placed into stream channels and floodplains to provide aquatic benefits. Juniper can be felled or placed into the stream to promote channel aggradation as long as such actions do not obstruct fish movement and use of spawning gravels or increase width to depth ratios.

e. On steep or south-facing slopes, where ground vegetation is sparse, leave felled juniper in sufficient quantities to promote reestablishment of vegetation and prevent erosion.

f. If seeding is a part of the action, consider whether seeding will be most appropriate before or after juniper treatment.

g. When using feller-buncher and slash-buster equipment, operate equipment in a manner that minimizes soil compaction and disturbance to soils and native vegetation to the extent possible. Equipment exclusion areas (buffer area along stream channels) should be as wide as the feller-buncher or slash-buster arm.

47. **Bull Trout Protection** includes the removal of brook trout or other non-native fish species via electrofishing or other manual means to reduce competition or hybridization with bull trout.

a. The measures specified in this PDC are designed to protect ESA-listed species under NMFS' jurisdiction. This opinion does not authorize incidental take for bull trout.

b. For brook trout or other non-native fish species removal, staff experienced in the specific removal method shall be involved in project design and implementation.
c. When using electrofishing for removal of brook trout or other non-native fish species, use the following guidelines:
    i. Electrofishing shall be conducted using the methods outlined in the NMFS' guidelines (NMFS 2000).
    ii. Electrofishing equipment shall be operated at the lowest possible effective settings to minimize injury or mortality to bull trout.
    iii. To reduce adverse effects to bull trout, electrofishing shall only occur from May 1 (or after emergence occurs) to July 31 in known bull trout spawning areas. No electrofishing will occur in any bull trout habitat after August 15.
    iv. Electrofishing shall not be conducted when the water conditions are turbid and visibility is poor. This condition may be experienced when the sampler cannot see the stream bottom in 1 foot of water.
    v. Electrofishing will not be conducted within core areas that contain 100 or fewer adult bull trout.
d. Other removal methods, such as dip netting, spearing, and other means can be used.

48. **Beaver Habitat Restoration** includes installation of in-channel structures to encourage beavers to build dams in incised channels and across potential floodplain surfaces.

a. **In-channel structures**
    i. Consist of porous channel-spanning structures comprised of biodegradable vertical posts (beaver dam support structures) approximately 0.5 to 1 meter apart and at a height intended to act as the crest elevation of an active beaver dam. Variation of this restoration treatment may include post lines only, post lines with wicker weaves, construction of starter dams, reinforcement of existing active beaver dams, and reinforcement of abandoned beaver dams as described by Pollock *et al.* (2013 *(In prep.);* 2012a).
    ii. Place beaver dam support structures in areas conducive to dam construction as determined by stream gradient or historical beaver use.
    iii. Place in areas with sufficient deciduous shrub and trees to promote sustained beaver occupancy.
b. **Habitat Restoration**
    i. Beaver Restoration activities may include planting riparian hardwoods (species such as willow, red osier dogwood, and alder) and building exclosures (such as temporary fences) to protect and enhance existing or planted riparian hardwoods until they are established as described by the Malheur National Forest and the Keystone Project (2007).
    ii. Maintain or develop grazing plans that will ensure the success of beaver habitat restoration objectives.

49. **Wetland Restoration** restores degraded wetlands by (a) excavation and removal of fill materials; (b) contouring to reestablish more natural topography; (c) setting back existing dikes, berms and levees; (d) reconnecting or recreating historical tidal and fluvial channels; (e) planting native wetland species; or (f) a combination of the above methods.

This action does not include installation of water control structures or fish passage structures.

a. Include applicable General Construction Measures (PDC 13-32) and PDC for specific types of actions as applicable (*e.g.*, Off- and Side-Channel Habitat Restoration (PDC 37); Set-Back or Removal of Existing Berms, Dikes, and Levees for Wetland and Estuary Restoration (PDC 39); and Dam and Legacy Structure Removal (PDC 35)) to ensure that all adverse effects to fish and their designated critical habitats are within the range of effects considered in this opinion.

50. **Tide/Flood Gate Removal, Replacement, or Retrofit** projects may include the removal, replacement, or the upgrade of existing tide and flood gates by modifying gate components and mechanisms in tidal stream systems where full tidal exchange is incompatible with current land use where backwater effects are of concern. Projects will be implemented to reconnect stream/slough corridors, floodplains, and estuaries, reestablish wetlands, improve aquatic organism passage, and restore more natural channel and flow conditions. Tide/flood gate replacement or retrofit may include, but is not limited to, excavation of existing channels, adjacent floodplains, flood channels, and wetlands, and may include structural elements such as streambank restoration and hydraulic roughness elements. Placement of new gates where they did not previously exist is not covered in this consultation.

a. **NMFS review and approval.** NMFS will review tide/flood gate removal, replacement, and retrofit projects for consistency with *Anadromous Salmonid Passage Facility Design* (NMFS 2011a).
b. For removal projects, if a culvert or bridge will be constructed at the location of a removed tide gate, the structure will be large enough to allow for a full tidal exchange.
c. Follow PDC for Staging, Storage, and Stockpile Areas (#16), Hazardous Material Spill Prevention and Control (#18), Equipment, Vehicles, and Power Tools (#19), Surface Water Withdrawal and Construction Discharge Water (#23), Work Area Isolation (#27), Timing of In-Water Work (# 25), Fish Capture and Release (# 28); Site Restoration (#31), and Revegetation (#32). Excavation below the OHW line shall be conducted to the maximum extent possible during low tide cycles or low flow cycles in the downstream watercourse.
d. **Overall design goals.** Tide/flood gate replacement or retrofit design data will demonstrate:
    i. A clear linkage to limiting factors identified within an appropriate sub-basin plan or recovery plan, or based on recommendations by a technical oversight and steering committee within a localized region.
    ii. The identification and, to the extent possible, the correction of the degraded baseline condition.
    iii. The use of analytical approaches for determination of the tidal prism and exchange.
    iv. Appropriate self-sustaining hydrologic design that includes climate change to reduce maintenance.

e. **General project design criteria**
   i. Site specific project design criteria will be set based on tidal restoration, fish passage, and flood protection needs as determined and set forth by the RRT.
   ii. Tide/Flood Gate Replacement or Retrofit Options
      1. Dike removal
      2. Dike breach
      3. Dike setback
      4. Bridge
      5. Non-gated pipe (NGP) or "bare" culvert
         a. Existing pipe minus the tide gate (removed)
         b. Installation of new pipe minus a tide gate
   iii. Tide Gate
      1. Fiberglass or aluminum gate
      2. Side hinged gate
      3. Self-regulating tide gate (SRT)
         a. Tension (cable) operated
         b. Float (cam) operated
   iv. Hybrid (such as SRT coupled with NGP)
   v. Other design options as recommended by the RRT
   vi. Design actions to restore tidal exchange characteristics—elevation, cross-sectional area, timing—in a manner that closely mimics, to the greatest degree possible, those that would naturally occur at that stream type.

f. **Design report & associated documentation.** Tide/flood gate replacement and retrofit design and adaptive management documentation shall include:
   i. Background and Problem Statement
      1. Site history
      2. Environmental baseline
      3. Problem Description
      4. Cause of problem
   ii. Project Description
      1. Goals/objectives
      2. Project elements
      3. Sequencing, implementation
         a. Place cofferdam upstream of the culvert to prevent drainage water from entering the work area. A downstream cofferdam will also be installed to isolate the work area from the watercourse.
         a. The existing culvert requiring replacement is then excavated with equipment staged on the dike or shoreline above OHW.
         b. Excavated material is stockpiled upland for replacement in the dike once the new culvert is in-place.
         c. Waste water removed from within the cofferdam work area shall be discharged to a location landward of OHW line in

a manner that allows removal of fine sediments prior to the discharged water returning to the watercourses.

d. Upon completion of the tide gate/flood gate repairs and/or replacement, all material used to construct the cofferdams shall be removed from the watercourses and the project site returned to pre-project or improved conditions.

e. Restore LW features to redeveloping tidal channels.

f. Drainage ditches will be filled to become part of the surrounding contiguous tidal marsh or will be modified to become part of the tidal channel network.

4. Proposed work window
5. Recovery trajectory: How will the new stream channel develop and evolve?

iii. Design Analysis, including technical analyses, computations relating design to analysis, and references. Analyses shall be appropriate to the level of project complexity. At a minimum, analyses will include the following:

1. Hydraulic Analysis
    a. Model conditions, duration, boundary conditions, inputs, and outputs will be collaboratively developed by RRT and modeler.
2. Sediment Assessment
3. Risk Analysis

iv. Detailed construction drawings

v. Other regulatory jurisdictions for tide and floodgate repair and replacement will also be addressed: *i.e.,* ACOE, River and Harbors Act §10, Clean Water Act §404, CZMA, ODFW Fish Passage OAR; ODEQ & WDOE §401, WDFW Hydraulic Project Approval, Washington Environmental Policy Act evaluation, Washington Shoreline Management Act

vi. River Restoration Tool. Review by the RRT will also include an evaluation using the River Restoration Analysis Tool (restorationreview.com), and therefore the following questions will be addressed in the project documentation:

1. Problem Identification
    a. Is the problem identified?
    b. Are causes identified at appropriate scales?
2. Project Context
    a. Is the project identified as part of a plan, such as a watershed action plan or recovery plan?
    b. Does the project consider ecological, geomorphic, and socioeconomic context?
3. Goals & Objectives
    a. Do goals and objectives address problem, causes, and context?
    b. Are objectives measurable?

4. Alternatives Evaluation
    a. Were alternative considered?
    b. Are uncertainties and risk associated with selected alternative acceptable?
5. Project Design
    a. Do project elements collectively support project objectives?
    b. Are design criteria defined for all project elements?
    c. Do project elements work with stream processes to create and maintain habitat?
    d. Is the technical basis of design sound for each project element?
6. Implementation
    g. Are plans and specifications sufficient in scope and detail to execute the project?
    h. Does plan address potential implementation impacts and risks?
7. Monitoring and Management
    a. Does monitoring plan address project compliance?
    b. Does monitoring plan directly measure project effectiveness?
    c. Does the maintenance plan include replacement for components that corrode over time?

g. **Monitoring and adaptive management.** Develop a monitoring and adaptive management plan that has been reviewed and approved by the RRT, that includes the following:
    i. Introduction
    ii. Existing monitoring protocols
    iii. Project effectiveness monitoring plan
    iv. Project review team triggering conditions
    v. Monitoring frequency, timing, and duration
    vi. Monitoring technique protocols
    vii. Data storage and analysis
    viii. Monitoring quality assurance plan
    ix. Literature cited

The NMFS relied on the foregoing description of the proposed action, including all PDC, to complete this consultation. However, unforeseen occurrences or changed circumstances encountered while carrying out the proposed action may require a significant change in the proposed design, construction methods, or other on-the-ground practices.

These changes may, in turn, result in effects of the action which exceed the amount or extent of take specified in the incidental take statement or otherwise affect listed species or designated critical habitat in ways not previously considered. Therefore, USFWS, NOAA RC, or any other cooperating party will keep NMFS informed of any such changes to ensure that conclusions drawn during consultation remain valid.

1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For this consultation, the overall program action area consists of the combined action areas for each action to be authorized or carried out under this opinion within the range of ESA-listed salmon or steelhead, green sturgeon, and eulachon designated critical habitat, or designated EFH in Oregon,[23] Washington, and Idaho. Additionally, the action area includes all Puget Sound waters accessible to listed bocaccio, canary rockfish, and yelloweye rockfish. The action area also includes the Hoh-Quillayute sub-basin whose watershed includes habitat for the Lake Ozette sockeye (Table 1). The action area includes all upland, riparian and aquatic areas affected by site preparation, construction, and site restoration design criteria at each action site.

Each individual project authorized under this opinion will have a project-level action area that exists within the program action area. Individual project-level action areas include riparian areas, banks, and the stream channel in an area extending no more than 150 feet upstream (the beneficial effects of the action can extend much further upstream if fish passage is restored) and 300 feet downstream from the action footprint, where aquatic habitat conditions will be temporarily degraded until site restoration is complete. This estimate is based on an analysis of typical turbidity flux downstream from a nonpoint discharge in a stream with a low flow channel that is greater than 200 feet, although the actual turbidity flux at each project site is likely to be proportionately smaller for streams with a smaller low flow channel width (Rosetta 2005), or may be somewhat greater for project areas that are subject to tidal or coastal scour.

2. ENDANGERED SPECIES ACT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the USFWS, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat.

Section 7(b)(3) requires that at the conclusion of consultation, the Service provide an opinion stating how the agencies' actions will affect listed species or their critical habitat. If incidental take is expected, section 7(b)(4) requires the provision of an incidental take statement specifying the impact of any incidental taking, and including reasonable and prudent measures to minimize such impacts.

[23] The waters that form the Klamath River system do not fall within the action area because the Klamath basin is not within the NMFS West Coast Region's area of responsibility in Oregon and thus no USFWS and NOAA RC projects will be authorized within that basin (nor will USFWS and NOAA RC projects authorized in other areas have effects in that basin).

2.1 Approach to the Analysis

Section 7(a)(2) of the ESA requires Federal agencies to consult with NMFS to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts to the conservation value of the designated critical habitat.

"To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02).

This opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[24]

We will use the following approach to determine whether the proposed action described in Section 1.3 is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
- Reach jeopardy and adverse modification conclusions.
- If necessary, define a reasonable and prudent alternative to the proposed action.

In this opinion, NMFS concludes that the proposed action is not likely to adversely affect (NLAA) southern DPS green sturgeon or their designated critical habitat, or southern resident killer whales, which do not have designated critical habitat in the action area. See section 2.11 for details.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be affected by the proposed action. The status is the level of risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical

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[24] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large is climate change.

2.2.1 Status of the Species

For Pacific salmon, steelhead, and other relevant species NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany *et al.* 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These attributes are influenced by survival, behavior, and experiences throughout a species' entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends fundamentally on habitat quality and spatial configuration and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation at single genes to complex life history traits (McElhany *et al.* 2000).

"Abundance" generally refers to the number of naturally-produced adults (*i.e*., the progeny of naturally-spawning parents) in the natural environment (*e.g*., on spawning grounds).

"Productivity," as applied to viability factors, refers to the entire life cycle; *i.e*., the number of naturally-spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany *et al*. (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species' populations has been determined, NMFS assesses the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany *et al.* 2000).

The summaries that follow describe the status of the 20 ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this opinion. More detailed information on the status and trends of the species considered in this opinion, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register (Table 1).

Climate change is likely to play an increasingly important role in determining the abundance of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. Areas with elevations high enough to maintain temperatures well below freezing for most of the winter and early-spring will be less affected. Low-elevation areas are likely to be more affected.

During the last century, average regional air temperatures increased by 1.5°F, and increased up to 4°F in some areas. Warming is likely to continue during the next century as average temperatures increase another 3 to 10°F. Overall, about one-third of the current cold-water fish habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (USGCRP 2009).

Precipitation trends during the next century are less certain than for temperature but more precipitation is likely to occur during October through March and less during summer months, and more of the winter precipitation is likely to fall as rain rather than snow (ISAB 2007; USGCRP 2009). Where snow occurs, a warmer climate will cause earlier runoff so stream flows in late spring, summer, and fall will be lower and water temperatures will be warmer (ISAB 2007; USGCRP 2009).

Higher winter stream flows increase the risk that winter floods in sensitive watersheds will damage spawning redds and wash away incubating eggs. Earlier peak stream flows will also flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and the risk of predation. Lower stream flows and warmer water temperatures during summer will degrade summer rearing conditions, in part by increasing the prevalence and virulence of fish diseases and parasites (USGCRP 2009). Other adverse effects are likely to include altered migration patterns, accelerated embryo development, premature emergence of fry, variation in quality and quantity of tributary rearing habitat, and increased competition and predation risk from warm-water, non-native species (ISAB 2007).

The earth's oceans are also warming, with considerable interannual and inter-decadal variability superimposed on the longer-term trend (Bindoff *et al.* 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances (Scheuerell and Williams 2005; USGCRP 2009; Zabel *et al.* 2006). Ocean conditions adverse to salmon and steelhead may be more likely under a warming climate (Zabel *et al.* 2006).

The status of species and critical habitat sections below are organized under four recovery domains (Table 5) to better integrate recovery planning information that NMFS is developing on the conservation status of the species and critical habitats considered in this consultation.

Recovery domains are the geographically-based areas that NMFS is using to prepare multi-species recovery plans.

Table 5. Recovery planning domains identified by NMFS and their ESA-listed salmon and steelhead species.

Recovery Domain	Species
Puget Sound	PS Chinook salmon Hood Canal (HC)HC summer-run chum salmon Lake Ozette sockeye salmon PS steelhead
Willamette-Lower Columbia (WLC)	LCR Chinook salmon UWR Chinook salmon CR chum salmon LCR coho salmon LCR steelhead UWR steelhead
Interior Columbia (IC)	UCR spring-run Chinook salmon SR spring/summer-run Chinook salmon SR fall-run Chinook salmon SR sockeye salmon MCR steelhead UCR steelhead SRB steelhead
Oregon Coast (OC)	OC coho salmon
Southern Oregon/Northern California Coasts (SONCC)	SONCC coho salmon

For each recovery domain, a technical review team (TRT) appointed by NMFS has developed, or is developing, criteria necessary to identify independent populations within each species, recommended viability criteria for those species, and descriptions of factors that limit species survival. Viability criteria are prescriptions of the biological conditions for populations, biogeographic strata, and evolutionarily significant units (ESU) that, if met, would indicate that an ESU will have a negligible risk of extinction over a 100-year time frame.[25]

Although the TRTs operated from the common set of biological principals described in McElhany *et al.* (2000), they worked semi-independently from each other and developed criteria suitable to the species and conditions found in their specific recovery domains. All of the criteria

[25] For Pacific salmon, NMFS uses its 1991 ESU policy, that states that a population or group of populations will be considered a Distinct Population Segment if it is an Evolutionarily Significant Unit. An ESU represents a distinct population segment of Pacific salmon under the Endangered Species Act that 1) is substantially reproductively isolated from conspecific populations and 2) represents an important component of the evolutionary legacy of the species. The species *O. mykiss* is under the joint jurisdiction of NMFS and the Fish and Wildlife Service, so in making its listing January, 2006 determinations NMFS elected to use the 1996 joint FWS-NMFS DPS policy for this species.

have qualitative as well as quantitative aspects. The diversity of salmonid species and populations makes it impossible to set narrow quantitative guidelines that will fit all populations in all situations.

For this and other reasons, viability criteria vary among species, mainly in the number and type of metrics and the scales at which the metrics apply (*i.e.*, population, major population group (MPG), or ESU) (Busch *et al.* 2008).

The abundance and productivity (A&P) score considers the TRT's estimate of a populations' minimum threshold population, natural spawning abundance and the productivity of the population. Productivity over the entire life cycle and factors that affect population growth rate provide information on how well a population is "performing" in the habitats it occupies during the life cycle. Estimates of population growth rate that indicate a population is consistently failing to replace itself are an indicator of increased extinction risk. The four metrics (abundance, productivity, spatial structure, and diversity) are not independent of one another and their relationship to sustainability depends on a variety of interdependent ecological processes (Wainwright *et al.* 2008).

Integrated spatial structure and diversity (SS/D) risk combines risk for likely, future environmental conditions, and diversity (Ford 2011; McElhany *et al.* 2007; McElhany *et al.* 2000). Diversity factors include:

- *Life history traits* include the distribution of major life history strategies within a population, variability of traits, mean value of traits, and loss of traits.
- *Effective population size*: One of the indirect measures of diversity is effective population size. A population at chronic low abundance or experiencing even a single episode of low abundance is at a higher extinction risk because of loss of genetic variability, inbreeding and the expression of inbreeding depression, or the effects of mutation accumulation.
- *Impact of hatchery fish*: Interbreeding of wild populations and hatchery origin fish are a significant risk factor to the diversity of wild populations if the proportion of hatchery fish in the spawning population is high and their genetic similarity to the wild population is low.
- *Anthropogenic mortality:* The susceptibility to mortality from harvest or habitat alterations will differ depending on size, age, run timing, disease resistance or other traits.
- *Habitat diversity:* Habitat characteristics have clear selective effects on populations, and changes in habitat characteristics are likely to eventually lead to genetic changes through selection for locally adapted traits. In assessing risk associated with altered habitat diversity, historical diversity is used as a reference point.

Overall viability risk scores (high to low) and population persistence scores are based on combined ratings for the A&P and SS/D[26] metrics (Table 6) (McElhany *et al.* 2006). Persistence probabilities, which are provided here for Lower Columbia River salmon and steelhead, are the complement of a population's extinction risk (*i.e.*, persistence probability = 1 – extinction risk) (NMFS 2013a). The IC-TRT has provided viability criteria that are based on McElhany (2000)

[26] The WLC-TRT provided ratings for diversity and spatial structure risks. The IC-TRT provided spatial structure and diversity ratings combined as an integrated SS/D risk.

and McElhany (2006), as well as the results of previous applications in other TRTs and a review of specific information available relative to listed IC ESU populations (Ford 2011; IC-TRT 2007).

Table 6. Population persistence categories from McElhany *et al.* (2006). A low or negligible risk of extinction is considered "viable" (Ford 2011). Population persistence categories correspond to: 4 = very low (VL), 3 = low (L), 2 = moderate (M), 1 = high (H), and 0 = very high (VH) in Oregon populations, which corresponds to "extirpated or nearly so" (E) in Washington populations (Ford 2011).

Population Persistence Category	Probability of population persistence in 100 years	Probability of population extinction in 100 years	Description
0	0-40%	60-100%	Either extinct or "high" risk of extinction
1	40-75%	25-60%	Relatively "high" risk of extinction in 100 years
2	75-95%	5-25%	"Moderate" risk of extinction in 100 years
3	95-99%	1-5%	"Low" (negligible) risk of extinction in 100 years
4	>99%	<1%	"Very low" risk of extinction in 100 years

The boundaries of each population were defined using a combination of genetic information, geography, life-history traits, morphological traits, and population dynamics that indicate the extent of reproductive isolation among spawning groups. To date, the TRTs have divided the 19 species of salmon and steelhead considered in this opinion into a total of 304 populations, although the population structure of Puget Sound (PS) steelhead has yet to be resolved. The overall viability of a species is a function of the VSP attributes of its constituent populations. Until a viability analysis of a species is completed, the VSP guidelines recommend that all populations should be managed to retain the potential to achieve viable status to ensure a rapid start along the road to recovery, and that no significant parts of the species are lost before a full recovery plan is implemented (McElhany *et al.* 2000).

The size and distribution of the populations considered in this opinion generally have declined over the last few decades due to natural phenomena and human activity, including climate change (as described in section 2.2), the operation of hydropower systems, over-harvest, effects of hatcheries, and habitat degradation.

Enlarged populations of terns, seals, California sea lions, and other aquatic predators in the Pacific Northwest may be limiting the productivity of some Pacific salmon and steelhead populations (Ford 2011).

Viability status or probability or population persistence is described below for each of the populations considered in this opinion. Although eulachon are part of more than one recovery domain structure, they are presented below for convenience as part of the PS recovery domain.

Puget Sound Recovery Domain. Species considered in the PS recovery domain include PS Chinook salmon, Hood Canal (HC) summer-run chum salmon, Lake Ozette (LO) sockeye salmon, PS steelhead, and southern DPS eulachon. The PS TRT has identified 22 extant demographically-independent populations of Chinook salmon and two of summer-run chum salmon,[27] (Ford 2011)(Table 7). These populations were further aggregated into strata, groupings above the population level that are connected by some degree of migration, based on ecological subregions. The PS steelhead TRT has not yet finalized its viability criteria for the PS steelhead DPS and is still conducting analyses to identify populations and MPGs within the DPS.

Table 7. Numbers of historical and extant populations for ESA-listed salmon and steelhead in the PS recovery domain (Ford 2011).

Species	Historical Populations	Extant Populations
PS Chinook salmon	31	22
HC summer-run chum salmon	18	2
LO sockeye salmon	1	1
PS steelhead	Not available	

Status of PS Chinook Salmon

Spatial Structure and Diversity. This species includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington, and progeny of 26 artificial propagation programs. The PS-TRT identified 22 historical populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity (Table 8). The NMFS adopted the Shared Strategy for Puget Sound's locally-developed listed species recovery plan for PS Chinook salmon in 2007 (Shared Strategy for Puget Sound 2007).

[27] One HC chum salmon population has four extant spawning aggregations and one has 10 extant spawning aggregations; some of these are recently reintroduced. Spawning aggregations are also referred to as subpopulations.

Table 8. Extant PS Chinook salmon populations in each geographic region (Ford 2011).

Geographic Region	Population (Watershed)
Strait of Georgia	North Fork Nooksack River
	South Fork Nooksack River
Strait of Juan de Fuca	Elwha River
	Dungeness River
Hood Canal	Skokomish River
	Mid Hood Canal River
Whidbey Basin	Skykomish River
	Snoqualmie River
	North Fork Stillaguamish River
	South Fork Stillaguamish River
	Upper Skagit River
	Lower Skagit River
	Upper Sauk River
	Lower Sauk River
	Suiattle River
	Upper Cascade River
Central/South Puget Sound Basin	Cedar River
	North Lake Washington/ Sammamish River
	Green/Duwamish River
	Puyallup River
	White River
	Nisqually River

Indices of spatial distribution and diversity have not been developed at the population level. Based on a Shannon Diversity Index at the ESU level, diversity is declining (due primarily to the increased abundance of returns to the Whidbey Basin region) for both distribution among populations and among regions (Ford 2011). Overall, the new information on abundance, productivity, spatial structure and diversity since the 2005 status review does not indicate a change in the biological risk category (Ford 2011).

Abundance and Productivity. No trend was notable for the total ESU escapements; while trends vary from decreasing to increasing among populations. Natural-origin pre-harvest recruit escapements remained fairly constant from 1985-2009. Returns (pre-harvest run size) from the natural spawners were highest in 1985, declined through 1994, remained low through 1999, increased in 2000 and again in 2001, and have declined through 2009, with 2009 having the lowest returns since 1997. Median recruits per spawner for the last 5-year period (brood years 2002-2006) is the lowest over any of the 5-year intervals. Many of the habitat and hatchery actions identified in the Puget Sound Chinook salmon recovery plan are likely to take years or decades to be implemented and to produce significant improvements in natural population attributes, and these trends are consistent with these expectations (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011; Shared Strategy for Puget Sound 2007; SSPS 2007):

- Degraded nearshore and estuarine habitat: Residential and commercial development has reduced the amount of functioning nearshore and estuarine habitat available for salmon rearing and migration. The loss of mudflats, eelgrass meadows, and macroalgae further limits salmon foraging and rearing opportunities in nearshore and estuarine areas.
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, stream substrate, and water quality have been degraded for adult spawning, embryo incubation, and rearing as a result of cumulative impacts of agriculture, forestry, and development.
- Anadromous salmonid hatchery programs: Salmon and steelhead released from Puget Sound hatcheries operated for harvest augmentation purposes pose ecological, genetic, and demographic risks to natural-origin Chinook salmon populations.
- Salmon harvest management: Total fishery exploitation rates have decreased 14 to 63% from rates in the 1980s, but weak natural-origin Chinook salmon populations in Puget Sound still require enhanced protective measures to reduce the risk of overharvest in Chinook salmon-directed fisheries.

Status of HC Summer-run Chum Salmon

Spatial Structure and Diversity. This species includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries; populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington; and progeny of eight artificial propagation programs. The Strait of Juan de Fuca population spawns in rivers and streams entering the eastern Strait and Admiralty Inlet. The Hood Canal population includes all spawning aggregations within the Hood Canal area (Hood Canal Coordinating Council 2005; NMFS 2007b). The PS-TRT identified two independent populations of Hood Canal summer chum salmon (NMFS 2007a), which include 16 historical stocks or spawning aggregations (including eight that are extant), based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity (Table 9). The historical populations included at least those 16 spawning aggregation units and likely some additional undocumented and less-persistent aggregations (NMFS 2007a). Programs are underway to reintroduce summer-run chum salmon to several of the watersheds where stocks were lost.

Table 9. HC summer-run chum salmon populations (geographic regions), population aggregations, and their status (Ford 2011).

Geographic Region (Population)	Stock (Watershed)	Status
Strait of Juan de Fuca	Dungeness River	Unknown <5 adult returns annually recently
	Jimmycomelately Creek	Extant
	Salmon River	Extant
	Snow River	Extant
	Chimacum Creek	Extinct but reintroduced with natural spawning reported starting in 1999
Hood Canal	Big Quilcene River	Extant
	Little Quilcene River	Extant
	Dosewallips River	Extant
	Duckabush River	Extant
	Hamma Hamma River	Extant
	Lilliwaup Creek	Extant
	Big Beef Creek	Extinct but reintroduced with adult returns reported starting in 2001
	Anderson Creek	Extinct
	Dewatto Creek	Extinct, no returns mid 1990's, some natural recolonization apparent but numbers remain low (<70 annually)
	Tahuya River	Extinct but reintroduced with increased adult returns reported starting 2006
	Union River	Extant
	Skokomish River	Extinct; no spawning reported prior to 2001; very low numbers of adult returns (<40 annually) reported in recent years
	Finch Creek	Extinct

Diversity is increasing from the low values seen in the 1990s, due both to the reintroduction of spawning aggregates and the more uniform relative abundance between populations; this is a good sign for viability in terms of spatial structure and diversity. Spawning survey data shows that the spawning distribution within most streams has been extended farther upstream as abundance has increased (WDFW and Point No Point Treaty Tribes 2007). Estimates of population viability from three time periods (brood years 1971-2006, 1985-2006, and 1990-2006) all indicate that Hood Canal and Strait of Juan de Fuca populations of summer-run chum salmon are not currently viable (Ford 2011).

Abundance and Productivity. Overall, the new information considered does not indicate a change in the biological risk category since the last status review in 2005 (Ford 2011). The spawning abundance of this species has clearly increased since the time of listing, although the recent abundance is down from the previous 5 years. However, productivity in the last 5-year period (2002-2006) has been very low, especially compared to the relatively high productivity in the 5-10 previous years (WDFW and Point No Point Treaty Tribes 2007). This is a concern for viability. Since abundance is increasing and productivity is decreasing, improvements in habitat and ecosystem function likely are needed.

Limiting factors include (Hood Canal Coordinating Council 2005; NMFS 2007b; NOAA Fisheries 2011):

- Nearshore and estuarine habitat throughout the range of the species has been altered by human activities. Nutrient loading has lowered dissolved oxygen concentrations, which can kill or stress marine organisms, including salmon. Residential and commercial development has reduced the amount of functioning habitat available for salmon rearing and migration. The loss of mudflats, eelgrass meadows, and macroalgae further limits salmon foraging and rearing opportunities in nearshore and estuarine areas.
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, stream substrate, and stream flow have been degraded as a result of cumulative impacts of agriculture, forestry, and development.

Status of LO Sockeye Salmon

Spatial Structure and Diversity. This species includes all naturally spawned populations of sockeye salmon in Ozette Lake and streams and tributaries flowing into Ozette Lake, Washington, and progeny of two artificial propagation programs. The LO Technical Recovery Team concluded that five extant spawning aggregations in Ozette Lake are different subpopulations within a single population (Currens *et al.* 2009; NMFS 2009a). The subpopulations can be grouped according to whether they spawn in tributaries or near lake beaches (NMFS 2009a).

Abundance and Productivity. LO sockeye salmon population sizes remain very small compared to historical sizes. Additionally, population estimates remain highly variable and uncertain, making it impossible to detect changes in abundance trends or in productivity in recent years. The most recent brood years (1999-2003) have had the lowest average recruits per spawner. Spatial structure and diversity are also difficult to appraise; there is currently no successfully quantitative program to monitor beach spawning or spawning at other tributaries. Assessment methods must improve to evaluate the status of this species and its responses to recovery actions. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting factors include (NMFS 2009a; NOAA Fisheries 2011; USDC 2009a):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, lake beach spawning habitat, and stream substrate have been degraded as a result of cumulative impacts of forest practices, agriculture, and development.
- Predation: Harbor seals and river otters, and predaceous non-native and native fish species, are reducing the abundance of adult fish that successfully spawn, and the abundance of sockeye smolts escaping seaward from the watershed each year.

Status of PS Steelhead

Spatial Structure and Diversity. Steelhead populations can be divided into two basic reproductive ecotypes, based on the state of sexual maturity at the time of river entry (summer or winter) and duration of spawning migration (Burgner *et al.* 1992)(Table 10).

The PS DPS includes all naturally spawned anadromous winter-run and summer-run steelhead populations in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive), as well as the Green River natural and Hamma Hamma winter-run steelhead hatchery stocks. Non-anadromous ‘‘resident’’ *O. mykiss* occur within the range of PS steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard *et al.* 2007; USDC 2007).

Table 10. PS steelhead populations and risk of extinction (Ford 2011).

Geographic Region (MPGs)	**Population (Watershed)**	**Extinction Risk (probability of decline to 10% of its current estimated abundance)**
Northern Cascades	Samish River (winter)	High—about 80% within 25 years
	Skagit River (winter)	High—about 80% within 75 years.
	Snohomish River (winter)	Moderately High—about 50% within 100 years
	Stillaguamish River (winter)	High—about 90% within 60 years
	Tolt River summer	High—nearly 80% within 100 years
	Nooksack River (winter)	Unable to calculate
South Puget Sound	Lake Washington (winter)	High—~ 90% within 40 years
	Green River (winter)r	High—about 90% within 80 years
	Nisqually River (winter)	High—about 80% within 40 years
	Puyallup River (winter)	High—about 90% within 25-30 years
	White River (winter)	High—about 90% within 50 years
	South Sound Tributaries (winter)	Unable to calculate
Olympic	Elwha River (winter)	Fairly High— ~ 90% within 40 years
	Dungeness River (winter)	High—within 100 years (population too low to calculate %)
	Port Angeles (winter)	High—nearly 80% within 100 years
	West Hood Canal (winter)	Low—near zero within 100 years
	East Hood Canal (winter)	Low—about 30% within 100 years
	Skokomish River (winter)	High—about 80% within 80 years

The Puget Sound Steelhead TRT has completed a set of simple population viability analyses (PVAs) for these draft populations and MPGs within the DPS. No new estimates of productivity, spatial structure and diversity of PS steelhead have been made available since the 2007 review, when the BRT concluded that low and declining abundance and low and declining productivity were substantial risk factors for the species (USDC 2007). Loss of diversity and spatial structure were judged to be “moderate” risk factors. Since the listing of this species, this threat has not changed appreciably (Ford 2011).

Abundance and Productivity. The BRT considered the major risk factors facing Puget Sound steelhead to be: widespread declines in abundance and productivity for most natural steelhead populations in the ESU, including those in Skagit and Snohomish rivers (previously considered to be strongholds); the low abundance of several summer-run populations; and the sharply diminishing abundance of some steelhead populations, especially in south Puget Sound, Hood Canal, and the Strait of Juan de Fuca (Hard *et al.* 2007).

For all but a few putative PS steelhead populations, estimates of mean population growth rates obtained from observed spawner or redd counts are declining—typically 3 to 10% annually—and extinction risk within 100 years for most populations in the DPS is estimated to be moderate to high, especially for draft populations in the putative South Sound and Olympic MPGs. Most populations within the DPS continue downward trends in estimated abundance, a few sharply so. Extinction risk within 100 years for most populations in the DPS is estimated to be moderate to high, especially for populations in the South Sound and Olympic MPGs.

Limiting factors include (NOAA Fisheries 2011):

- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years.
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania) inconsistent with wild stock diversity throughout the DPS.
- Declining diversity in the DPS, including the uncertain but weak status of summer-run fish in the DPS.
- A reduction in spatial structure for steelhead in the DPS.
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of LW.
- Increased flood frequency and peak flows during storms, reduced groundwater-driven summer flows in the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, has resulted in gravel scour, streambank erosion, and sediment deposition.
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, have increased the likelihood of gravel scour and dislocation of rearing juveniles.

Status of Southern DPS Eulachon

Spatial Structure and Diversity. The southern DPS of eulachon occur in four salmon recovery domains: Puget Sound, the Willamette and Lower Columbia, Oregon Coast, and Southern Oregon/Northern California Coasts. The ESA-listed population of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Core populations for this species include the Fraser River, Columbia River and (historically) the Klamath River. Eulachon leave saltwater to spawn in their natal streams late winter through early summer, and typically spawn at night in the lower reaches of larger rivers fed by snowmelt. After hatching, larvae are carried downstream and widely dispersed by estuarine and ocean currents. Eulachon movements in the ocean are poorly known although the amount of eulachon bycatch in the pink shrimp fishery seems to indicate that the distribution of these organisms overlap in the ocean.

Abundance and Productivity. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River with no evidence of returning to their former population levels since then (Drake *et al.* 2008).

Persistent low returns and landings of eulachon in the Columbia River from 1993 to 2000 prompted the states of Oregon and Washington to adopt a Joint State Eulachon Management Plan in 2001 that provides for restricted harvest management when parental run strength, juvenile production, and ocean productivity forecast a poor return (WDFW and ODFW 2001). Despite a brief period of improved returns in 2001–2003, the returns and associated commercial landings have again declined to the very low levels observed in the mid-1990s (Joint Columbia River Management Staff 2009), and since 2005, the fishery has operated at the most conservative level allowed in the management plan (Joint Columbia River Management Staff 2009). Large commercial and recreational fisheries have occurred in the Sandy River in the past. The most recent commercial harvest in the Sandy River was in 2003. No commercial harvest has been recorded for the Grays River from 1990 to the present, but larval sampling has confirmed successful spawning in recent years (USDC 2011).

Limiting Factors include (Gustafson *et al.* 2011; Gustafson *et al.* 2010; NOAA Fisheries 2011):

- Changes in ocean conditions due to climate change, particularly in the southern portion of its range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success.
- Climate-induced change to freshwater habitats, dams and water diversions (particularly in the Columbia and Klamath Rivers where hydropower generation and flood control are major activities)
- Bycatch of eulachon in commercial fisheries
- Adverse effects related to dams and water diversions
- Artificial fish passage barriers
- Increased water temperatures, insufficient streamflow
- Altered sediment balances
- Water pollution
- Over-harvest
- Predation

Willamette-Lower Columbia Recovery Domain. Species considered in the Willamette-Lower Columbia (WLC) Recovery Domain include LCR Chinook salmon, UWR Chinook salmon, CR chum salmon, LCR coho salmon, LCR steelhead, UWR steelhead, and southern DPS eulachon. The WLC-TRT has identified 107 demographically independent populations of Pacific salmon and steelhead (Table 11). These populations were further aggregated into strata, groupings above the population level that are connected by some degree of migration, based on ecological subregions. All 107 populations use parts of the mainstem of the Columbia River and the Columbia River estuary for migration, rearing, and smoltification.

Table 11. Populations of ESA-listed salmon and steelhead in the WLC recovery domain.

Species	Populations
LCR Chinook salmon	32
UWR Chinook salmon	7
CR chum salmon	17
LCR coho salmon	24
LCR steelhead	23
UWR steelhead	4

Status of LCR Chinook Salmon

Spatial Structure and Diversity. This species includes all naturally-spawned populations of Chinook salmon in the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River; the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River; and progeny of seventeen artificial propagation programs.[28] LCR Chinook populations exhibit three different life history types base on return timing and other features: fall-run (a.k.a. "tules"), late-fall-run (a.k.a. "brights"), and spring-run. The WLC-TRT identified 32 historical populations of LCR Chinook salmon— seven in the coastal subregion, six in the Columbia Gorge, and 19 in the Cascade Range (Table 12). Spatial structure has been substantially reduced in several populations. Low abundance, past broodstock transfers and other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among LCR Chinook salmon populations. Hatchery-origin fish spawning naturally may also have reduced population productivity (Lower Columbia Fish Recovery Board 2010; NMFS 2013a; ODFW 2010). Out of the 32 populations that make up this ESU, only the two late-fall runs, the North Fork Lewis and Sandy, are considered viable. Most populations (26 out of 32) have a very low probability of persistence over the next 100 years (and some are extirpated or nearly so) (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2013a; ODFW 2010). Five of the six strata fall significantly short of the WLC-TRT criteria for viability; one stratum, Cascade late-fall, meets the WLC TRT criteria (NMFS 2013a).

[28] In 2009, the Elochoman tule fall Chinook salmon program was discontinued and four new fall Chinook salmon programs have been initiated. In 2011, NMFS recommended removing the Elochoman program from the ESU and adding the new programs to the ESU (NMFS 2011b).

Table 12. LCR Chinook salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine overall net persistence probability of the population (NMFS 2013a). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum: Ecological Subregion	Stratum: Run Timing	Spawning Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Cascade Range	Spring	Upper Cowlitz River (WA)	VL	L	M	VL
		Cispus River (WA)	VL	L	M	VL
		Tilton River (WA)	VL	VL	VL	VL
		Toutle River (WA)	VL	H	L	VL
		Kalama River (WA)	VL	H	L	VL
		North Fork Lewis (WA)	VL	L	M	VL
		Sandy River (OR)	M	M	M	M
	Fall	Lower Cowlitz River (WA)	VL	H	M	VL
		Upper Cowlitz River (WA)	VL	VL	M	VL
		Toutle River (WA)	VL	H	M	VL
		Coweeman River (WA)	L	H	H	L
		Kalama River (WA)	VL	H	M	VL
		Lewis River (WA)	VL	H	H	VL
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	VL	VH	L	VL
		Sandy River (OR)	VL	M	L	VL
		Washougal River (WA)	VL	H	M	VL
	Late Fall	North Fork Lewis (WA)	VH	H	H	VH
		Sandy River (OR)	VH	M	M	H
Columbia Gorge	Spring	White Salmon River (WA)	VL	VL	VL	VL
		Hood River (OR)	VL	VH	VL	VL
	Fall	Lower Gorge (WA & OR)	VL	M	L	VL
		Upper Gorge (WA & OR)	VL	M	L	VL
		White Salmon River (WA)	VL	L	L	VL
		Hood River (OR)	VL	VH	L	VL
Coast Range	Fall	Young Bay (OR)	L	VH	L	L
		Grays/Chinook rivers (WA)	VL	H	VL	VL
		Big Creek (OR)	VL	H	L	VL
		Elochoman/Skamokawa creeks (WA)	VL	H	L	VL
		Clatskanie River (OR)	VL	VH	L	VL
		Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
		Scappoose River (OR)	L	H	L	L

<u>Abundance and Productivity</u>. A&P ratings for LCR Chinook salmon populations are currently “low” to “very low” for most populations, except for spring Chinook salmon in the Sandy River, which are “moderate” and late-fall Chinook salmon in North Fork Lewis River and Sandy River, which are “very high” (NMFS 2013a). Low abundance of natural-origin spawners (100 fish or fewer) has increased genetic and demographic risks. Other LCR Chinook populations have higher total abundance, but several of these also have high proportions of hatchery-origin spawners.

Particularly for tule fall Chinook salmon populations, poor data quality prevents precise quantification of population abundance and productivity; data quality has been poor because of inadequate spawning surveys and the presence of unmarked hatchery-origin spawners (Ford 2011).

Limiting Factors include (NMFS 2013a; NOAA Fisheries 2011):

- Degraded estuarine and near-shore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Reduced access to spawning and rearing habitat mainly as a result of tributary hydropower projects
- Hatchery-related effects
- Harvest-related effects on fall Chinook salmon
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

Status of UWR Chinook Salmon

Spatial Structure and Diversity. This species includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River; in the Willamette River and its tributaries above Willamette Falls, Oregon; and progeny of seven artificial propagation programs. All seven historical populations of UWR Chinook salmon identified by the WLC-TRT occur within the action area and are contained within a single ecological subregion, the western Cascade Range (Table 13). The McKenzie River population currently characterized as at a “low” risk of extinction and the Clackamas population has a “moderate” risk. (Ford 2011). Consideration of data collected since the last status review in 2005 has confirmed the high fraction of hatchery origin fish in all of the populations of this species (even the Clackamas and McKenzie rivers have hatchery fractions above WLC-TRT viability thresholds). All of the UWR Chinook salmon populations have “moderate” or “high” risk ratings for diversity. Clackamas River Chinook salmon have a “low” risk rating for spatial structure (Ford 2011).

Table 13. Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR Chinook salmon (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Extinction Risk
Clackamas River	M	M	L	M
Molalla River	VH	H	H	VH
North Santiam River	VH	H	H	VH
South Santiam River	VH	M	M	VH
Calapooia River	VH	H	VH	VH
McKenzie River	VL	M	M	L
Middle Fork Willamette River	VH	H	H	VH

Abundance and Productivity. The Clackamas and McKenzie river populations currently have the best risk ratings for A&P, spatial structure, and diversity. Data collected since the BRT status update in 2005 highlighted the substantial risks associated with pre-spawning mortality. Although recovery plans are targeting key limiting factors for future actions, there have been no significant on-the-ground-actions since the last status review to resolve the lack of access to historical habitat above dams nor have there been substantial actions removing hatchery fish from the spawning grounds. Overall, the new information does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011; ODFW and NMFS 2011):

- Significantly reduced access to spawning and rearing habitat because of tributary dams
- Degraded freshwater habitat, especially floodplain connectivity and function, channel structure and complexity, and riparian areas and LW recruitment as a result of cumulative impacts of agriculture, forestry, and development
- Degraded water quality and altered temperature as a result of both tributary dams and the cumulative impacts of agriculture, forestry, and urban development
- Hatchery-related effects
- Anthropogenic introductions of non-native species and out-of-ESU races of salmon or steelhead have increased predation on, and competition with, native UWR Chinook salmon
- Ocean harvest rates of approximately 30%

Status of CR Chum Salmon

Spatial Structure and Diversity. This species includes all naturally-spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon, and progeny of three artificial propagation programs. The WLC-TRT identified 17 historical populations of CR chum salmon and aggregated these into four strata (Myers *et al.* 2006)(Table 14). CR chum salmon spawning aggregations identified in the mainstem Columbia River were included in the population associated with the nearest river basin.

Table 14. CR chum salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2013a). Persistence probability ratings are very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum: Ecological Subregion	Stratum: Run Timing	Spawning Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Persistence Probability
Coast Range	Fall	Young's Bay (OR)	*	*	*	VL
		Grays/Chinook rivers (WA)	VH	M	H	M
		Big Creek (OR)	*	*	*	VL
		Elochoman/Skamakowa rivers (WA)	VL	H	L	VL
		Clatskanie River (OR)	*	*	*	VL
		Mill, Abernathy and Germany creeks (WA)	VL	H	L	VL
		Scappoose Creek (OR)	*	*	*	VL
Cascade Range	Summer	Cowlitz River (WA)	VL	L	L	VL
	Fall	Cowlitz River (WA)	VL	H	L	VL
		Kalama River (WA)	VL	H	L	VL
		Lewis River (WA)	VL	H	L	VL
		Salmon Creek (WA)	VL	L	L	VL
		Clackamas River (OR)	*	*	*	VL
		Sandy River (OR)	*	*	*	VL
		Washougal River (WA)	VL	H	L	VL
Columbia Gorge	Fall	Lower Gorge (WA & OR)	VH	H	VH	H
		Upper Gorge (WA & OR)	VL	L	L	VL

* No data are available to make a quantitative assessment.

The very low persistence probabilities or possible extirpations of most chum salmon populations are due to low abundance, productivity, spatial structure, and diversity. Although, hatchery production of chum salmon has been limited and hatchery effects on diversity are thought to have been relatively small, diversity has been greatly reduced at the ESU level because of presumed extirpations and the low abundance in the remaining populations (fewer than 100 spawners per year for most populations) (Lower Columbia Fish Recovery Board 2010; NMFS 2013a). The Lower Gorge population meets abundance and productivity criteria for very high levels of viability, but the distribution of spawning habitat (*i.e.,* spatial structure) for the population has been significantly reduced (Lower Columbia Fish Recovery Board 2010); spatial structure may need to be improved, at least in part, through better performance from the Oregon portion of the population (NMFS 2013a).

<u>Abundance and Productivity</u>. Of the 17 populations that historically made up this ESU, 15 of them (six in Oregon and nine in Washington) are so depleted that either their baseline probability of persistence is very low or they are extirpated or nearly so (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2013a; ODFW 2010). All three strata in the ESU fall significantly short of the WLC-TRT criteria for viability. Currently almost all natural production occurs in just two populations: the Grays/Chinook and the Lower Gorge.

The Grays/Chinook population has a moderate persistence probability, and the Lower Gorge population has a high probability of persistence (Lower Columbia Fish Recovery Board 2010; NMFS 2013a).

Limiting Factors include (NMFS 2013a; NOAA Fisheries 2011):

- Degraded estuarine and nearshore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Degraded freshwater habitat, in particular of floodplain connectivity and function, channel structure and complexity, stream substrate, and riparian areas and LW recruitment as a result of cumulative impacts of agriculture, forestry, and development
- Degraded stream flow as a result of hydropower and water supply operations
- Loss of access and loss of some habitat types as a result of passage barriers such as roads and railroads
- Reduced water quality
- Current or potential predation from hatchery-origin salmonids, including coho salmon
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

Status of LCR Coho Salmon

Spatial Structure and Diversity. This species includes all naturally-spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia up to and including the Big White Salmon and Hood rivers; in the Willamette River to Willamette Falls, Oregon; and progeny of 25 artificial propagation programs.[29] Spatial diversity is rated “moderate” to “very high” for all the populations, except the North Fork Lewis River, which has a “low” rating for spatial structure.

Three status evaluations of LCR coho salmon status, all based on WLC-TRT criteria, have been conducted since the last NMFS status review in 2005 (McElhany *et al.* 2007; NMFS 2013a). Out of the 24 populations that make up this ESU (Table 15), 21 are considered to have a very low probability of persisting for the next 100 years, and none is considered viable (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2013a; ODFW 2010).

[29] The Elochoman Hatchery Type-S and Type-N coho salmon programs were eliminated in 2008. The last adults from these two programs returned to the Elochoman in 2010. NMFS has recommended that these two programs be removed from the ESU (NMFS 2011b).

Table 15. LCR coho salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2013a). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Ecological Subregions	Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Coast Range	Young's Bay (OR)	VL	VH	VL	VL
	Grays/Chinook rivers (WA)	VL	H	VL	VL
	Big Creek (OR)	VL	H	L	VL
	Elochoman/Skamokawa creeks (WA)	VL	H	VL	VL
	Clatskanie River (OR)	L	VH	M	L
	Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
	Scappoose River (OR)	M	H	M	M
Cascade Range	Lower Cowlitz River (WA)	VL	M	M	VL
	Upper Cowlitz River (WA)	VL	M	L	VL
	Cispus River (WA)	VL	M	L	VL
	Tilton River (WA)	VL	M	L	VL
	South Fork Toutle River (WA)	VL	H	M	VL
	North Fork Toutle River (WA)	VL	M	L	VL
	Coweeman River (WA)	VL	H	M	VL
	Kalama River (WA)	VL	H	L	VL
	North Fork Lewis River (WA)	VL	L	L	VL
	East Fork Lewis River (WA)	VL	H	M	VL
	Salmon Creek (WA)	VL	M	VL	VL
	Clackamas River (OR)	M	VH	H	M
	Sandy River (OR)	VL	H	M	VL
	Washougal River (WA)	VL	H	L	VL
Columbia Gorge	Lower Gorge Tributaries (WA & OR)	VL	M	VL	VL
	Upper Gorge/White Salmon (WA)	VL	M	VL	VL
	Upper Gorge Tributaries/Hood (OR)	VL	VH	L	VL

<u>Abundance and Productivity</u>. In Oregon, the Clatskanie Creek and Clackamas River populations have "low" and "moderate" persistence probability ratings for A&P, while the rest are rated "very low." All of the Washington populations have "very low" A&P ratings. The persistence probability for diversity is "high" in the Clackamas population, "moderate" in the Clatskanie, Scappoose, Lower Cowlitz, South Fork Toutle, Coweeman, East Fork Lewis, and Sandy populations, and "low" to "very low" in the rest (NMFS 2013a). Uncertainty is high because of a lack of adult spawner surveys. Smolt traps indicate some natural production in Washington populations, though given the high fraction of hatchery origin spawners suspected to occur in these populations it is not clear that any are self-sustaining. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011; NMFS 2011b; NMFS 2013a).

Limiting Factors include (NMFS 2013a; NOAA Fisheries 2011):

- Degraded estuarine and near-shore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Fish passage barriers that limit access to spawning and rearing habitats
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Hatchery-related effects
- Harvest-related effects
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

Status of LCR Steelhead

Spatial Structure and Diversity. Four strata and 23 historical populations of LCR steelhead occur within the DPS: 17 winter-run populations and six summer-run populations, within the Cascade and Gorge ecological subregions (Table 16).[30] The DPS also includes the progeny of ten artificial propagation programs.[31] Summer steelhead return to freshwater long before spawning. Winter steelhead, in contrast, return from the ocean much closer to maturity and spawn within a few weeks. Summer steelhead spawning areas in the Lower Columbia River are found above waterfalls and other features that create seasonal barriers to migration. Where no temporal barriers exist, the winter-run life history dominates.

[30] The White Salmon and Little White Salmon steelhead populations are part of the Middle Columbia steelhead DPS and are addressed in a separate species-level recovery plan, the Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan (NMFS 2009b).

[31] In 2007, the release of Cowlitz Hatchery winter steelhead into the Tilton River was discontinued; in 2009, the Hood River winter steelhead program was discontinued; and in 2010, the release of hatchery winter steelhead into the Upper Cowlitz and Cispus rivers was discontinued. In 2011, NMFS recommended removing these programs from the DPS. A Lewis River winter steelhead program was initiated in 2009, and in 2011, NMFS proposed that it be included in the DPS (NMFS 2011b).

Table 16. LCR steelhead strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2013a). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum		Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Ecological Subregion	**Run Timing**					
Cascade Range	Summer	Kalama River (WA)	H	VH	M	M
		North Fork Lewis River (WA)	VL	VL	VL	VL
		East Fork Lewis River (WA)	VL	VH	M	VL
		Washougal River (WA)	M	VH	M	M
	Winter	Lower Cowlitz River (WA)	L	M	M	L
		Upper Cowlitz River (WA)	VL	M	M	VL
		Cispus River (WA)	VL	M	M	VL
		Tilton river (WA)	VL	M	M	VL
		South Fork Toutle River (WA)	M	VH	H	M
		North Fork Toutle River (WA)	VL	H	H	VL
		Coweeman River (WA)	L	VH	VH	L
		Kalama River (WA)	L	VH	H	L
		North Fork Lewis River (WA)	VL	M	M	VL
		East Fork Lewis River (WA)	M	VH	M	M
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	M	VH	M	M
		Sandy River (OR)	L	M	M	L
		Washougal River (WA)	L	VH	M	L
Columbia Gorge	Summer	Wind River (WA)	VH	VH	H	H
		Hood River (OR)	VL	VH	L	VL
	Winter	Lower Gorge (WA & OR)	L	VH	M	L
		Upper Gorge (OR & WA)	L	M	M	L
		Hood River (OR)	M	VH	M	M

It is likely that genetic and life history diversity has been reduced as a result of pervasive hatchery effects and population bottlenecks. Spatial structure remains relatively high for most populations Out of the 23 populations, 16 are considered to have a “low” or “very low” probability of persisting over the next 100 years, and six populations have a “moderate” probability of persistence (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2013a; ODFW 2010). All four strata in the DPS fall short of the WLC-TRT criteria for viability (NMFS 2013a).

Baseline persistence probabilities were estimated to be “low” or “very low” for three out of the six summer steelhead populations that are part of the LCR DPS, moderate for two, and high for one, the Wind, which is considered viable. Thirteen of the 17 LCR winter steelhead populations have “low” or “very low” baseline probabilities of persistence, and the remaining four are at “moderate” probability of persistence (Table 16) (Lower Columbia Fish Recovery Board 2010; NMFS 2013a; ODFW 2010).

Abundance and Productivity. The "low" to "very low" baseline persistence probabilities of most Lower Columbia River steelhead populations reflects low abundance and productivity (NMFS 2013a). All of the populations increased in abundance during the early 2000s, generally peaking in 2004. Most populations have since declined back to levels within one standard deviation of the long term mean. Exceptions are the Washougal summer-run and North Fork Toutle winter-run, which are still higher than the long term average, and the Sandy, which is lower. In general, the populations do not show any sustained dramatic changes in abundance or fraction of hatchery origin spawners since the 2005 status review (Ford 2011). Although current LCR steelhead populations are depressed compared to historical levels and long-term trends show declines, many populations are substantially healthier than their salmon counterparts, typically because of better habitat conditions in core steelhead production areas (Lower Columbia Fish Recovery Board 2010; NMFS 2013a).

Limiting Factors include (NMFS 2013a; NOAA Fisheries 2011):

- Degraded estuarine and nearshore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and recruitment of LW, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Reduced access to spawning and rearing habitat mainly as a result of tributary hydropower projects and lowland development
- Avian and marine mammal predation in the lower mainstem Columbia River and estuary.
- Hatchery-related effects
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

Status of UWR Steelhead.

Spatial Structure and Diversity. This species includes all naturally-spawned steelhead populations below natural and manmade impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River. One stratum and four extant populations of UWR steelhead occur within the DPS (Table 17). Historical observations, hatchery records, and genetics suggest that the presence of UWR steelhead in many tributaries on the west side of the upper basin is the result of recent introductions. Nevertheless, the WLC-TRT recognized that although west side UWR steelhead does not represent a historical population, those tributaries may provide juvenile rearing habitat or may be temporarily (for one or more generations) colonized during periods of high abundance. Hatchery summer-run steelhead that are released in the subbasins are from an out-of-basin stock, not from the DPS. Additionally, stocked summer steelhead that have become established in the McKenzie River were not considered in the identification of historical populations (ODFW and NMFS 2011).

Table 17. Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR steelhead (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Extinction Risk
Molalla River	VL	M	M	L
North Santiam River	VL	M	H	L
South Santiam River	VL	M	M	L
Calapooia River	M	M	VH	M

Abundance and Productivity. Since the last status review in 2005, UWR steelhead initially increased in abundance but subsequently declines and current abundance is at the levels observed in the mid-1990s when the DPS was first listed. The DPS appears to be at lower risk than the UWR Chinook salmon ESU, but continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011; ODFW and NMFS 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW recruitment, and stream flow have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Degraded water quality and altered temperature as a result of both tributary dams and the cumulative impacts of agriculture, forestry, and urban development
- Reduced access to spawning and rearing habitats mainly as a result of artificial barriers in spawning tributaries
- Hatchery-related effects: impacts from the non-native summer steelhead hatchery program
- Anthropogenic introductions of non-native species and out-of-ESU races of salmon or steelhead have increased predation and competition on native UWR steelhead

Interior Columbia Recovery Domain. Species in the Interior Columbia (IC) recovery domain include UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, UCR steelhead, Mid-Columbia River (MCR) steelhead, and SRB steelhead. The IC-TRT identified 82 populations of those species based on genetic, geographic (hydrographic), and habitat characteristics (Table 18). In some cases, the IC-TRT further aggregated populations into “major groupings” based on dispersal distance and rate, and drainage structure, primarily the location and distribution of large tributaries (IC-TRT 2003). All 82 populations identified use the lower mainstem of the Snake River, the mainstem of the Columbia River, and the Columbia River estuary, or part thereof, for migration, rearing, and smoltification.

Table 18. Populations of ESA-listed salmon and steelhead in the IC recovery domain.

Species	Populations
UCR spring-run Chinook salmon	3
SR spring/summer-run Chinook salmon	28
SR fall-run Chinook salmon	1
SR sockeye salmon	1
MCR steelhead	17
UCR steelhead	4
SRB steelhead	24

The IC-TRT also recommended viability criteria that follow the VSP framework (McElhany *et al.* 2006) and described biological or physical performance conditions that, when met, indicate a population or species has a 5% or less risk of extinction over a 100-year period (IC-TRT 2007; see also NRC 1995).

Status of UCR Spring-run Chinook Salmon

Spatial Structure and Diversity**.** This species includes all naturally-spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River), the Columbia River upstream to Chief Joseph Dam, and progeny of six artificial propagation programs. The IC-TRT identified four independent populations of UCR spring-run Chinook salmon in the upriver tributaries of Wenatchee, Entiat, Methow, and Okanogan (extirpated), but no major groups due to the relatively small geographic area affected (Ford 2011; IC-TRT 2003)(Table 19).

Table 19. Scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for spring-run UCR Chinook salmon (Ford 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E).

Population	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Wenatchee River	H	H	H	H
Entiat River	H	H	H	H
Methow River	H	H	H	H
Okanogan River				E

The composite SS/D risks for all three of the extant populations in this MPG are at "high" risk. The spatial processes component of the SS/D risk is "low" for the Wenatchee River and Methow River populations and "moderate" for the Entiat River (loss of production in lower section increases effective distance to other populations). All three of the extant populations in this MPG are at "high" risk for diversity, driven primarily by chronically high proportions of hatchery-origin spawners in natural spawning areas and lack of genetic diversity among the natural-origin spawners (Ford 2011).

Increases in natural origin abundance relative to the extremely low spawning levels observed in the mid-1990s are encouraging; however, average productivity levels remain extremely low. Overall, the viability of Upper Columbia Spring Chinook salmon ESU has likely improved somewhat since the last status review, but the ESU is still clearly at "moderate-to-high" risk of extinction (Ford 2011).

Abundance and Productivity. UCR spring-run Chinook salmon is not currently meeting the viability criteria (adapted from the IC-TRT) in the Upper Columbia Recovery Plan. A&P remains at "high" risk for each of the three extant populations in this MPG/ESU (Table 19). The 10-year geometric mean abundance of adult natural origin spawners has increased for each population relative to the levels for the 1981-2003 series, but the estimates remain below the corresponding IC-TRT thresholds. Estimated productivity (spawner to spawner return rate at low to moderate escapements) was on average lower over the years 1987-2009 than for the previous period. The combinations of current abundance and productivity for each population result in a "high" risk rating.

Limiting Factors include (NOAA Fisheries 2011; Upper Columbia Salmon Recovery Board 2007):

- Mainstem Columbia River hydropower–related adverse effects: upstream and downstream fish passage, ecosystem structure and function, flows, and water quality
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW recruitment, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Degraded estuarine and nearshore marine habitat
- Hatchery related effects: including past introductions and persistence of non-native (exotic) fish species continues to affect habitat conditions for listed species
- Harvest in Columbia River fisheries

Status of SR Spring/summer-run Chinook Salmon

Spatial Structure and Diversity. This species includes all naturally-spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins; and progeny of fifteen artificial propagation programs. The IC-TRT currently believes there are 27 extant and 4 extirpated populations of SR spring/summer-run Chinook salmon, and aggregated these into major population groups (Ford 2011; IC-TRT 2007). Each of these populations faces a "high" risk of extinction (Ford 2011) (Table 20).

Table 20. SR spring/summer-run Chinook salmon ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SR spring/summer-run Chinook salmon (Ford 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E).

Ecological Subregions	Spawning Populations (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Lower Snake River	Tucannon River	H	M	M	H
	Asotin River				E
Grande Ronde and Imnaha rivers	Wenaha River	H	M	M	H
	Lostine/Wallowa River	H	M	M	H
	Minam River	H	M	M	H
	Catherine Creek	H	M	M	H
	Upper Grande Ronde R.	H	M	H	H
	Imnaha River	H	M	M	H
	Big Sheep Creek				E
	Lookingglass Creek				E
South Fork Salmon River	Little Salmon River	*	*	*	H
	South Fork mainstem	H	M	M	H
	Secesh River	H	L	L	H
	EF/Johnson Creek	H	L	L	H
Middle Fork Salmon River	Chamberlin Creek	H	L	L	H
	Big Creek	H	M	M	H
	Lower MF Salmon	H	M	M	H
	Camas Creek	H	M	M	H
	Loon Creek	H	M	M	H
	Upper MF Salmon	H	M	M	H
	Sulphur Creek	H	M	M	H
	Bear Valley Creek	H	L	L	H
	Marsh Creek	H	L	L	H
Upper Mainstem Salmon	N. Fork Salmon River	H	L	L	H
	Lemhi River	H	H	H	H
	Pahsimeroi River	H	H	H	H
	Upper Salmon-lower mainstem	H	L	L	H
	East Fork Salmon River	H	H	H	H
	Yankee Fork	H	H	H	H
	Valley Creek	H	M	M	H
	Upper Salmon main	H	M	M	H
	Panther Creek				E

* Insufficient data.

<u>Abundance and Productivity</u>. Population level status ratings remain at "high" risk across all MPGs within the ESU, although recent natural spawning abundance estimates have increased, all populations remain below minimum natural origin abundance thresholds (Table 20). Spawning escapements in the most recent years in each series are generally well below the peak returns but above the extreme low levels in the mid-1990s.

Relatively low natural production rates and spawning levels below minimum abundance thresholds remain a major concern across the ESU.

The ability of SR spring/summer-run Chinook salmon populations to be self-sustaining through normal periods of relatively low ocean survival remains uncertain. Factors cited by Good (2005) remain as concerns or key uncertainties for several populations. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, stream substrate, elevated water temperature, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Mainstem Columbia River and Snake River hydropower impacts
- Harvest-related effects
- Predation

Status of SR Fall-run Chinook Salmon

Spatial Structure and Diversity**.** This species includes all naturally-spawned populations of fall-run Chinook salmon in the mainstem Snake River below Hells Canyon Dam, and in the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River, and progeny of four artificial propagation programs. The IC-TRT identified three populations of this species, although only the lower mainstem population exists at present, and it spawns in the lower main stem of the Clearwater, Imnaha, Grande Ronde, Salmon and Tucannon rivers. The extant population of Snake River fall-run Chinook salmon is the only remaining population from an historical ESU that also included large mainstem populations upstream of the current location of the Hells Canyon Dam complex (Ford 2011; IC-TRT 2003). The population is at moderate risk for diversity and spatial structure. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Abundance and Productivity. The recent increases in natural origin abundance are encouraging. However, hatchery origin spawner proportions have increased dramatically in recent years. On average, 78% of the estimated adult spawners have been hatchery origin over the most recent brood cycle. The apparent leveling off of natural returns in spite of the increases in total brood year spawners may indicate that density dependent habitat effects are influencing production or that high hatchery proportions may be influencing natural production rates. The A&P risk rating for the population is "moderate." Given the combination of current A&P and SS/D ratings summarized above, the overall viability rating for Lower SR fall Chinook salmon would be rated as "maintained."[32]

[32] "Maintained" population status is for populations that do not meet the criteria for a viable population but do support ecological functions and preserve options for ESU/DPS recovery.

Limiting Factors include (NOAA Fisheries 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, and channel structure and complexity have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Harvest-related effects
- Loss of access to historic habitat above Hells Canyon and other Snake River dams
- Mainstem Columbia River and Snake River hydropower impacts
- Hatchery-related effects
- Degraded estuarine and nearshore habitat

Status of SR Sockeye Salmon

Spatial Structure and Diversity**.** This species includes all anadromous and residual sockeye salmon from the Snake River basin, Idaho, and artificially-propagated sockeye salmon from the Redfish Lake captive propagation program. The IC-TRT identified historical sockeye salmon production in at least five Stanley Basin and Sawtooth Valley lakes and in lake systems associated with Snake River tributaries currently cut off to anadromous access (*e.g.,* Wallowa and Payette Lakes), although current returns of SR sockeye salmon are extremely low and limited to Redfish Lake (IC-TRT 2007).

Abundance and Productivity. This species is still at extremely high risk across all four basic risk measures (abundance, productivity, spatial structure and diversity. Although the captive brood program has been successful in providing substantial numbers of hatchery produced *O. nerka* for use in supplementation efforts, substantial increases in survival rates across life history stages must occur to re-establish sustainable natural production (Hebdon *et al.* 2004; Keefer *et al.* 2008). Overall, although the risk status of the Snake River sockeye salmon ESU appears to be on an improving trend, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors. The key factor limiting recovery of SR sockeye salmon ESU is survival outside of the Stanley Basin. Portions of the migration corridor in the Salmon River are impeded by water quality and temperature (Idaho Department of Environmental Quality 2011). Increased temperatures likely reduce the survival of adult sockeye returning to the Stanley Basin. The natural hydrological regime in the upper mainstem Salmon River Basin has been altered by water withdrawals. In most years, sockeye adult returns to Lower Granite suffer catastrophic losses (Reed *et al.* 2003) (*e.g.*, greater than 50% mortality in one year) before reaching the Stanley Basin, although the factors causing these losses have not been identified. In the Columbia and lower Snake River migration corridor, predation rates on juvenile sockeye salmon are unknown, but terns and cormorants consume 12% of all salmon smolts reaching the estuary, and piscivorous fish consume an estimated 8% of migrating juvenile salmon (NOAA Fisheries 2011).

Status of MCR Steelhead

Spatial Structure and Diversity**.** This species includes all naturally-spawned steelhead populations below natural and artificial impassable barriers in streams from above the Wind

River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding steelhead from the Snake River basin; and progeny of seven artificial propagation programs. The IC-TRT identified 17 extant populations in this DPS (IC-TRT 2003). The populations fall into four major population groups: the Yakima River Basin (four extant populations), the Umatilla/Walla-Walla drainages (three extant and one extirpated populations); the John Day River drainage (five extant populations) and the Eastern Cascades group (five extant and two extirpated populations) (Table 21) (Ford 2011; NMFS 2009b).

Table 21. Ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for MCR steelhead (Ford 2011; NMFS 2009b). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS.

Ecological Subregions	Population (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Cascade Eastern Slope Tributaries	Fifteenmile Creek	L	L	L	Viable
	Klickitat River	M	M	M	MT?
	Eastside Deschutes River	L	M	M	Viable
	Westside Deschutes River	H	M	M	H*
	Rock Creek	H	M	M	H?
	White Salmon				E*
	Crooked River				E*
John Day River	Upper Mainstem	M	M	M	MT
	North Fork	VL	L	L	Highly Viable
	Middle Fork	M	M	M	MT
	South Fork	M	M	M	MT
	Lower Mainstem	M	M	M	MT
Walla Walla and Umatilla rivers	Umatilla River	M	M	M	MT
	Touchet River	M	M	M	H
	Walla Walla River	M	M	M	MT
Yakima River	Satus Creek	M	M	M	Viable (MT)
	Toppenish Creek	M	M	M	Viable (MT)
	Naches River	H	M	M	H
	Upper Yakima	H	H	H	H

* Re-introduction efforts underway (NMFS 2009b).

Straying frequencies into at least the Lower John Day River population are high. Out-of-basin hatchery stray proportions, although reduced, remain very high in the Deschutes River basin.

<u>Abundance and Productivity</u>. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural origin returns to the John Day River have decreased.

There have been improvements in the viability ratings for some of the component populations, but the MCR steelhead DPS is not currently meeting the viability criteria (adopted from the IC-TRT) in the MCR steelhead recovery plan (NMFS 2009b). In addition, several of the factors cited by Good (2005) remain as concerns or key uncertainties. Natural origin spawning estimates of populations have been highly variable with respect to meeting minimum abundance thresholds. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NMFS 2009b; NOAA Fisheries 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas, fish passage, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, tributary hydro system activities, and development
- Mainstem Columbia River hydropower–related impacts
- Degraded estuarine and nearshore marine habitat
- Hatchery-related effects
- Harvest-related effects
- Effects of predation, competition, and disease

Status of UCR Steelhead

Spatial Structure and Diversity**.** This species includes all naturally-spawned steelhead populations below natural and manmade impassable barriers in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the U.S.-Canada border, and progeny of six artificial propagation programs. Four independent populations of UCR steelhead were identified by the IC-TRT in the same upriver tributaries as for UC spring-run Chinook salmon (*i.e.*, Wenatchee, Entiat, Methow, and Okanogan; Table 22) and, similarly, no major population groupings were identified due to the relatively small geographic area involved (Ford 2011; IC-TRT 2003). All extant populations are considered to be at high risk of extinction (Table 22)(Ford 2011). With the exception of the Okanogan population, the Upper Columbia populations rated as "low" risk for spatial structure. The "high" risk ratings for SS/D are largely driven by chronic high levels of hatchery spawners within natural spawning areas and lack of genetic diversity among the populations. The proportions of hatchery origin returns in natural spawning areas remain extremely high across the DPS, especially in the Methow and Okanogan River populations. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Table 22. Summary of the key elements (A&P, diversity, and SS/D) and scores used to determine current overall viability risk for UCR steelhead populations (Ford 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Population (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Wenatchee River	H	H	H	H
Entiat River	H	H	H	H
Methow River	H	H	H	H
Okanogan River	H	H	H	H

Abundance and Productivity. Upper Columbia steelhead populations have increased in natural origin abundance in recent years, but productivity levels remain low. The modest improvements in natural returns in recent years are probably primarily the result of several years of relatively good natural survival in the ocean and tributary habitats.

Limiting Factors include (NOAA Fisheries 2011; Upper Columbia Salmon Recovery Board 2007):

- Mainstem Columbia River hydropower–related adverse effects
- Impaired tributary fish passage
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW recruitment, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Effects of predation, competition, and disease mortality: Fish management, including past introductions and persistence of non-native (exotic) fish species continues to affect habitat conditions for listed species.
- Hatchery-related effects
- Harvest-related effects

Status of SRB Steelhead

Spatial Structure and Diversity**.** This species includes all naturally-spawned steelhead populations below natural and manmade impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho, and progeny of six artificial propagation programs. The IC-TRT identified 24 populations in five major groups (Table 23) (Ford 2011; IC-TRT 2010). The IC-TRT has not assessed the viability of this species. The relative proportion of hatchery fish in natural spawning areas near major hatchery release sites is highly uncertain. There is little evidence for substantial change in ESU viability relative to the previous BRT and IC-TRT reviews. Overall, therefore, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Table 23. Ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SRB steelhead (Ford 2011; NMFS 2011c). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS.

Ecological subregions	Spawning Populations (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk*
Lower Snake River	Tucannon River	**	M	M	H
	Asotin Creek	**	M	M	MT
Grande Ronde River	Lower Grande Ronde	**	M	M	Not rated
	Joseph Creek	VL	L	L	Highly viable
	Upper Grande Ronde	M	M	M	MT
	Wallowa River	**	L	L	H
Clearwater River	Lower Clearwater	M	L	L	MT
	South Fork Clearwater	H	M	M	H
	Lolo Creek	H	M	M	H
	Selway River	H	L	L	H
	Lochsa River	H	L	L	H
Salmon River	Little Salmon River	**	M	M	MT
	South Fork Salmon	**	L	L	H
	Secesh River	**	L	L	H
	Chamberlain Creek	**	L	L	H
	Lower MF Salmon	**	L	L	H
	Upper MF Salmon	**	L	L	H
	Panther Creek	**	M	H	H
	North Fork Salmon	**	M	M	MT
	Lemhi River	**	M	M	MT
	Pahsimeroi River	**	M	M	MT
	East Fork Salmon	**	M	M	MT
	Upper Main Salmon	**	M	M	MT
Imnaha	Imnaha River	M	M	M	MT

* There is uncertainty in these ratings due to a lack of population-specific data.
** Insufficient data.

Abundance and Productivity. The level of natural production in the two populations with full data series and the Asotin Creek index reaches is encouraging, but the status of most populations in this DPS remains highly uncertain. Population-level natural origin abundance and productivity inferred from aggregate data and juvenile indices indicate that many populations are likely below the minimum combinations defined by the IC-TRT viability criteria.

Limiting Factors include (IC-TRT 2010; NMFS 2011c):

- Mainstem Columbia River hydropower–related adverse effects
- Impaired tributary fish passage

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW recruitment, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Impaired water quality and increased water temperature
- Related harvest effects, particularly for B-run steelhead
- Predation
- Genetic diversity effects from out-of-population hatchery releases

Oregon Coast Recovery Domain. The OC recovery domain includes OC coho salmon and southern DPS eulachon, on the Oregon coast and streams south of the Columbia River and north of Cape Blanco. Streams and rivers in this area drain west into the Pacific Ocean, and vary in length from less than a mile to more than 210 miles in length.

Status of OC Coho Salmon

Spatial Structure and Diversity**.** This species includes populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco. The Cow Creek stock (South Umpqua population) is included as part of the ESU because the original brood stock was founded from the local, natural origin population and natural origin coho salmon have been incorporated into the brood stock on a regular basis.

The OC-TRT identified 56 populations; 21 independent and 35 dependent. The dependent populations were dependent on strays from other populations to maintain them over long time periods. The TRT also identified 5 biogeographic strata (Table 24)(Lawson *et al.* 2007).

Table 24. OC coho salmon populations. Dependent populations (D) are populations that historically would not have had a high likelihood of persisting in isolation for 100 years. These populations relied upon periodic immigration from other populations to maintain their abundance. Independent populations are populations that historically would have had a high likelihood of persisting in isolation from neighboring populations for 100 years and are rated as functionally independent (FI) and potentially independent (PI) (Lawson *et al.* 2007; McElhany *et al.* 2000).

Stratum	Population	Type	Stratum	Population	Type
North Coast	Necanicum River	PI	Mid-Coast (cont.)	Alsea River	FI
	Ecola Creek	D		Big Creek (Alsea)	D
	Arch Cape Creek	D		Vingie Creek	D
	Short Sands Creek	D		Yachats River	D
	Nehalem River	FI		Cummins Creek	D
	Spring Creek	D		Bob Creek	D
	Watseco Creek	D		Tenmile Creek	D
	Tillamook Bay	FI		Rock Creek	D
	Netarts Bay	D		Big Creek (Siuslaw)	D
	Rover Creek	D		China Creek	D
	Sand Creek	D		Cape Creek	D
	Nestucca River	FI		Berry Creek	D
	Neskowin Creek	D		Sutton Creek	D
Mid-Coast	Salmon River	PI	Lakes	Siuslaw River	FI
	Devils Lake	D		Siltcoos Lake	PI
	Siletz River	FI		Tahkenitch Lake	PI
	Schoolhouse Creek	D		Tenmile Lakes	PI
	Fogarty Creek	D	Umpqua	Lower Umpqua River	FI
	Depoe Bay	D		Middle Umpqua River	FI
	Rocky Creek	D		North Umpqua River	FI
	Spencer Creek	D		South Umpqua River	FI
	Wade Creek	D	Mid-South Coast	Threemile Creek	D
	Coal Creek	D		Coos River	FI
	Moolack Creek	D		Coquille River	FI
	Big Creek (Yaquina)	D		Johnson Creek	D
	Yaquina River	FI		Twomile Creek	D
	Theil Creek	D		Floras Creek	PI
	Beaver Creek	PI		Sixes River	PI

A 2010 BRT noted significant improvements in hatchery and harvest practices have been made (Stout *et al.* 2012). However, harvest and hatchery reductions have changed the population dynamics of the ESU. Current concerns for spatial structure focus on the Umpqua River. Of the four populations in the Umpqua stratum, the North Umpqua and South Umpqua, were of particular concern. The North Umpqua is controlled by Winchester Dam and has historically been dominated by hatchery fish. Hatchery influence has recently been reduced, but the natural productivity of this population remains to be demonstrated. The South Umpqua is a large, warm system with degraded habitat. Spawner distribution appears to be seriously restricted in this population, and it is probably the most vulnerable of any population in this ESU to increased temperatures.

Current status of diversity shows improvement through the waning effects of hatchery fish on populations of OC coho salmon. In addition, recent efforts in several coastal estuaries to restore lost wetlands should be beneficial. However, diversity is lower than it was historically because of the loss of both freshwater and tidal habitat loss coupled with the restriction of diversity from very low returns over the past 20 years.

Abundance and Productivity. It has not been demonstrated that productivity during periods of poor marine survival is now adequate to sustain the ESU. Recent increases in adult escapement do not provide strong evidence that the century-long downward trend has changed. The ability of the OC coho salmon ESU to survive another prolonged period of poor marine survival remains in question. Wainwright (2008) determined that the weakest strata of OC coho salmon were in the North Coast and Mid-Coast of Oregon, which had only "low" certainty of being persistent. The strongest strata were the Lakes and Mid-South Coast, which had "high" certainty of being persistent. To increase certainty that the ESU as a whole is persistent, they recommended that restoration work should focus on those populations with low persistence, particularly those in the North Coast, Mid-Coast, and Umpqua strata.

Limiting Factors include (NOAA Fisheries 2011; Stout *et al.* 2012):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and LW supply, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, instream mining, dams, road crossings, dikes, levees, *etc.*
- Fish passage barriers that limit access to spawning and rearing habitats
- Adverse climate, altered past ocean/marine productivity, and current ocean ecosystem conditions have favored competitors and predators and reduced salmon survival rates in freshwater rivers and lakes, estuaries, and marine environments

Southern Oregon and Northern California Coasts Recovery Domain. The SONCC recovery domain includes coho salmon and southern DPS eulachon. The SONCC recovery domain extends from Cape Blanco, Oregon, to Punta Gorda, California. This area includes many small-to-moderate-sized coastal basins, where high quality habitat occurs in the lower reaches of each basin, and three large basins (Rogue, Klamath and Eel) where high quality habitat is in the lower reaches, little habitat is provided by the middle reaches, and the largest amount of habitat is in the upper reaches.

Status of SONCC Coho Salmon

Spatial Structure and Diversity**.** This species includes all naturally-spawned populations of coho salmon in coastal streams from the Elk River near Cape Blanco, Oregon, through and including the Mattole River near Punta Gorda, California, and progeny of three artificial propagation programs (NMFS 2012b). Williams *et al.* (2006) designated 45 populations of coho salmon in the SONCC coho salmon ESU. These populations were further grouped into seven diversity strata based on the geographical arrangement of the populations and basin-scale genetic, environmental, and ecological characteristics (Table 25).

Table 25. SONCC coho salmon populations in Oregon. Williams *et al.* (2006) classified populations as dependent or independent based on their historical population size. Independent populations are populations that historically would have had a high likelihood of persisting in isolation from neighboring populations for 100 years and are rated as functionally independent (FI) and potentially independent (PI). Core population types are independent populations judged most likely to become viable most quickly. Non-core 1 population types are independent populations judged to have lesser potential for rapid recovery than the core populations. Dependent populations (D) are populations that historically would not have had a high likelihood of persisting in isolation for 100 years. These populations relied upon periodic immigration from other populations to maintain their abundance. Two ephemeral populations (E) are defined as populations both small enough and isolated enough that they are only intermittently present (McElhany *et al.* 2000; NMFS 2012b; Williams *et al.* 2006).

Stratum	Population	Population Type
Northern Coastal	Elk River	FI Core
	Hubbard Creek	E
	Brush Creek	D
	Mussel Creek	D
	Euchre Creek	E
	Lower Rogue River	PI Non-Core 1
	Hunter Creek	D
	Pistol River	D
	Chetco River	FI Core
	Winchuck River*	PI Non-Core 1
Interior Rogue	Upper Rogue River	FI Core
	Middle Rogue/Applegate*	FI Non-Core 1
	Illinois River*	FI Core
Interior Klamath	Upper Klamath River*	FI Core
Central Coastal	Smith River*	FI core

* Populations that also occur partly in California.

NMFS considered the role each population is expected to play in a recovered ESU to determine population abundance and juvenile occupancy targets for all the populations in the SONCC coho salmon ESU. Independent populations are evaluated using a modified Bradbury (1995) framework. This model uses three groupings of criteria for ranking watersheds for Pacific salmon restoration prioritization: 1) biological and ecological resources (Biological Importance); 2) watershed integrity and salmonid extinction risk (Integrity and Risk); and 3) potential for restoration (Optimism and Potential). Scores for Biological Importance are based on the concept of VSPs (McElhany *et al.* 2000), and are used to describe the current status of the population (population size, productivity, spatial structure, and diversity). "Core" populations were designated based on current condition, geographic location in the ESU, low risk threshold compared to the number of spawners needed for the entire stratum, and other factors. "Non-core 1" populations are in the moderate risk threshold, which is the depensation threshold[33]

[33] Williams (2008) defines the depensation threshold as one spawner per km of stream with estimated rearing potential or Intrinsic Potential.

multiplied by four. NMFS chooses this target if the population is likely to ultimately produce considerably more than the depensation threshold, but less than the low risk threshold.

The draft recovery plan establishes the following criteria at the ESU, diversity strata, and population scales to measure whether the recovery objectives are met (NMFS 2012b).

VSP Parameter	Population Type	Recovery Objective	Recovery Criteria
Abundance	Core	Low risk of extinction.	The geometric mean of wild spawners over 12 years at least meets the "low risk threshold" of spawners for each core population
	Non-Core 1	Moderate or low risk of extinction.	The annual number of wild spawners meets or exceeds the moderate risk threshold for each non-core population
Productivity	Core and Non-Core 1	Population growth rate is not negative.	Slope of regression of the geometric mean of wild spawners over the time series ≥ zero
Spatial Structure	Core and Non-Core 1	Ensure populations are widely distributed.	Annual within-population distribution ≥ 80% of habitat (outside of a temperature mask)
	Non-Core 2 and Dependent	Achieve inter- and intra-stratum connectivity.	20% of accessible habitat is occupied in years following spawning of cohorts that experienced good marine survival
Diversity	Core and Non-Core 1	Achieve low or moderate hatchery impacts on wild fish.	Proportion of hatchery-origin spawners (pHOS) ≤ 0.10
	Core and Non-Core 1	Achieve life history diversity.	Variation is present in migration timing, age structure, size and behavior. Variation in these parameters is retained.

Abundance and Productivity. Although long-term data on abundance of SONCC coho salmon are scarce, available evidence from shorter-term research and monitoring efforts indicate that conditions have worsened for populations since the last formal status review was published (Good *et al.* 2005; NMFS 2012b). Because the extinction risk of an ESU depends upon the extinction risk of its constituent independent populations and the population abundance of most independent populations are below their depensation threshold, the SONCC coho salmon ESU is at high risk of extinction and is not viable (NMFS 2012b).

Limiting Factors. Threats from natural or man-made factors have worsened in the past 5 years, primarily due to four factors: small population dynamics, climate change, multi-year drought, and poor ocean survival conditions (NMFS 2012b; NOAA Fisheries 2011). Limiting factors include:

- Lack of floodplain and channel structure
- Impaired water quality
- Altered hydrologic function (timing of volume of water flow)
- Impaired estuary/mainstem function
- Degraded riparian forest conditions
- Altered sediment supply
- Increased disease/predation/competition
- Barriers to migration

- Adverse fishery-related effects
- Adverse hatchery-related effects

2.2.2 Status of the Critical Habitats

This section examines the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated areas. These features are essential to the conservation of the listed species because they support one or more of the species' life stages (*e.g.*, sites with conditions that support spawning, rearing, migration and foraging).

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC_5) in terms of the conservation value they provide to each listed species they support.[34] The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NOAA Fisheries 2005). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (*e.g.*, one of a very few spawning areas), a unique contribution of the population it served (*e.g.*, a population at the extreme end of geographic distribution), or the fact that it serves another important role (*e.g.*, obligate area for migration to upstream spawning areas).

The physical or biological features of freshwater spawning and incubation sites, include water flow, quality and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles (Table 26-27). These features are essential to conservation because without them the species cannot successfully spawn and produce offspring. The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

[34] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NOAA Fisheries 2005).

Table 26. Primary constituent elements (PCEs) of critical habitats designated for ESA-listed salmon and steelhead species considered in the opinion (except SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, and SONCC coho salmon), and corresponding species life history events.

Primary Constituent Elements		Species Life History Event
Site Type	**Site Attribute**	
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation and "reverse smoltification" Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing
Offshore marine areas	Forage Water quality	Adult growth and sexual maturation Adult spawning migration Subadult rearing

Table 27. PCEs of critical habitats designated for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, SONCC coho salmon, and corresponding species life history events.

Primary Constituent Elements		Species Life History Event
Site	**Site Attribute**	
Spawning and juvenile rearing areas	Access (sockeye) Cover/shelter Food (juvenile rearing) Riparian vegetation Space (Chinook, coho) Spawning gravel Water quality Water temp (sockeye) Water quantity	Adult spawning Embryo incubation Alevin growth and development Fry emergence from gravel Fry/parr/smolt growth and development
Adult and juvenile migration corridors	Cover/shelter Food (juvenile) Riparian vegetation Safe passage Space Substrate Water quality Water quantity Water temperature Water velocity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Areas for growth and development to adulthood	Ocean areas – not identified	Nearshore juvenile rearing Subadult rearing Adult growth and sexual maturation Adult spawning migration

CHART Salmon and Steelhead Critical Habitat Assessments. The CHART for each recovery domain assessed biological information pertaining to areas under consideration for designation as critical habitat to identify the areas occupied by listed salmon and steelhead, determine whether those areas contained PCEs essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3 point score for the PCEs in each HUC_5 watershed for:

Factor 1. Quantity,
Factor 2. Quality – Current Condition,
Factor 3. Quality – Potential Condition,
Factor 4. Support of Rarity Importance,
Factor 5. Support of Abundant Populations, and
Factor 6. Support of Spawning/Rearing.

Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality - current condition), which considers the existing condition of the quality of PCEs in the HUC_5 watershed; and Factor 3 (quality – potential condition), which considers the likelihood of achieving PCE potential in the HUC_5 watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

Southern DPS Eulachon. Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington (USDC 2011). All of these areas are designated as migration and spawning habitat for this species. In Oregon, 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek have been designated. The mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles is also designated as critical habitat. Table 28 delineates the designated physical or biological features for eulachon.

Table 28. Physical or biological features of critical habitats designated for eulachon and corresponding species life history events.

Physical or biological features		Species Life History Event
Site Type	**Site Attribute**	
Freshwater spawning and incubation	Flow Water quality Water temperature Substrate	Adult spawning Incubation
Freshwater migration	Flow Water quality Water temperature Food	Adult and larval mobility Larval feeding

The range of eulachon in the Pacific Northwest completely overlaps with the range of several ESA-listed stocks of salmon and steelhead. Although the habitat requirements of these fishes differ somewhat from eulachon, efforts to protect habitat generally focus on the maintenance of watershed processes that will be expected to benefit eulachon. The BRT identified dams and water diversions as moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath systems, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods (Gustafson *et al.* 2010). Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown (Gustafson *et al.* 2010). The BRT identified dredging as a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.

The lower Columbia River mainstem provides spawning and incubation sites, and a large migratory corridor to spawning areas in the tributaries. Prior to the construction of Bonneville Dam, eulachon ascended the Columbia River as far as Hood River, Oregon. Major tributaries that support spawning runs include the Grays, Skamokawa, Elochoman, Kalama, Lewis and Sandy rivers.

The number of eulachon returning to the Umpqua River seems to have declined in the 1980s, and does not appear to have rebounded to previous levels. Additionally, eulachon are regularly caught in salmonid smolt traps operated in the lower reaches of Tenmile Creek by ODFW.

Puget Sound Recovery Domain. Critical habitat has been designated in Puget Sound for PS Chinook salmon, HC summer-run chum salmon, LO sockeye salmon, and southern DPS eulachon, and proposed for PS steelhead. Major tributary river basins in the Puget Sound basin include the Nooksack, Samish, Skagit, Sauk, Stillaguamish, Snohomish, Lake Washington, Cedar, Sammamish, Green, Duwamish, Puyallup, White, Carbon, Nisqually, Deschutes, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers and Soos Creek.

Landslides can occur naturally in steep, forested lands, but inappropriate land use practices likely have accelerated their frequency and the amount of sediment delivered to streams. Fine sediment from unpaved roads has also contributed to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and LW recruitment (Shared Strategy for Puget Sound 2007).

Diking, agriculture, revetments, railroads and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and LW. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water which ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Shared Strategy for Puget Sound 2007; Spence *et al.* 1996).

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of suspended sediment, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (Shared Strategy for Puget Sound 2007).

Peak stream flows have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (Shared Strategy for Puget Sound 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist *et al.* 2011).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS Chinook salmon populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat (*e.g*., Elwha River dams block anadromous fish access to 70 miles of potential habitat) changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and LW to downstream areas (Shared Strategy for Puget Sound 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion headgates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system (WDFW 2009). Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in many Puget Sound tributary basins (Shared Strategy for Puget Sound 2007).

The nearshore marine habitat has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound's tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (Shared Strategy for Puget Sound 2007).

Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (Hood Canal Coordinating Council 2005; Shared Strategy for Puget Sound 2007).

In summary, critical habitat throughout the Puget Sound basin has been degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of LW, intense urbanization, agriculture, alteration of floodplain and stream morphology (*i.e*., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors in areas of critical habitat.

The PS recovery domain CHART determined that only a few watersheds with PCEs for Chinook salmon in the Whidbey Basin (Skagit River/Gorge Lake, Cascade River, Upper Sauk River, and the Tye and Beckler rivers) are in good to excellent condition with no potential for improvement. Most HUC_5 watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement (Table 29).

Table 29. **Puget Sound Recovery Domain:** Current and potential quality of HUC5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and chum salmon (CM) (NOAA Fisheries 2005).[35] Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	**Potential PCE Condition**
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = reduced, with high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Potential Quality
Strait of Georgia and Whidbey Basin #1711000xxx			
Skagit River/Gorge Lake (504), Cascade (506) & Upper Sauk (601) rivers, Tye & Beckler rivers (901)	CK	3	3
Skykomish River Forks (902)	CK	3	1
Skagit River/Diobsud (505), Illabot (507), & Middle Skagit/Finney Creek (701) creeks; & Sultan River (904)	CK	2	3
Skykomish River/Wallace River (903) & Skykomish River/Woods Creek (905)	CK	2	2
Upper (602) & Lower (603) Suiattle rivers, Lower Sauk (604), & South Fork Stillaguamish (802) rivers	CK	2	1
Samish River (202), Upper North (401), Middle (402), South (403), Lower North (404), Nooksack River; Nooksack River (405), Lower Skagit/Nookachamps Creek (702) & North Fork (801) & Lower (803) Stillaguamish River	CK	1	2
Bellingham (201) & Birch (204) bays & Baker River (508)	CK	1	1
Whidbey Basin and Central/South Basin #1711001xxx			

[35] On January 14, 2013, NMFS published a proposed rule for the designation of critical habitat for LCR coho salmon and PS steelhead (USDC 2013). A draft biological report, which includes a CHART assessment for PS salmon, was also completed (NMFS 2012c). Habitat quality assessments for PS steelhead are out for review; therefore, they are not included on this table.

Current PCE Condition	**Potential PCE Condition**
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = reduced, with high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Potential Quality
Lower Snoqualmie River (004), Snohomish (102), Upper White (401) & Carbon (403) rivers	CK	2	2
Middle Fork Snoqualmie (003) & Cedar rivers (201), Lake Sammamish (202), Middle Green River (302) & Lowland Nisqually (503)	CK	2	1
Pilchuck (101), Upper Green (301), Lower White (402), & Upper Puyallup River (404) rivers, & Mashel/Ohop(502)	CK	1	2
Lake Washington (203), Sammamish (204) & Lower Green (303) rivers	CK	1	1
Puyallup River (405)	CK	0	2
Hood Canal #1711001xxx			
Dosewallips River (805)	CK/CM	2	1/2
Kitsap – Kennedy/Goldsborough (900)	CK	2	1
Hamma Hamma River (803)	CK/CM	1/2	1/2
Lower West Hood Canal Frontal (802)	CK/CM	0/2	0/1
Skokomish River (701)	CK/CM	1/0	2/1
Duckabush River (804)	CK/CM	1	2
Upper West Hood Canal Frontal (807)	CM	1	2
Big Quilcene River (806)	CK/CM	1	1/2
Deschutes Prairie-1 (601) & Prairie-2 (602)	CK	1	1
West Kitsap (808)	CK/CM	1	1
Kitsap – Prairie-3 (902)	CK	1	1
Port Ludlow/Chimacum Creek (908)	CM	1	1
Kitsap – Puget (901)	CK	0	1
Kitsap – Puget Sound/East Passage (904)	CK	0	0
Strait of Juan de Fuca Olympic #1711002xxx			
Dungeness River (003)	CK/CM	2/1	1/2
Discovery Bay (001) & Sequim Bay (002)	CM	1	2
Elwha River (007)	CK	1	2
Port Angeles Harbor (004)	CK	1	1

Willamette-Lower Columbia Recovery Domain. Critical habitat was designated in the WLC recovery domain for UWR spring-run Chinook salmon, LCR Chinook salmon, LCR steelhead, UWR steelhead, CR chum salmon, southern DPS eulachon, and proposed for LCR coho salmon. In addition to the Willamette and Columbia River mainstems, important tributaries on the Oregon side of the WLC include Youngs Bay, Big Creek, Clatskanie River, and Scappoose River in the Oregon Coast subbasin; Hood River in the Gorge; and the Sandy, Clackamas, Molalla, North and South Santiam, Calapooia, McKenzie, and Middle Fork Willamette rivers in the West Cascades subbasin.

Land management activities have severely degraded stream habitat conditions in the Willamette River mainstem above Willamette Falls and associated subbasins. In the Willamette River mainstem and lower sub-basin mainstem reaches, high density urban development and widespread agricultural effects have reduced aquatic and riparian habitat quality and complexity, and altered sediment and water quality and quantity, and watershed processes. The Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75%. In addition, the construction of 37 dams in the basin blocked access to more than 435 miles of stream and river spawning habitat. The dams alter the temperature regime of the Willamette River and its tributaries, affecting the timing and development of naturally-spawned eggs and fry. Logging in the Cascade and Coast Ranges, and agriculture, urbanization, and gravel mining on valley floors have contributed to increased erosion and sediment loads throughout the WLC domain.

The mainstem Willamette River has been channelized and stripped of LW. Development began to encroach on the riparian forest beginning in the 1870s (Sedell and Froggatt 1984). Gregory (2002a) calculated that the total mainstem Willamette River channel area decreased from 41,000 to 23,000 acres between 1895 and 1995. They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench, and that due to this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach from Newberg to Albany (RM 50 to 120) incurred losses of 12% primary channel area, 16% side channels, 33% alcoves, and 9% islands. Even greater changes occurred in the upper reach, from Albany to Eugene (RM 187). There, approximately 40% of both channel length and channel area were lost, along with 21% of the primary channel, 41% of side channels, 74% of alcoves, and 80% of island areas.

The banks of the Willamette River have more than 96 miles of revetments; approximately half were constructed by the ACOE. Generally, the revetments were placed in the vicinity of roads or on the outside bank of river bends, so that while only 26% of the total length is revetted, 65% of the meander bends are revetted (Gregory *et al.* 2002b). The majority of dynamic sections have been armored, reducing adjustments in channel bed and sediment storage by the river, and thereby diminishing both the complexity and productivity of aquatic habitats (Gregory *et al.* 2002b).

Riparian forests have diminished considerably in the lower reaches of the Willamette River (Gregory *et al.* 2002c). Sedell and Froggatt (1984) noted that agriculture and cutting of streamside trees were major agents of change for riparian vegetation, along with snagging of LW in the channel. The reduced shoreline, fewer and smaller snags, and reduced riparian forest comprise large functional losses to the river, reducing structural features, organic inputs from litter fall, entrained allochthonous materials, and flood flow filtering capacity. Extensive changes began before the major dams were built, with navigational and agricultural demands dominating the early use of the river. The once expansive forests of the Willamette River floodplain provided valuable nutrients and organic matter during flood pulses, food sources for macroinvertebrates, and slow-water refugia for fish during flood events. These forests also cooled river temperatures as the river flowed through its many channels.

Gregory *et al.* (2002c) described the changes in riparian vegetation in river reaches from the mouth to Newberg, from Newberg to Albany, and from Albany to Eugene. They noted that the riparian forests were formerly a mosaic of brush, marsh, and ash tree openings maintained by annual flood inundation. Below the City of Newberg, the most noticeable change was that conifers were almost eliminated. Above Newberg, the formerly hardwood-dominated riparian forests along with mixed forest made up less than half of the riparian vegetation by 1990, while agriculture dominated. This conversion has reduced river shading and the potential for recruitment of wood to the river, reducing channel complexity and the quality of rearing, migration and spawning habitats.

Hyporheic flow in the Willamette River has been examined through discharge measurements and found to be significant in some areas, particularly those with gravel deposits (Fernald *et al.* 2001; Wentz *et al.* 1998). The loss of channel complexity and meandering that fosters creations of gravel deposits decreases the potential for hyporheic flows, as does gravel mining. Hyporheic flow processes water and affects its quality on reemerging into the main channel, stabilizing variations in physical and chemical water characteristics. Hyporheic flow is important for ecological functions, some aspects of water quality (such as temperature and dissolved oxygen), and some benthic invertebrate life stages. Alcove habitat, which has been limited by channelization, combines low hydraulic stress and high food availability with the potential for hyporheic flows across the steep hydraulic gradients in the gravel separating them from the main channel (Fernald *et al.* 2001).

On the mainstem of the Columbia River, hydropower projects, including the Federal Columbia River Hydropower System (FCRPS), have significantly degraded salmon and steelhead habitats (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011d; NMFS 2013a). The series of dams and reservoirs that make up the FCRPS block an estimated 12 million cubic yards of debris and sediment that would otherwise naturally flow down the Columbia River and replenish shorelines along the Washington and Oregon coasts.

Industrial harbor and port development are also significant influences on the Lower Willamette and Lower Columbia rivers (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011d; NMFS 2013a). Since 1878, 100 miles of river channel within the mainstem Columbia River, its estuary, and Oregon's Willamette River have been dredged as a navigation channel by the ACOE. Originally dredged to a 20-foot minimum depth, the Federal navigation channel of the Lower Columbia River is now maintained at a depth of 43 feet and a width of 600 feet. The Lower Columbia River supports five ports on the Washington State side: Kalama, Longview, Skamania County, Woodland, and Vancouver. In addition to loss of riparian habitat, and disruption of benthic habitat due to dredging, high levels of several sediment chemicals, such as arsenic and polycyclic aromatic hydrocarbons (PAHs), have been identified in Lower Columbia River watersheds in the vicinity of the ports and associated industrial facilities.

The most extensive urban development in the Lower Columbia River subbasin has occurred in the Portland/Vancouver area. Outside of this major urban area, the majority of residences and businesses rely on septic systems.

Common water quality issues with urban development and residential septic systems include higher water temperatures, lowered dissolved oxygen, increased fecal coliform bacteria, and increased chemicals associated with pesticides and urban runoff.

The Columbia River estuary has lost a significant amount of the tidal marsh and tidal swamp habitats that are critical to juvenile salmon and steelhead, particularly small or ocean-type species (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011d; NMFS 2013a). Edges of marsh areas provide sheltered habitats for juvenile salmon and steelhead where food, in the form of amphipods or other small invertebrates which feed on marsh detritus, is plentiful, and larger predatory fish can be avoided. Historically, floodwaters of the Columbia River inundated the margins and floodplains along the estuary, allowing juvenile salmon and steelhead access to a wide expanse of low-velocity marshland and tidal channel habitats. In general, the riverbanks were gently sloping, with riparian and wetland vegetation at the higher elevations of the river floodplain becoming habitat for salmon and steelhead during flooding river discharges or flood tides. Sherwood *et al.* (1990) estimated that the Columbia River estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970. This study further estimated an 80% reduction in emergent vegetation production and a 15% decline in benthic algal production.

Habitat and food-web changes within the estuary, and other factors affecting salmon population structure and life histories, have altered the estuary's capacity to support juvenile salmon (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011d; NMFS 2013a). Diking and filling activities have reduced the tidal prism and eliminate emergent and forested wetlands and floodplain habitats. These changes have likely reduced the estuary's salmon-rearing capacity. Moreover, water and sediment in the Lower Columbia River and its tributaries have toxic contaminants that are harmful to aquatic resources (Lower Columbia River Estuary Partnership 2007).

Contaminants of concern include dioxins and furans, heavy metals, polychlorinated biphenyls (PCBs) and organochlorine pesticides such as DDT. Simplification of the population structure and life-history diversity of salmon possibly is yet another important factor affecting juvenile salmon viability. Restoration of estuarine habitats, particularly diked emergent and forested wetlands, reduction of avian predation by terns, and flow manipulations to restore historical flow patterns have likely begun to enhance the estuary's productive capacity for salmon, although historical changes in population structure and salmon life histories may prevent salmon from making full use of the productive capacity of estuarine habitats.

The WLC recovery domain CHART determined that most HUC_5 watersheds with PCEs for salmon or steelhead are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement. Only watersheds in the upper McKenzie River and its tributaries are in good to excellent condition with no potential for improvement (Table 30).

Table 30. Willamette-Lower Columbia Recovery Domain: Current and potential quality of HUC5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK), chum salmon (CM), and steelhead (ST) (NOAA Fisheries 2005).[36] Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC5 Code(s)	Listed Species	Current Quality	Restoration Potential
Columbia Gorge #1707010xxx			
Wind River (511)	CK/ST	2/2	2/2
East Fork Hood (506), & Upper (404) & Lower Cispus (405) rivers	CK/ST	2/2	2/2
Plympton Creek (306)	CK	2	2
Little White Salmon River (510)	CK	2	0
Grays Creek (512) & Eagle Creek (513)	CK/CM/ST	2/1/2	1/1/2
White Salmon River (509)	CK/CM	2/1	1/2
West Fork Hood River (507)	CK/ST	1/2	2/2
Hood River (508)	CK/ST	1/1	2/2
Unoccupied habitat: Wind River (511)	Chum conservation value "Possibly High"		
Cascade and Coast Range #1708000xxx			
Lower Gorge Tributaries (107)	CK/CM/ST	2/2/2	2/3/2
Lower Lewis (206) & North Fork Toutle (504) rivers	CK/CM/ST	1/3/1	2/1/2
Salmon (101), Zigzag (102), & Upper Sandy (103) rivers	CK/ST	2/2	2/2
Big Creek (602)	CK/CM	2/2	2/2
Coweeman River (508)	CK/CM/ST	2/2/1	2/1/2
Kalama River (301)	CK/CM/ST	1/2/2	2/1/2
Cowlitz Headwaters (401)	CK/ST	2/2	1/1
Skamokawa/Elochoman (305)	CK/CM	2/1	2
Salmon Creek (109)	CK/CM/ST	1/2/1	2/3/2
Green (505) & South Fork Toutle (506) rivers	CK/CM/ST	1/1/2	2/1/2
Jackson Prairie (503) & East Willapa (507)	CK/CM/ST	1/2/1	1/1/2
Grays Bay (603)	CK/CM	1/2	2/3
Upper Middle Fork Willamette River (101)	CK	2	1
Germany/Abernathy creeks (304)	CK/CM	1/2	2
Mid-Sandy (104), Bull Run (105), & Lower Sandy (108) rivers	CK/ST	1/1	2/2
Washougal (106) & East Fork Lewis (205) rivers	CK/CM/ST	1/1/1	2/1/2
Upper Cowlitz (402) & Tilton rivers (501) & Cowlitz Valley Frontal (403)	CK/ST	1/1	2/1

[36] On January 14, 2013, NMFS published a proposed rule for the designation of critical habitat for LCR coho salmon and PS steelhead (USDC 2013). A draft biological report, which includes a CHART assessment for PS steelhead, was also completed (NMFS 2012c). Habitat quality assessments for LCR coho salmon are out for review; therefore, they are not included on this table.

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC5 Code(s)	Listed Species	Current Quality	Restoration Potential
Clatskanie (303) & Young rivers (601)	CK	1	2
Rifle Reservoir (502)	CK/ST	1	1
Beaver Creek (302)	CK	0	1
Unoccupied Habitat: Upper Lewis (201) & Muddy (202) rivers; Swift (203) & Yale (204) reservoirs	CK & ST Conservation Value "Possibly High"		
Willamette River #1709000xxx			
Upper (401) & South Fork (403) McKenzie rivers; Horse Creek (402); & McKenzie River/Quartz Creek (405)	CK	3	3
Lower McKenzie River (407)	CK	2	3
South Santiam River (606)	CK/ST	2/2	1/3
South Santiam River/Foster Reservoir (607)	CK/ST	2/2	1/2
North Fork of Middle Fork Willamette (106) & Blue (404) rivers	CK	2	1
Upper South Yamhill River (801)	ST	2	1
Little North Santiam River (505)	CK/ST	1/2	3/3
Upper Molalla River (905)	CK/ST	1/2	1/1
Abernethy Creek (704)	CK/ST	1/1	1/2
Luckiamute River (306) & Yamhill (807) Lower Molalla (906) rivers; Middle (504) & Lower (506) North Santiam rivers; Hamilton Creek/South Santiam River (601); Wiley Creek (608); Mill Creek/Willamette River (701); & Willamette River/Chehalem Creek (703); Lower South (804) & North (806) Yamhill rivers; & Salt Creek/South Yamhill River (805)	CK/ST	1	1
Hills (102) & Salmon (104) creeks; Salt Creek/Willamette River (103), Hills Creek Reservoir (105), Middle Fork Willamette/Lookout Point (107); Little Fall (108) & Fall (109) creeks; Lower Middle Fork of Willamette (110), Long Tom (301), Marys (305) & Mohawk (406) rivers	CK	1	1
Willamina Creek (802) & Mill Creek/South Yamhill River (803)	ST	1	1
Calapooia River (303); Oak (304) Crabtree (602), Thomas (603) & Rickreall (702) creeks; Abiqua (901), Butte (902) & Rock (903) creeks/Pudding River; & Senecal Creek/Mill Creek (904)	CK/ST	1/1	0/1
Row River (201), Mosby (202) & Muddy (302) creeks, Upper (203) & Lower (205) Coast Fork Willamette River	CK	1	0
Unoccupied habitat in North Santiam (501) & North Fork Breitenbush (502) rivers; Quartzville Creek (604) and Middle Santiam River (605)	CK & ST Conservation Value "Possibly High"		
Unoccupied habitat in Detroit Reservoir/Blowout Divide Creek (503)	Conservation Value: CK "Possibly Medium"; ST Possibly High"		
Lower Willamette #1709001xxx			

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Collawash (101), Upper Clackamas (102), & Oak Grove Fork (103) Clackamas rivers	CK/ST	2/2	3/2
Middle Clackamas River (104)	CK/ST	2/1	3/2
Eagle Creek (105)	CK/ST	2/2	1/2
Gales Creek (002)	ST	2	1
Lower Clackamas River (106) & Scappoose Creek (202)	CK/ST	1	2
Dairy (001) & Scoggins (003) creeks; Rock Creek/Tualatin River (004); & Tualatin River (005)	ST	1	1
Johnson Creek (201)	CK/ST	0/1	2/2
Lower Willamette/Columbia Slough (203)	CK/ST	0	2

Interior Columbia Recovery Domain. Critical habitat has been designated in the IC recovery domain, which includes the Snake River Basin, for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, UCR spring-run Chinook salmon, SR sockeye salmon, MCR steelhead, UCR steelhead, and SRB steelhead.

Habitat quality in tributary streams in the IC recovery domain varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (NMFS 2009b; Wissmar *et al.* 1994). Critical habitat throughout much of the IC recovery domain has been degraded by intense agriculture, alteration of stream morphology (*i.e.*, channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, logging, mining, and urbanization. Reduced summer stream flows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in developed areas.

Migratory habitat quality in this area has been severely affected by the development and operation of the FCRPS dams and reservoirs in the mainstem Columbia River, Bureau of Reclamation tributary projects, and privately owned dams in the Snake and Upper Columbia river basins. For example, construction of Hells Canyon Dam eliminated access to several likely production areas in Oregon and Idaho, including the Burnt, Powder, Weiser, Payette, Malheur, Owyhee, and Boise river basins (Good *et al.* 2005), and Grand Coulee and Chief Joseph dams completely block anadromous fish passage on the upper mainstem Columbia River.

Hydroelectric development modified natural flow regimes, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivorous and avian predation on juvenile salmon and steelhead, and delayed migration for both adult and juveniles. Physical features of dams such as turbines also kill migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles.

Similarly, development and operation of extensive irrigation systems and dams for water withdrawal and storage in tributaries have altered hydrological cycles. A series of large regulating dams on the middle and upper Deschutes River affect flow and block access to upstream habitat, and have extirpated one or more populations from the Cascades Eastern Slope major population (IC-TRT 2003). Similarly, operation and maintenance of large water reclamation systems such as the Umatilla Basin and Yakima Projects have significantly reduced flows and degraded water quality and physical habitat in this domain.

Many stream reaches designated as critical habitat in the IC recovery domain are over-allocated under state water law, with more allocated water rights than existing streamflow. Withdrawal of water, particularly during low-flow periods that commonly overlap with agricultural withdrawals, often increases summer stream temperatures, blocks fish migration, strands fish, and alters sediment transport (Spence *et al.* 1996). Reduced tributary stream flow has been identified as a major limiting factor for all listed salmon and steelhead species in this recovery domain except SR fall-run Chinook salmon and SR sockeye salmon (NMFS 2007c; NOAA Fisheries 2011).

Many stream reaches designated as critical habitat are listed on the state of Oregon's Clean Water Act section 303(d) list for water temperature. Many areas that were historically suitable rearing and spawning habitat are now unsuitable due to high summer stream temperatures. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water for agricultural or municipal use all contribute to elevated stream temperatures. Contaminants such as insecticides and herbicides from agricultural runoff and heavy metals from mine waste are common in some areas of critical habitat.

The IC recovery domain is a very large and diverse area. The CHART determined that few watersheds with PCEs for Chinook salmon or steelhead are in good to excellent condition with no potential for improvement. Overall, most IC recovery domain watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or high potential for improvement. In Washington, the Upper Methow, Lost, White, and Chiwawa watersheds are in good-to-excellent condition with no potential for improvement. In Oregon, only the Lower Deschutes, Minam, Wenaha, and Upper and Lower Imnaha Rivers HUC_5 watersheds are in good-to-excellent condition with no potential for improvement. In Idaho, a number of watersheds with PCEs for steelhead (Upper Middle Salmon, Upper Salmon/Pahsimeroi, Middle Fork Salmon, Little Salmon, Selway, and Lochsa rivers) are in good-to-excellent condition with no potential for improvement. Additionally, several Lower Snake River HUC_5watersheds in the Hells Canyon area, straddling Oregon and Idaho, are in good-to-excellent condition with no potential for improvement (Table 31).

Table 31. Interior Columbia Recovery Domain: Current and potential quality of Oregon and Washington HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and steelhead (ST) (NOAA Fisheries 2005). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Upper Columbia # 1702000xxx			
White (101), Chiwawa (102), Lost (801) & Upper Methow (802) rivers	CK/ST	3	3
Upper Chewuch (803) & Twisp rivers (805)	CK/ST	3	2
Lower Chewuch River (804); Middle (806) & Lower (807) Methow rivers	CK/ST	2	2
Salmon Creek (603) & Okanogan River/Omak Creek (604)	ST	2	2
Upper Columbia/Swamp Creek (505)	CK/ST	2	1
Foster Creek (503) & Jordan/Tumwater (504)	CK/ST	1	1
Upper (601) & Lower (602) Okanogan River; Okanogan River/Bonaparte Creek (605); Lower Similkameen River (704); & Lower Lake Chelan (903)	ST	1	1
Unoccupied habitat in Sinlahekin Creek (703)	ST Conservation Value "Possibly High"		
Upper Columbia #1702001xxx			
Entiat River (001); Nason/Tumwater (103); & Lower Wenatchee River (105)	CK/ST	2	2
Lake Entiat (002)	CK/ST	2	1
Columbia River/Lynch Coulee (003); Sand Hollow (004); Yakima/Hansen Creek (604), Middle Columbia/Priest Rapids (605), & Columbia River/Zintel Canyon (606)	ST	2	1
Icicle/Chumstick (104)	CK/ST	1	2
Lower Crab Creek (509)	ST	1	2
Rattlesnake Creek (204)	ST	0	1
Yakima #1703000xxx			
Upper (101) & Middle (102) Yakima rivers; Teanaway (103) & Little Naches (201) rivers; Naches River/Rattlesnake Creek (202); & Ahtanum (301) & Upper Toppenish (303) & Satus (305) creeks	ST	2	2
Umtanum/Wenas (104); Naches River/Tieton River (203); Upper Lower Yakima River (302); & Lower Toppenish Creek (304)	ST	1	2
Yakima River/Spring Creek (306)	ST	1	1
Lower Snake River #1706010xxx			
Snake River/Granite (101), Getta (102), & Divide (104) creeks; Upper (201) & Lower (205) Imnaha River; Snake River/Rogersburg (301);	ST	3	3

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC5 Code(s)	Listed Species	Current Quality	Restoration Potential
Minam (505) & Wenaha (603) rivers			
Grande Ronde River/Rondowa (601)	ST	3	2
Big (203) & Little (204) Sheep creeks; Asotin River (302); Catherine Creek (405); Lostine River (502); Bear Creek (504); & Upper (706) & Lower (707) Tucannon River	ST	2	3
Middle Imnaha River (202); Snake River/Captain John Creek (303); Upper Grande Ronde River (401); Meadow (402); Beaver (403); Indian (409), Lookingglass (410) & Cabin (411) creeks; Lower Wallowa River (506); Mud (602), Chesnimnus (604) & Upper Joseph (605) creeks	ST	2	2
Ladd Creek (406); Phillips/Willow Creek (408); Upper (501) & Middle (503) Wallowa rivers; & Lower Grande Ronde River/Menatche Creek (607)	ST	1	3
Five Points (404); Lower Joseph (606) & Deadman (703) creeks	ST	1	2
Tucannon/Alpowa Creek (701)	ST	1	1
Mill Creek (407)	ST	0	3
Pataha Creek (705)	ST	0	2
Snake River/Steptoe Canyon (702) & Penawawa Creek (708)	ST	0	1
Flat Creek (704) & Lower Palouse River (808)	ST	0	0
Mid-Columbia #1707010xxx			
Wood Gulch (112); Rock Creek (113); Upper Walla Walla (201), Upper Touchet (203), & Upper Umatilla (301) rivers; Meacham (302) & Birch (306) creeks; Upper (601) & Middle (602) Klickitat River	ST	2	2
Glade (105) & Mill (202) creeks; Lower Klickitat River (604); Mosier Creek (505); White Salmon River (509); Middle Columbia/Grays Creek (512)	ST	2	1
Little White Salmon River (510)	ST	2	0
Middle Touchet River (204); McKay Creek (305); Little Klickitat River (603);Fifteenmile (502) & Fivemile (503) creeks	ST	1	2
Alder (110) & Pine (111) creeks; Lower Touchet River (207), Cottonwood (208), Pine (209) & Dry (210) creeks; Lower Walla Walla River (211); Umatilla River/Mission Creek (303) Wildhorse Creek (304); Umatilla River/Alkali Canyon (307); Lower Butter Creek (310); Upper Middle Columbia/Hood (501); Middle Columbia/Mill Creek (504)	ST	1	1
Stage Gulch (308) & Lower Umatilla River (313)	ST	0	1
John Day #170702xxx			
Middle (103) & Lower (105) South Fork John Day rivers; Murderers (104) & Canyon (107) creeks; Upper John Day (106) & Upper North	ST	2	2

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC5 Code(s)	Listed Species	Current Quality	Restoration Potential
Fork John Day (201) rivers; & Desolation Creek (204)			
North Fork John Day/Big Creek (203); Cottonwood Creek (209) & Lower NF John Day River (210)	ST	2	1
Strawberry (108), Beech (109), Laycock (110), Fields (111), Mountain (113) & Rock (114) creeks; Upper Middle John Day River (112); Granite (202) & Wall (208) creeks; Upper (205) & Lower (206) Camas creeks; North Fork John Day/Potamus Creek (207); Upper Middle Fork John Day River (301) & Camp (302), Big (303) & Long (304) creeks; Bridge (403) & Upper Rock (411) creeks; & Pine Hollow (407)	ST	1	2
John Day/Johnson Creek (115); Lower Middle Fork John Day River (305); Lower John Day River/Kahler Creek (401), Service (402) & Muddy (404) creeks; Lower John Day River/Clarno (405); Butte (406), Thirtymile (408) & Lower Rock (412) creeks; Lower John Day River/Ferry (409) & Scott (410) canyons; & Lower John Day River/McDonald Ferry (414)	ST	1	1
Deschutes #1707030xxx			
Lower Deschutes River (612)	ST	3	3
Middle Deschutes River (607)	ST	3	2
Upper Deschutes River (603)	ST	2	1
Mill Creek (605) & Warm Springs River (606)	ST	2	1
Bakeoven (608) & Buck Hollow (611) creeks; Upper (701) & Lower (705) Trout Creek	ST	1	2
Beaver (605) & Antelope (702) creeks	ST	1	1
White River (610) & Mud Springs Creek (704)	ST	1	0
Unoccupied habitat in Deschutes River/McKenzie Canyon (107) & Haystack (311); Squaw Creek (108); Lower Metolius River (110), Headwaters Deschutes River (601)	ST Conservation Value "Possibly High"		

Oregon Coast Recovery Domain. In this recovery domain, critical habitat has been designated for OC coho salmon, and southern DPS eulachon. Many large and small rivers supporting significant populations of coho salmon flow through this domain, including the Nehalem, Nestucca, Siletz, Yaquina, Alsea, Siuslaw, Umpqua, Coos, and Coquille.
The historical disturbance regime in the central Oregon Coast Range was dominated by a mixture of high and low-severity fires, with a natural rotation of approximately 271 years. Old-growth forest coverage in the Oregon Coast Range varied from 25 to 75% during the past 3,000 years, with a mean of 47%, and never fell below 5% (Wimberly *et al.* 2000).

Currently, the Coast Range has approximately 5% old-growth, almost all of it on Federal lands. The dominant disturbance now is logging on a cycle of approximately 30 to 100 years, with fires suppressed.

Oregon's assessment of OC coho salmon (Nicholas *et al.* 2005) mapped how streams with high intrinsic potential for rearing are distributed by land ownership categories. Agricultural lands and private industrial forests have by far the highest percentage of land ownership in high intrinsic potential areas and along all coho salmon stream miles. Federal lands have only about 20% of coho salmon stream miles and 10% of high intrinsic potential stream reaches. Because of this distribution, activities in lowland agricultural areas are particularly important to the conservation of OC coho salmon.

The OC coho salmon assessment concluded that at the scale of the entire domain, pools are generally abundant, although slow-water and off-channel habitat (which are important refugia for coho salmon during high winter flows) are limited in the majority of streams when compared to reference streams in minimally-disturbed areas. Amounts of LW in streams are low in all four ODFW monitoring areas and land-use types relative to reference conditions. Amounts of fine sediment are high in three of the four monitoring areas, and were comparable to reference conditions only on public lands. Approximately 62 to 91% of tidal wetland acres (depending on estimation procedures) have been lost for functionally and potentially independent populations of coho salmon.

As part of the coastal coho salmon assessment, the Oregon Department of Environmental Quality analyzed the status and trends of water quality in the range of OC coho salmon using the Oregon water quality index, which is based on a combination of temperature, dissolved oxygen, biological oxygen demand, pH, total solids, nitrogen, total phosphates, and bacteria. Using the index at the species scale, 42% of monitored sites had excellent to good water quality, and 29% show poor to very poor water quality (ODEQ 2005). Within the four monitoring areas, the North Coast had the best overall conditions (six sites in excellent or good condition out of nine sites), and the Mid-South coast had the poorest conditions (no excellent condition sites, and only two out of eight sites in good condition). For the 10-year period monitored between 1992 and 2002, no sites showed a declining trend in water quality. The area with the most improving trends was the North Coast, where 66% of the sites (six out of nine) had a significant improvement in index scores. The Umpqua River basin, with one out of nine sites (11%) showing an improving trend, had the lowest number of improving sites.

Southern Oregon/Northern California Coasts Recovery Domain. In this recovery domain critical habitat has been designated for SONCC coho salmon, and southern DPS eulachon. Many large and small rivers supporting significant populations of coho salmon flow through this area, including the Elk, Rogue, Chetco, Smith and Klamath. The following summary of critical habitat information in the Elk, Rogue, and Chetco rivers is also applicable to habitat characteristics and limiting factors in other basins in this area.

The Elk River flows through Curry County, and drains approximately 92 square miles (or 58,678 acres)(Maguire 2001). Historical logging, mining, and road building have degraded stream and riparian habitats in the Elk River basin.

Limiting factors identified for salmon and steelhead production in this basin include sparse riparian cover, especially in the lower reaches, excessive fine sediment, high water temperatures, and noxious weed invasions (Maguire 2001).

The Rogue River drains approximately 5,160 square miles within Curry, Jackson and Josephine counties in southwest Oregon. The mainstem is about 200 miles long and traverses the coastal mountain range into the Cascades. The Rogue River estuary has been modified from its historical condition. Jetties were built by the ACOE in 1960, which stabilized and deepened the mouth of the river. A dike that extends from the south shore near Highway 101 to the south jetty was completed in 1973. This dike created a backwater for the large shallow area that existed here, which has been developed into a boat basin and marina, eliminating most of the tidal marsh.

The quantity of estuary habitat is naturally limited in the Rogue River. The Rogue River has a drainage area of 5,160 square miles, but the estuary at 1,880 acres is one of the smallest in Oregon. Between 1960 and 1972, approximately 13 acres of intertidal and 14 acres of subtidal land were filled in to build the boat basin dike, the marina, north shore riprap and the other north shore developments (Hicks 2005). Jetties constructed in 1960 to stabilize the mouth of the river and prevent shoaling have altered the Rogue River, which historically formed a sill during summer months (Hicks 2005).

The Lower Rogue Watershed Council's watershed analysis (Hicks 2005). lists factors limiting fish production in tributaries to Lower Rogue River watershed. The list includes water temperatures, low stream flows, riparian forest conditions, fish passage and over-wintering habitat. Limiting factors identified for the Upper Rogue River basin include fish passage barriers, high water temperatures, insufficient water quantity, lack of LW, low habitat complexity, and excessive fine sediment (Rogue Basin Coordinating Council 2006).

The Chetco River estuary has been significantly modified from its historical condition. Jetties were erected by the ACOE in 1957, which stabilized and deepened the mouth of the river. These jetties have greatly altered the mouth of the Chetco River and how the estuary functions as habitat for salmon migrating to the ocean. A boat basin and marina were built in the late 1950s and eliminated most of the functional tidal marsh. The structures eliminated shallow water habitats and vegetation in favor of banks stabilized with riprap. Since then, nearly all remaining streambank habitat in the estuary has been stabilized with riprap. The factors limiting fish production in the Chetco River appear to be high water temperature caused by lack of shade, especially in tributaries, high rates of sedimentation due to roads, poor over-wintering habitat due to a lack of LW in tributaries and the mainstem, and poor quality estuary habitat (Maguire 2001).

2.3 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

As described above in the Status of the Species and Critical Habitat sections, factors that limit the recovery of species considered in this opinion vary with the overall condition of aquatic habitats on private, state, and Federal lands. Within the program-level action area, many stream and riparian areas have been degraded by the effects of land and water use, including road construction, forest management, agriculture, mining, transportation, urbanization, and water development. Each of these economic activities has contributed to myriad interrelated factors resulting in the decline of species considered in this opinion. Among the most important of these are changes in stream channel morphology, degradation of spawning substrates, reduced instream roughness and cover, loss and degradation of estuarine rearing habitats, loss of wetlands, loss and degradation of riparian areas, water quality (*e.g.*, temperature, sediment, dissolved oxygen, contaminants) degradation, blocked fish passage, direct take, and loss of habitat refugia. Climate change is likely to play an increasingly important role in determining the abundance of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest.

Anadromous salmonids have been affected by the development and operation of dams. Dams, without adequate fish passage systems, have extirpated anadromous fish from their pre-development spawning and rearing habitats. Dams and reservoirs, within the currently accessible migratory corridor, have greatly altered the river environment and have affected fish passage. The operation of water storage projects has altered the natural hydrograph of many rivers. Water impoundment and dam operations also affect downstream water quality characteristics, a vital component of anadromous fish survival. In recent years, high quality fish passage is being restored where it did not previously exist, either through improvements to existing fish passage facilities or through dam removal (*e.g.*, Elwha Dams, Marmot Dam on the Sandy River, and Powerdale Dam on the Hood River).

Within the habitat currently accessible by species considered in this opinion, dams have negatively affected spawning and rearing habitat. Floodplains have been reduced, off-channel habitat features have been eliminated or disconnected from the main channel, and the amount of LW debris in mainstem rivers has been greatly reduced. Remaining habitats are often affected by flow fluctuations associated with reservoir water management for power peaking, flood control, and other operations.

The development of hydropower and water storage projects within the Columbia River Basin has resulted in the inundation of many mainstem spawning and shallow-water rearing areas (loss of spawning gravels and access to spawning and rearing areas). It has also altered water quality (reduced spring turbidity levels), water quantity (seasonal changes in flows and consumptive losses resulting from use of stored water for agricultural, industrial, or municipal purposes), water temperature (including generally warmer minimum winter temperatures and cooler maximum summer temperatures), water velocity (reduced spring flows and increased cross-sectional areas of the river channel), food (alteration of food webs, including the type and availability of prey species), and safe passage (increased mortality rates of migrating juveniles) (Ferguson *et al.* 2005; Williams *et al.* 2005).

Fish considered in this opinion are exposed to high rates of predation during all life stages.

Fish, birds, and marine mammals, including harbor seals, sea lions, and killer whales all prey on juvenile and adult salmon. The Columbia River Basin has a diverse assemblage of native and introduced fish species, some of which prey on salmon, steelhead, and eulachon. The primary resident fish predators of salmonids in many areas of Oregon are northern pikeminnow (native), smallmouth bass (introduced), and walleye (introduced). Other predatory resident fish include channel catfish (introduced), Pacific lamprey (native), yellow perch (introduced), largemouth bass (introduced), and bull trout (native). Increased predation by non-native predators has and continues to decrease salmonid population abundance and productivity. Forty species of freshwater fish have been introduced in Washington and are now self-sustaining, making up nearly half of the state's freshwater fish fauna (Wydoski and Whitney 2003). As in Oregon, most of the introduced species are warm-water game fish that are thriving in reservoirs and other areas where stream temperatures are higher than natural conditions because of human-caused changes to the landscape. Introduced species are frequently predators on native species, compete for food resources, alter freshwater habitats, and are displacing native salmonids from areas that historically had colder water temperatures.

Avian predation is another factor limiting salmonid recovery in the Columbia River Basin. Throughout the basin, piscivorous birds congregate near hydroelectric dams and in the estuary near man-made islands and structures. Avian predation has been exacerbated by environmental changes associated with river developments. Water clarity caused by suspended sediments settling in impoundments increases the vulnerability of migrating smolts. Smolt migration is delayed in project reservoirs, particularly immediately upstream from dams, where the juvenile bypass systems concentrate smolts, increasing their exposure to avian predators. Dredge spoil islands, associated with maintaining the Columbia River navigation channel, provide habitat for nesting Caspian terns and other piscivorous birds. Caspian terns, double-crested cormorants, glaucous-winged/western gull hybrids, California gulls, and ring-billed gulls are the principal avian predators in the basin. As with piscivorous predators, predation by birds has and continues to decrease salmonid population abundance and productivity.

The existing highway system contributes to a poor environmental baseline condition in several significant ways. Many miles of highway that parallel streams have degraded streambank conditions by armoring the banks with rip rap, degraded floodplain connectivity by adding fill to floodplains, and degraded water quality by discharging untreated or marginally-treated highway runoff to streams. Culvert and bridge stream crossings have similar effects, and create additional problems for fish when they act as physical or hydraulic barriers that prevent fish access to spawning or rearing habitat, or contribute to adverse stream morphological changes upstream and downstream of the crossing itself.

The environmental baseline includes the anticipated impacts of all Federal actions in the action area that have already undergone formal consultation. For example, from 2007 through 2012, the U.S Army Corps of Engineers (USACE) authorized 280 restoration actions in Oregon under the SLOPES programmatic consultation and another 397 actions for construction, minor discharge, over- and in-water structures, transportation, streambank stabilization, surveys, and utility lines in habitat affecting ESA-listed fish species (NMFS 2008a; NMFS 2008b).

The USACE, BPA, and Bureau of Reclamation have consulted on large water management actions, such as operation of the Federal Columbia River Power System, the Umatilla Basin Project, and the Deschutes Project. The U.S. Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM), and the U.S. Forest Service (USFS) have consulted on Federal land management throughout the Northwest, including restoration actions, forest management, livestock grazing, and special use permits. The BPA has also consulted on large restoration programs that consist of actions designed to address species limiting factors or make contributions that would aid in species recovery. After going through consultation, many ongoing actions, such as water management, have less impact on listed salmon and steelhead. Restoration actions may have short-term adverse effects, but generally result in long-term improvements to habitat condition and population abundance, productivity, and spatial structure.

The precise project-level action area for each restoration project is not yet known, so the current condition of fish or critical habitats in each project area, the factors responsible for that condition, and the conservation value of each site can only be partially described. Therefore, to complete the jeopardy and destruction or adverse modification of critical habitat analyses in this consultation, NMFS made the following assumptions regarding the environmental baseline in each area that will eventually be chosen to support an action:

1. The purpose of the proposed program is to implement habitat restoration and fish passage improvements for the benefit of populations of ESA-listed species.
2. Each individual action area will be occupied by one or more populations of ESA-listed species.
3. Restoration projects will occur at sites where the biological requirements of individual fish of ESA-listed species are not being fully met due, in part, to the presence of impaired fish passage, floodplain fill, streambank degradation, or degraded channel or riparian conditions.
4. Restoration projects will occur at sites where the biological requirements of individual fish of ESA-listed species are not being met due to one or more impaired aquatic habitat functions related to any of the habitat factors limiting the recovery of the species in that area.

It is very likely that a few action areas for some of these previously consulted upon actions will overlap with action areas for restoration actions covered under this new iteration of USFWS/NOAA RC programmatic consultation. Impacts to the environmental baseline from these previous actions vary from short-term adverse effects to long-term beneficial effects.

2.4 Effects of the Action on Species and Designated Critical Habitat

"Effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur.

This analysis begins with an overview of the scope of the USFWS/NOAA RC aquatic restoration program, deconstructs the program and individual types of actions, then examines the general environmental impacts of each of those elements in detail before analyzing their combined impact on species and designated critical habitats. Under the administrative portion of this action, the USFWS or NOAA RC will evaluate each individual action to ensure that the following conditions are true: (a) The requirements of this opinion are only applied where ESA-listed salmon, steelhead, or eulachon, or their designated critical habitats, or both, are present; (b) the anticipated range of effects is within the range considered in this opinion; (c) the action is carried out consistent with the PDC; and (d) action and program level monitoring and reporting requirements are met. Although that process will not, by itself, affect a listed species or critical habitat, it determines which factors must be considered to analyze the effects of each individual action that will be authorized or completed under this opinion.

A central part of the USFWS/NOAA RC program includes processes for program administration to ensure that individual projects covered by this analysis remain within the scope of effects considered here, and to ensure that the aggregate or program-level effects of those individual projects are also accounted for.

The discussion of the direct physical and chemical effects of the action on the environment will vary depending on the type of restoration or fish passage action being performed, but will all be based on a common set of effects related to construction. Actions involving fish passage restoration, off- or side channel reconstruction, set-back of an existing berm, dike or levee, or removal of a water control structure are likely to have all of the following effects; actions that only involve placement of boulders, gravel or wood will only have a subset of those effects, or will express those effects to a lesser degree.

Construction will have direct physical and chemical effects on the environment that commonly begin with pre-construction activity, such as surveying, minor vegetation clearing, and placement of stakes and flagging guides. This requires movement of personnel and sometimes machines over the action area. The next stage, site preparation, may require development of access roads, construction staging areas, and materials storage areas that affect more of the action area. If additional earthwork is necessary to clear, excavate, fill, or shape the site, more vegetation and topsoil may be removed, deeper soil layers exposed, and operations extended into the active channel. The final stage of construction is site restoration. This stage consists of any action necessary to undo disturbance caused by the action, and may include replacement of LW, native vegetation, topsoil, and native channel material displaced by construction, and otherwise restoring ecosystem processes that form and maintain productive fish habitats.

The physical, chemical, and biotic effects of each individual project the USFWS and NOAA RC propose under this opinion will vary according to the number and type of elements present, although each element will share, in relevant part, a common set of effects related to pre-construction and construction (Darnell 1976; Spence *et al.* 1996), site restoration (Cramer *et al.* 2003; Cramer 2012), and operation and maintenance. NMFS assumes that every individual project will share some of the effects described here in proportion to the project's complexity, footprint, and proximity to species and critical habitat, but that no action will have effects that are greater than the full range of effects described here, because every action is based on the same set of underlying construction activities or elements, and each element is limited by the same design criteria. The duration of construction required to complete most projects will normally be less than one year, although significant fish passage projects may require additional in-water work or upland work to complete. Projects requiring an EIS pursuant to NEPA are ineligible for coverage under this consultation if the EIS evaluates alternatives affecting listed species.

Program administration. The USFWS and NOAA RC will notify the appropriate NMFS office with information to review each proposed project to ensure that the opinion is being used as intended no later than 30-days before beginning in-water work. Before actions are funded or carried out, USFWS and NOAA RC will obtain an additional approval from NMFS for projects that involve: (a) Diversion of surface water using gravity or by pumping at a rate that exceeds 3 cubic feet per second (cfs), (b) a boulder structure or fish ladder for fish passage restoration, (c) channel reconstruction/relocation, and (d) dam removals. Large projects, such as channel reconstruction, dam removal, tide/flood gate replacement, and precedent and/or policy setting actions, such as the application of new technology, will be reviewed by a regional team of experts that includes NMFS and USFWS. Monitoring and reporting data will be entered into our Public Consultation Tracking System (PCTS) consultation initiation and reporting system. Shortly (within 60 days) after inwater work for a project is completed, USFWS or NOAA RC will submit the completion report portion of the implementation form, along with any pertinent information needed, to ensure that a completed project matches its proposed design.

As an additional program-level check on the continuing effects of the action, the USFWS and NOAA RC will report and meet with NMFS at least annually to review implementation of this opinion and opportunities to improve conservation, or make the program overall more effective or efficient. Application of consistent design criteria and engineering improvements to the maximum extent feasible in each recovery domain is likely to gradually reduce the total adverse impacts, improve ecosystem resilience, and contribute to management actions necessary for the recovery of ESA-listed species and critical habitats in the Northwest.

Preconstruction. Some restoration projects have little or even no construction footprint in the riparian zone, riparian area, or in the active channel. For example, piling removal and invasive or nonnative plant control have little ground disturbance. Other project footprints extend far into the active channel, such as fish passage restoration and water control structure removal, and may require activities like work area isolation, fish capture, and relocation.

Each construction footprint that extends into a riparian or instream area is likely to have short-term adverse effects due to the physical and chemical consequences of altering those environments, and to have long-term adverse effects due to the impact of maintaining the built environment's encroachment on aquatic habitats. Under the action as proposed, each project is also likely to have long-term positive effects through application of design criteria that reduce pre-existing impacts by, for example, improving floodplain connectivity, streambank function, water quality, or fish passage.

Surveying, mapping. Preconstruction activities for restoration projects typically include surveying, mapping, placement of stakes and flagging guides, exploratory drilling, minor vegetation clearing, opening access roads, and establishing vehicle and material staging areas. These activities entail minor movements of machines and personnel over the action area with minimal direct effects but important indirect effects by establishing geographic boundaries that will limit the environmental impact of subsequent activities. The USFWS and NOAA RC will ensure that work area limits are marked to preserve vegetation and reduce soil disturbance as a fundamental and effective management practice that will avoid and reduce the impact of all subsequent construction actions.

Habitat or fish surveys. USFWS and NOAA RC often conduct habitat or fish surveys as part of a restoration project. For instance, presence/absence fish surveys are often carried out prior to construction activities to determine if fish relocation will be necessary. NMFS has specified that fish surveys must only include non-lethal techniques, *i.e.,* snorkel, minnow trapping, not hooking or electrofishing. Engineering surveys are almost always necessary for culvert replacements and other construction activities. When these surveys are carried out within or in close proximity to streams, harassment of listed salmon and steelhead can occur. In some instances, fish are flushed from hiding cover and can become more susceptible to predation. The disturbance typically lasts a few hours and will not have population level effects. No measurable habitat effects are expected from this proposed activity category. This activity category does not cover research activities requiring an ESA section 10(a)(1)(A) permit.

Erosion and pollution control measures. The USFWS and NOAA RC will ensure that a suite of erosion and pollution control measures will be applied to any project that involves soil disturbance. Those measures will constrain the use and disposal of all hazardous products, the disposal of construction debris, secure the site against erosion and inundation during high flow events, and ensure that no earthwork will occur at an EPA-designated Superfund Site, a state-designated clean-up area, or in the likely impact zone of a significant contaminant source, as identified by historical information or best professional judgment. Any action involving off- and side-channel habitat restoration or set-back of an existing berm, dike or levee must include the results of a site assessment to identify the type, quantity, and extent of any potential contamination.

Roads and staging areas. Establishing access roads and staging areas requires disturbance of vegetation and soils that support floodplain and riparian function, such as delivery of LW and particulate organic matter, shade, development of root strength for slope and streambank stability, and sediment filtering and nutrient absorption from runoff (Darnell 1976; Spence *et al.* 1996). Although the size of areas likely to be adversely affected by actions proposed to be authorized or carried out under this opinion are small, and the effects are likely to be short-term (weeks or months), even small denuded areas will lose organic matter and dissolved minerals, such as nitrates and phosphates.

The microclimate at each action site where vegetation is removed is likely to become drier and warmer, with a corresponding increase in wind speed, and soil and water temperature. Water tables and spring flow in the immediate area may be temporarily reduced. Loose soil will temporarily accumulate in the construction area. In dry weather, part of this soil is dispersed as dust; in wet weather, part is transported to streams by erosion and runoff, particularly in steep areas. Erosion and runoff increase the supply of sediment to lowland drainage areas and eventually to aquatic habitats, where they increase total suspended solids and sedimentation.

Whenever possible, temporary access roads will not be built on steep slopes, where grade, soil, or other features suggest a likelihood of excessive erosion or failure; will use existing ways whenever possible; and will minimize soil disturbance and compaction within 150 feet of a stream, waterbody, or wetland. All temporary access roads will be obliterated when the action is completed, the soil will be stabilized and the site will be revegetated. Temporary roads in wet or flooded areas will be restored by the end of the applicable in-water work period.

During and after wet weather, increased runoff resulting from soil and vegetation disturbance at a construction site during both preconstruction and construction phases is likely to suspend and transport more sediment to receiving waters as long as construction continues so that multiyear projects are likely to cause more sedimentation. This increases total suspended solids and, in some cases, stream fertility. Increased runoff also increases the frequency and duration of high stream flows and wetland inundation in construction areas. Higher stream flow increases stream energy that scours stream bottoms and transports greater sediment loads farther downstream than would otherwise occur. Sediments in the water column reduce light penetration, increase water temperature, and modify water chemistry. Redeposited sediments partly or completely fill pools, reduce the width to depth ratio of streams, and change the distribution of pools, riffles, and glides. Increased fine sediments in substrate also reduce survival of eggs and fry, reducing spawning success of salmon and steelhead.

The installation and removal of pilings with a vibratory or impact hammer is likely to result in adverse effects to salmon, steelhead, and eulachon due to high levels of underwater sound that will be produced. Although there is little information regarding the effects on fish from underwater sound pressure waves generated during piling installation (Anderson and Reyff 2006; Laughlin 2006), laboratory research on the effects of sound on fish has used a variety of species and sounds (Hastings *et al.* 1996; Popper and Clarke 1976; Scholik and Yan 2002).

Because those data are not reported in a consistent manner and most studies did not examine the type of sound generated by pile driving, it is difficult to directly apply the results of those studies to pile driving effects on salmon, steelhead, and eulachon. However, it is well established that elevated sound can cause injuries to fish swim bladders and internal organs and temporary or permanent hearing damage. The degree to which normal behavior patterns are altered is less known, although it is likely that salmon, steelhead, and eulachon that are resident within the action area are more likely to sustain an injury than fish that are migrating up or downstream.

Removal of pilings within the wetted perimeter that are at the end of their service life will disturb sediments that become suspended in the water, often along with contaminants that may have been pulled up with, or attached to, the pile. A major release of PAHs into the water is likely to occur if creosote-treated pilings are damaged during removal, or if debris is allowed to re-enter or remain in the water.

PDC to minimize exposure of fish to high levels of underwater sound during pile driving and to reduce releases of suspended solids and contaminants during pile removal will minimize impacts to fish. PDC include requirements that pilings will be 24 inches in diameter or smaller, steel H-pile will be designated as HP24 or smaller, a vibratory hammer will be used whenever possible for piling installation, and full or partial (bubble curtain) isolation of the pile while it is being driven will occur. During pile extraction, care will be taken to ensure that sediment disturbance is minimized, including special measures for broken or intractable piles. All adhering sediment and floating debris will be contained and all residues will be properly disposed. Nonetheless, a small contaminant release will occur when a creosote pile is removed, and total suspended sediment will increase with every pile removal. It is still likely that sound energy will radiate directly or indirectly into the water as a result of pile driving, although widespread propagation of sounds injurious to fish is not expected to occur.

Manual, mechanical, biological and herbicidal treatments of invasive and non-native plants are often conducted as part of an action to restore native riparian vegetation on streambank and fish passage restoration projects. NMFS has recently analyzed the effects of these activities using the similar active ingredients and PDC for proposed USFS and BLM invasive plant control programs (NMFS 2010; NMFS 2012a). The types of plant control actions analyzed here are a conservative (*i.e.*, less aggressive) subset of the types of actions considered in those analyses, and the effects presented here are summarized from those analyses. Each type of treatment is likely to affect fish and aquatic macrophytes through a combination of pathways, including disturbance, chemical toxicity, dissolve oxygen and nutrients, water temperature, sediment, instream habitat structure, forage, and riparian and emergent vegetation (Table 32).

Table 32. Potential pathways of effects of invasive and non-native plant control.

	Pathways of Effects							
Treatment Methods	**Disturbance***	**Chemical toxicity**	**Dissolved oxygen and nutrients**	**Water temperature**	**Fine sediment and turbidity**	**Instream habitat structure**	**Forage**	**Riparian and emergent vegetation**
Manual	X					X	X	X
Mechanical	X			X	X		X	X
Biological				X	X			
Herbicides		X	X	X	X	X	X	X

*Stepping on redds, displacing fish, interrupting fish feeding, or disturbing banks.

Short-term displacement or disturbance of threatened and endangered fish are likely to occur from activities in the area that disturb or displace fish that are feeding, resting or moving through the area. The understory of knotweed is usually bare of any other plants and despite a large rhizome mass, it provides poor erosion control on streambanks. Treating streamside knotweed or blackberry (*Rubus armeniacus* and *R. lacinatus*) monocultures, and possibly other streamside woody invasive species (*i.e.,* tree of heaven, scotch broom, *etc.*) will not likely cause significant shade loss. Most invasive plants are understory species of streamside vegetation that do not provide the majority of streamside shade and furthermore will be replaced by planted native vegetation. Loss of shade would persist until native vegetation reaches and surpasses the height of the invasive plants that were removed. Shade recovery may take one to several years, depending on the success of invasive plant treatment, stream size and location, topography, growing conditions for the replacement plants, and the density and height of the invasive plants when treated. The short-term shade reduction that is likely to occur due to removal of riparian weeds could slightly affect stream temperatures or dissolved oxygen levels, which could cause short-term stress to fish adults, juveniles and eggs. NMFS did not identify adverse effects to macroinvertebrates from herbicide applications that follow these proposed PDC. Effects pathways are described in detail below.

Manual and mechanical treatments are likely to result in mild restoration construction effects (discussed above). Hand pulling of emergent vegetation is likely to result in a localized mobilization of suspended sediments. Treatment of knotweed and other streamside invasive species with herbicides (by stem injection or spot spray) or heavy machinery is likely to result in short-term releases of suspended sediment when treatment of locally extensive streamside monocultures occurs. Thus, these treatments are likely to affect a definite, broad area, and to produce at least minor damage to riparian soil and vegetation. In some cases, this will decrease stream shade, increase suspended sediment and temperature in the water column, reduce organic inputs (*e.g.*, insects, leaves, woody material), and alter streambanks and the composition of stream substrates. However, these circumstances are likely to occur only in rare cases, such as treatment of an invasive plant monoculture that encompasses a small stream channel. This effect would vary depending on site aspect, elevation, and amount of topographic shading, but is likely to decrease over time at all sites as shade from native vegetation is reestablished.

Biological controls work slowly, typically over several years, and are designed to work only on the target species. Thus, biological controls produce a smaller reduction of riparian and instream vegetation over a smaller area than manual and mechanical treatments and are unlikely to lead to bare ground and surface erosion that would release suspended sediment to streams. As treated invasive plants die, native plants are likely to become reestablished at each site; root systems will restore soil and streambank stability and vegetation will provide shade. Therefore, any adverse effects due to biological treatments, by themselves, are likely to be very mild. Biological controls typically work slowly over a period of years, and only on target species, and result in minimal impact to soils and vegetation from the actual release. Over time, successful biological control agents will reduce the size and vigor of host noxious weeds with minimal or no adverse effect to other plant species.

Herbicide applications. Stream margins often provide shallow, low-flow conditions, have a slow mixing rate with mainstem waters, and are the site at which subsurface runoff is introduced. Juvenile salmon and steelhead, particularly recently emerged fry, often use low-flow areas along stream margins. For example, wild Chinook salmon rear near stream margins until they reach about 60 mm in length. As juveniles grow, they migrate away from stream margins and occupy habitats with progressively higher flow velocities. Nonetheless, stream margins continue to be used by larger salmon and steelhead for a variety of reasons, including nocturnal resting, summer and winter thermal refuge, predator avoidance, and flow refuge. NMFS identified three scenarios for the analysis of herbicide application effects: (1) Runoff from riparian application; (2) application within perennial stream channels; and (3) runoff from intermittent stream channels and ditches.

Spray and vapor drift are important pathways for herbicide entry into aquatic habitats. Several factors influence herbicide drift, including spray droplet size, wind and air stability, humidity and temperature, physical properties of herbicides and their formulations, and method of application. For example, the amount of herbicide lost from the target area and the distance the herbicide moves both increase as wind velocity increases. Under inversion conditions, when cool air is near the surface under a layer of warm air, little vertical mixing of air occurs. Spray drift is most severe under these conditions, since small spray droplets will fall slowly and move to adjoining areas even with very little wind. Low relative humidity and high temperature cause more rapid evaporation of spray droplets between sprayer and target. This reduces droplet size, resulting in increased potential for spray drift. Vapor drift can occur when herbicide volatilizes. The formulation and volatility of the compound will determine its vapor drift potential. The potential for vapor drift is greatest under high air temperatures and low humidity and with ester formulations. For example, ester formulations of triclopyr are very susceptible to vapor drift, particularly at temperatures above 80°F (DiTomaso *et al.* 2006). Triclopyr, which is proposed, as well as many other herbicides and pesticides, are detected frequently in freshwater habitats within the four western states where listed Pacific salmonids are distributed (NMFS 2011e).

Several proposed PDC reduce the risk of herbicide drift. Ground equipment reduces the risk of drift, and hand equipment nearly eliminates it. Relatively calm conditions, preferably when humidity is high and temperatures are relatively low, and low sprayer nozzle height will reduce the distance that herbicide droplets will fall before reaching weeds or soil. Less distance means less travel time and less drift. Wind velocity is often greater as height above ground increases, so droplets from nozzles close to the ground would be exposed to lower wind speeds. The higher that an application is made above the ground, the more likely it is to be above an inversion layer that will not allow herbicides to mix with lower air layers and will increase long distance drift.

Surface water contamination with herbicides can occur when herbicides are applied intentionally or accidentally into ditches, irrigation channels or other bodies of water, or when soil-applied herbicides are carried away in runoff to surface waters. Direct application into water sources is generally used for control of aquatic species. Accidental contamination of surface waters can occur when irrigation ditches are sprayed with herbicides or when buffer zones around water sources are not wide enough. In these situations, use of hand application methods will greatly reduce the risk of surface water contamination.

The contribution from runoff will vary depending on site and application variables, although the highest pollutant concentrations generally occur early in the storm runoff period when the greatest amount of herbicide is available for dissolution (Stenstrom and Kayhanian 2005; Wood 2001). Lower exposures are likely when herbicide is applied to smaller areas, when intermittent stream channel or ditches are not completely treated, or when rainfall occurs more than 24 hours after application. Under the proposed action, some formulas of herbicide can be applied within the bankfull elevation of streams, in some cases up to the water's edge. Any juvenile fish in the margins of those streams are more likely to be exposed to herbicides as a result of overspray, inundation of treatment sites, percolation, surface runoff, or a combination of these factors. Overspray and inundation will be minimized through the use of dyes or colorants.

Groundwater contamination is another important pathway. Most herbicide groundwater contamination is caused by "point sources," such as spills or leaks at storage and handling facilities, improperly discarded containers, and rinses of equipment in loading and handling areas, often into adjacent drainage ditches. Point sources are discrete, identifiable locations that discharge relatively high local concentrations. In soil and water, herbicides persist or are decomposed by sunlight, microorganisms, hydrolysis, and other factors. 2,4-D and triclopyr are detected frequently in freshwater habitats within the four western states where listed Pacific salmonids are distributed (NMFS 2011e). Proposed PDC minimize these concerns by ensuing proper calibration, mixing, and cleaning of equipment. Non-point source groundwater contamination of herbicides is relatively uncommon but can occur when a mobile herbicide is applied in areas with a shallow water table. Proposed PDC minimize this danger by restricting the formulas used, and the time, place and manner of their application to minimize offsite movement.

Herbicide toxicity. Herbicides included in this invasive plant programmatic activity were selected due to their low to moderate aquatic toxicity to listed salmonids. The risk of adverse effects from the toxicity of herbicides and other compounds present in formulations to listed aquatic species is mitigated in this programmatic activity by reducing stream delivery potential by restricting application methods. Near wet stream channels, only aquatic labeled herbicides are to be applied. Aquatic glyphosate, aquatic imazapyr, and aquatic triclopyr-TEA can be applied up to the waterline, but only using hand selective techniques. A 15-foot buffer is required to use aquatic imazapyr and aquatic triclopyr-TEA by spot spraying. On dry streams, ditches, and wetlands, no buffers are required use the aquatic herbicides for spot spraying or hand selective application. The associated application methods were selected for their low risk of contaminating soils and subsequently introducing herbicides to streams. However, direct and indirect exposure and toxicity risks are inherent in some application scenarios.

Generally, herbicide active ingredients have been tested on only a limited number of species and mostly under laboratory conditions. While laboratory experiments can be used to determine acute toxicity and effects to reproduction, cancer rates, birth defect rates, and other effects to fish and wildlife, laboratory experiments do not typically account for species in their natural environments and little data is available from studies focused specifically on the listed species in this opinion. This leads to uncertainty in risk assessment analyses. Environmental stressors increase the adverse effects of contaminants, but the degree to which these effects are likely to occur for various herbicides is largely unknown.

The effects of the herbicide applications to various representative groups of species have been evaluated for each proposed herbicide. The effects of herbicide applications using spot spray, hand/select, and broadcast spray methods were evaluated under several exposure scenarios: (1) runoff from riparian (above the OHW mark) application along streams, lakes and ponds, (2) runoff from treated ditches and dry intermittent streams, and (3) application within perennial streams (dry areas within channel and emergent plants). The potential for herbicide movement from broadcast drift was also evaluated. Risks associated with exposure and associated effects were also evaluated for terrestrial species.

Although the PDC would minimize drift and contamination of surface and ground water, herbicides reaching surface waters will likely result in mortality to fish during incubation, or lead to altered development of embryos. Stehr *et al.* (2009) found that the low levels of herbicide delivered to surface waters are unlikely to be toxic to the embryos of ESA-listed salmon, steelhead and trout. However, mortality or sub-lethal effects such as reduced growth and development, decreased predator avoidance, or modified behavior are likely to occur. Herbicides are likely to also adversely affect the food base for listed salmonids and other fish, which includes terrestrial organisms of riparian origin, aquatic macroinvertebrates and forage fish.

Adverse effect threshold values for each species group were defined as either 1/20th of the LC50 value for listed salmonids, 1/10th of the LC50 value for non-listed aquatic species, or the lowest acute or chronic "no observable effect concentration," whichever was lower, found in Syracuse Environmental Research Associates, Inc. (SERA) risk assessments that were completed for the USFS; *i.e.*, sethoxydim (SERA 2001), sulfometuron-methyl (SERA 2004b), imazapic (SERA 2004c), chlorsulfuron (SERA 2004a), imazapyr (SERA 2011a), glyphosate (SERA 2011d), and triclopyr (SERA 2011c). These assessments form the basis of the analysis in this opinion. Generally, effect threshold values for listed salmonids were lower than values for other fish species groups, so values for salmonids were also used to evaluate potential effects to other listed fish. In the case of sulfometuron-methyl, threshold values for fathead minnow were lower than salmonid values, so threshold values for minnow were used to evaluate effects to listed fish.

Data on toxicity to wild fish under natural conditions are limited and most studies are conducted on lab specimens. Adverse effects could be observed in stressed populations of fish, and it is less likely that effects will be noted in otherwise healthy populations of fish. Chronic studies or even long-term studies on fish egg-and-fry are seldom conducted. Risk characterizations for both terrestrial and aquatic species are limited by the relatively few animal and plant species on which data are available, compared to the large number of species that could potentially be exposed. This limitation and consequent uncertainty is common to most if not all ecological risk assessments. Additionally, in laboratory studies, test animals are exposed to only a single chemical. In the environment, humans and wildlife may be exposed to multiple toxicants simultaneously, which can lead to additive or synergistic effects.

The effects of herbicides on salmonids are fully described by NMFS in other recent opinions with the EPA, USFS, BPA, and USACE (NMFS 2010; NMFS 2011e; NMFS 2011f; NMFS 2012a; NMFS 2013b; NMFS 2013d; NMFS 2013c) and in SERA reports. For the 2008 Aquatic Restoration Biological Opinion (ARBO) the USFS, BLM, and BIA evaluated the risk of adverse effects to listed salmonids and their habitat in terms of hazard quotient (HQ) values (NMFS 2008c).

HQ evaluations from the 2008 ARBO (NMFS 2008c) are summarized below for the herbicides (chlorsulfuron, clopyralid, glyphosate, imazapyr, metsulfuron methyl, sethoxydim, and sulfometuron methyl). HQs were calculated by dividing the expected environmental concentration by the effects threshold concentration. Adverse effect threshold concentrations are

1/20th (for ESA listed aquatic species) or 1/10th (all other species) of LC50 values, or "no observable adverse effect" concentrations, whichever concentration was lower. The water contamination rate (WCR) values are categorized by herbicide, annual rainfall level, and soil type. Variation of herbicide delivery to streams among soil types (clay, loam, and sand) is displayed as low and high WCR values. All WCR values are from risk assessments conducted by SERA. When there are HQ values greater than 1, adverse effects are likely to occur. Hazard quotient values were calculated for fish, aquatic invertebrates, algae, and aquatic macrophytes.

For imazapic, picloram, and triclopyr, we referred to NMFS' opinions, SERA reports, various other literature sources, and the 2013 BA for ARBO II (USDA-Forest Service *et al.* 2013) to characterize risk to listed fish species.

Chlorsulfuron. No chlorsulfuron HQ exceedences occur for fish or aquatic invertebrates. HQ exceedences occur for algae at rainfall rates of 50 and 150 inches per year, and for aquatic macrophytes at rainfall rates of 15, 50, and 150 inches per year.

The HQ values predicted for algae at 50 inches per year ranged from 0.002 to 2.8, and the HQ exceedence occurred at the maximum application rate on clay soils. The HQ values predicted for algae at 150 inches per year ranged from 0.02 to 5.0, and HQ exceedances occurred at both the typical (HQ of 1.1) and maximum (HQ of 5.0) application rates on clay soils. Application of chlorsulfuron adjacent to stream channels at the typical and maximum application rates, in rainfall regimes of 50 to 150 inches per year, is likely adversely affect algal production when occurring on soils with poor infiltration.

The HQ values predicted for aquatic macrophytes at 15 inches per year ranged from 0 to 64, and HQ exceedences occurred at both the typical and maximum application rates on clay soils. The HQ values for aquatic macrophytes at 50 inches per year ranged from 0.5 to 585, and ranged from 4.8 to 1,064 at 150 inches per year. The HQ exceedences at 50 and 150 inches per year occurred at both typical and maximum application rates, with lower HQ values occurring on loam soils, and the highest values on clay soils. Given the wide range of HQ values observed among soil types at a given rainfall rate, soil type is clearly a major driver of exposure risk for chlorsulfuron, with low permeability soils markedly increasing exposure levels. Application of chlorsulfuron adjacent to stream channels at the typical and maximum application rates, in rainfall regimes of 15 to 150 inches per year, is likely to adversely affect aquatic macrophytes. Application on soils with low infiltration rates will have a substantially higher risk of resulting in adverse effects.

Clopyralid. Application of clopyralid under the modeled scenario did not result in any HQ exceedences for any of the species groups. Clopyralid applications are not likely to adversely affect listed salmonids or their habitat because HQ values are less than 1.

Glyphosate. Glyphosate HQ exceedences occurred for fish and algae at a rainfall rate of 150 inches per year, and no HQ exceedences occurred for aquatic invertebrates or aquatic macrophytes. The HQ exceedences occurred at the maximum application rates only. The HQ values for fish at 150 inches per year ranged from 1.5 to 3.6, and occurred within a narrow range on all soil types. The HQ values for algae at 150 inches per year ranged from 0.8 to 2.0 in sand.

Application of glyphosate adjacent to stream channels at application rates approaching the maximum, in rainfall regimes approaching 150 inches per year, on all soil types is likely to adversely affect listed salmonids. When glyphosate is applied adjacent to stream channels at rates approaching the maximum on sandy soils, in rainfall regimes approaching 150 inches per year, adverse effects to algal production will occur.

Imazapic. Aquatic animals appear to be relatively insensitive to imazapic exposures, with LC50 values of greater than 100 mg/L for both acute toxicity and reproductive effects. Aquatic macrophytes may be much more sensitive, with an acute EC50 of 6.1 µg/L in duck weed (*Lemna gibba*). Aquatic algae appear to be much less sensitive, with EC50 values of greater than 45 µg/L. No toxicity studies have been located on the effects of imazapic on amphibians or microorganisms (SERA 2004c).

Imazapyr. No HQ exceedences occurred for imazapyr for fish or aquatic invertebrates. HQ exceedances occurred for algae and aquatic macrophytes at a rainfall rate of 150 inches per year.

The HQ values for algae at 150 inches per year ranged from 0 to 1.3. The HQ exceedence at 150 inches per year occurred only at the maximum application rate on clay soils. The HQ values for aquatic macrophytes at 150 inches per year ranged from 0 to 2.0. The HQ exceedence at 150 inches per year occurred only at the maximum application rate on clay soils. Given the range of HQ values observed for imazapyr at a rainfall rate of 150 inches per year, soil type is an important factor in determining exposure risk, with low permeability soils markedly increasing exposure levels. Application of imazapyr adjacent to stream channels at application rates approaching the maximum on soils with low permeability, in rainfall regimes approaching 150 inches per year, is likely to adversely affect algal production and aquatic macrophytes.

Algae and macrophytes provide food for aquatic macroinvertebrates, particularly those in the scraper feeding guild (Williams and Feltmate 1992). These macroinvertebrates in turn provide food for rearing juvenile salmonids. Consequently, adverse effects on algae and aquatic macrophyte production may cause a reduction in availability of forage for juvenile salmonids. Over time, juvenile salmonids that receive less food have lower body condition and smaller size at smoltification. However, the small amount of imazapyr expected to reach the water should not result in effects this severe.

Metsulfuron methyl. No HQ exceedences occurred for metsulfuron for fish, aquatic invertebrates, or algae. The HQ exceedences for aquatic macrophytes occurred at the maximum application rate on clay soils at rainfall rates of 50 and 150 inches per year. The HQ values ranged from 0.009 to 1.0 at 50 inches, and from 0.02 to 1.9 at 150 inches per year.

Given the range of HQ values observed for metsulfuron at each rainfall level, soil type is an important factor in determining exposure risk, with low permeability soils markedly increasing exposure levels. In areas with rainfall rates between 50 and 150 inches per year, application of metsulfuron adjacent to stream channels on soils with low permeability at application rates approaching the maximum is likely to adversely affect aquatic macrophytes. A slight decrease in forage availability for juvenile salmonids will result from adverse effects to aquatic macrophytes.

Picloram. Based on expected concentrations of picloram in surface water, all central estimates of the HQs are below the level of concern for fish, aquatic invertebrates, and aquatic plants. No risk characterization for aquatic-phase amphibians can be developed because no directly useful data are available. Upper bound HQs exceed the level of concern for longer-term exposures in sensitive species of fish (HQ=3) and peak exposures in sensitive species of algae (HQ=8). It does not seem likely that either of these HQs would be associated with overt or readily observable effects in either fish or algal populations for typical applications. In the event of an accidental spill, substantial mortality will be likely in both sensitive species of fish and sensitive species of algae (SERA 2011b).

Sethoxydim. No HQ exceedences occurred for sethoxydim for aquatic invertebrates, algae, or aquatic macrophytes. The HQ exceedences for fish occurred at rainfall rates of 50 and 150 inches per year, and ranged from 0.3 to 1.0, and from 1.1 to 3.0, respectively. The HQ exceedence at 50 inches per year occurred only at the maximum application rate on loam soils. The HQ exceedences at 150 inches per year occurred at the typical application rate on sand, and at the maximum application rate on loam soil.

The HQ values for sethoxydim were calculated using the toxicity data for the Poast formulation, and incorporates the toxicity of naphtha solvent. The toxicity of sethoxydim alone for fish and aquatic invertebrates is much less than that of the formulated product (about 30 times less toxic for invertebrates, and about 100 times less toxic for fish). Since the naphtha solvent tends to volatilize or adsorb to sediments, using Poast formulation data to predict indirect aquatic effects from runoff leaching is likely to overestimate adverse effects (SERA 2001). Project design criteria sharply reduce the risk of naptha solvent presence in percolation runoff reaching streams. When design criteria to reduce naptha solvent exposure are employed, application of sethoxydim adjacent to stream channels will not adversely affect listed salmonids or their habitat.

Sulfometuron-methyl. No HQ exceedences occurred for sulfometuron-methyl for fish, aquatic invertebrates, or algae. The HQ exceedence for aquatic macrophytes occurred at a rainfall rate of 150 inches per year on clay soils, and HQ values ranged from 0.007 to 3.8. Considering the range of HQ values observed for sulfometuron at each rainfall level, soil type is an important factor in determining exposure risk, with low permeability soils markedly increasing exposure levels. In areas with a rainfall rate approaching 150 inches per year, application of metsulfuron adjacent to stream channels on soils with low permeability at application rates approaching the maximum is likely to adversely affect aquatic macrophytes. A slight decrease in forage availability for juvenile salmonids will result from adverse effects to aquatic macrophytes.

Triclopyr. With the exception of aquatic plants, substantial risks to nontarget species (including humans) associated with the contamination of surface water are low, relative to risks associated with contaminated vegetation. Stehr *et al.*(2009) observed no developmental effects at nominal concentrations of 10 mg/L or less for purified triclopyr alone or for the TEA formulations Garlon 3A and Renovate.

Adjuvants. Washington State Departments of Agriculture and Ecology have the following criteria for the registration of spray adjuvants for aquatic use in Washington:

- The adjuvant must fulfill all requirements for registration of a food / feed use spray adjuvant in Washington.
- The adjuvant must be either slightly toxic or practically non-toxic to freshwater fish. Rainbow trout (*Oncorhynchus mykiss*) is the preferred test species.
- The adjuvant must be moderately toxic, slightly toxic or practically non-toxic to aquatic invertebrates. Either *Daphnia magna* or *Daphnia pulex* are acceptable test species.
- The adjuvant formulation must contain less than 10% alkyl phenol ethoxylates (including alkyl phenol ethoxylate phosphate esters).
- The adjuvant formulation must not contain any alkyl amine ethoxylates (including tallow amine ethoxylates).

NMFS has excluded several of these compounds because they do contain alkyl phenol ethoxylates (APEOs). Alkylphenols, including nonylphenol (NP) and nonylphenol ethoxylates (NPE), have been detected in the natural environment, including ambient air, sewage treatment plant effluent, sediment, soil, and surface waters, in wildlife, household dust, and human tissues. NP and NPE are toxic to aquatic organisms, and the breakdown products of nonylphenol ethoxylates (NP and shorter-chained ethoxylates) are more toxic and more persistent than their parent chemicals. NP has been shown to have estrogenic effects in a number of aquatic organisms (Environment Canada and Health Canada 2001; Lani 2010; Servos 1999). Environment Canada and Health Canada (2001) concluded that nonylphenol and its ethoxylates are entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. Zoller (2006) reported that egg production by zebrafish, exposed to 75, 25 and 10 µg/L of a typical industrial APEO was reduced up to 89.6%, 84.7% and 76.9%, respectively, between the 8th and 28th days of exposure.

Summary. Stehr *et al.* (2009) studied developmental toxicity in zebrafish *(Danio rerio)*, which involved conducting rapid and sensitive phenotypic screens for potential developmental defects resulting from exposure to six herbicides (picloram, clopyralid, imazapic, glyphosate, imazapyr, and triclopyr) and several technical formulations. Available evidence indicates that zebrafish embryos are reasonable and appropriate surrogates for embryos of other fish, including salmonids. The absence of detectable toxicity in zebrafish screens is unlikely to represent a false negative in terms of toxicity to early developmental stages of threatened or endangered salmonids. Their results indicate that low levels of noxious weed control herbicides are unlikely to be toxic to the embryos of ESA-listed salmon, steelhead, and trout. Those findings do not necessarily extend to other life stages or other physiological processes (*e.g.*, smoltification, disease susceptibility, behavior).

The proposed PDC, including limitations on the herbicides, adjuvants, carriers, handling procedures, application methods, drift minimization measures, and riparian buffers, will greatly reduce the likelihood that significant amounts of herbicide will be transported to aquatic habitats, although some herbicides are still likely to enter streams through aerial drift, in association with eroded sediment in runoff, and dissolved in runoff, including runoff from intermittent streams and ditches. The indirect effects or long-term consequences of invasive, non-native plant control will depend on the long-term progression of climatic factors and the success of follow-up management actions to exclude undesirable species from the action area, provide early detection and rapid response before such species establish a secure position in the plant community, eradicate incipient populations, and control existing populations.

Effects of Near and Instream Restoration Construction. Use of heavy equipment for vegetation removal and earthwork compact the soil, thus reducing permeability and infiltration. Use of heavy equipment, including stationary equipment like generators and cranes, also creates a risk that accidental spills of fuel, lubricants, hydraulic fluid, coolants, and other contaminants may occur. Petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, contain PAHs, which are acutely toxic to salmon, steelhead, and other fish and aquatic organisms at high levels of exposure and cause sublethal adverse effects on aquatic organisms at lower concentrations (Heintz *et al.* 2000; Heintz *et al.* 1999; Incardona *et al.* 2005; Incardona *et al.* 2004; Incardona *et al.* 2006). It is likely that petroleum-based contaminants have similar effects on eulachon. Therefore, before entering wetlands or within 150 feet of a waterbody, petroleum-based hydraulic fluids will be replaced with biodegradable products. The intent of this PDC is to prevent hydraulic fluid spilling into and polluting natural water bodies in the event of an accidental release due to equipment leakage or hydraulic component failure. Furthermore, the Washington State Department of Transportation (2010) requires that all equipment entering waters containing bull trout use vegetable oil or other biodegradable, acceptable hydraulic fluid substitute.

The USFWS and NOAA RC will require that heavy-duty equipment and vehicles for each project be selected with care and attention to features that minimize adverse environmental effects (*e.g.*, minimal size, temporary mats or plates within wet areas or sensitive soils), use of staging areas at least 150 feet from surface waters, and regular inspection and cleaning before operation to ensure that vehicles remain free of external oil, grease, mud, and other visible contaminants. Also, as noted above, to reduce the likelihood that sediment or pollutants will be carried away from project construction sites, the USFWS and NOAA RC will ensure that clearing areas are limited and that a suite of erosion and pollution control measures will be applied to any project that involves the likelihood of soil and vegetation disturbance that can increase runoff and erosion, including securing the site against erosion, inundation, or contamination by hazardous or toxic materials.

Work involving the presence of equipment or vehicles in the active channel when ESA-listed fish are present is likely to result in injury or death of some individuals. The USFWS and NOAA RC will avoid or reduce that risk by having mechanized equipment work from the top of the streambank, unless work from another location will result in less habitat disturbance, and limiting the timing of that work to avoid vulnerable life stages of ESA-listed fish, including migration, spawning and rearing. Further, when work in the active channel involves substantial excavation, backfilling, embankment construction, or similar work below OHW where adult or juvenile fish are reasonably certain to be present, or 300 feet or less upstream from spawning habitats, the USFWS and NOAA RC will require that the work area be effectively isolated from the active channel to reduce the likelihood of direct, mechanical interactions with fish, or indirect interactions through environmental effects. Regardless of whether a work area is isolated or not, and with few exceptions, the USFWS and NOAA RC will require that passage for adult and juvenile fish that meets NMFS' (2011a) criteria, or most recent version, will be provided around the project area during and after construction.

If any juvenile fish are likely to be present in the work isolation area, the USFWS and NOAA RC will require that they be captured and released. However, it is unlikely that any adult fish, including salmon, steelhead, or eulachon will be affected by this procedure because it will occur when adults are unlikely to be present and, if any are present, their size allows them to easily escape from the containment area. Capturing and handling fish causes them stress though they typically recover fairly rapidly from the process and therefore the overall effects of the procedure are generally short-lived (NMFS 2002).

The primary contributing factors to stress and death from handling are differences in water temperature between the river where the fish are captured and wherever the fish are held, dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on fish increases rapidly from handling if the water temperature exceeds 64°F or dissolved oxygen is below saturation. The USFWS and NOAA RC's conservation measures regarding fish capture and release, use of pump screens during the de-watering phase, and fish passage around the isolation area are based on standard NMFS guidance to reduce the adverse effects of these activities (NMFS 2011a).

Direct habitat loss refers to displacement of native streambed material and diversity by the installation of rock or other hard structures within the functional floodplain. The habitat features of concern include water velocity, depth, substrate size, gradient, accessibility and space that are suitable for salmon and steelhead rearing. In spawning areas, rock and other hard structures are often used to replace spawning gravels, and realign channels to eliminate natural meanders, bends, spawning riffles and other habitat elements. Riffles and gravel bars downstream are scoured when flow velocity is increased. For eulachon, the important habitat features are flow, water quality and substrate conditions, primarily in lower Columbia River tributaries.

In this programmatic opinion, rock may not be used for streambank restoration, except as ballast to stabilize LW. Damaged streambanks will be restored to a natural slope, pattern, and profile suitable for establishment of permanent woody vegetation, without changing the location of the streambank toe. Rock and other hard structures within the functional floodplain reduce water quality by reducing or eliminating riparian vegetation that regulates the quantity and quality of runoff and, together with channel complexity, help to maintain and reduce stream temperatures. The benefits of using rock or other hard structures for this purpose are often speculative or minimal, at best, particularly in contrast to the multiple habitat benefits provided by other erosion control methods that do not require hardening of the streambank or bed (Cramer *et al.* 2003; Cramer 2012).

Treated wood as a construction material is not allowed for bridge projects under this consultation. Copper and other toxic chemicals, such as zinc, arsenic, chromium, and PAHs, that leach from pesticide-treated wood used to construct roads, culverts or bridges are likely to adversely affect salmon, steelhead, and eulachon that spawn, rear, or migrate by those structures, and when they ingest contaminated prey (Poston 2001). These effects are unpredictable, with the intensity of effect depending on numerous factors. Effects from the use of treated wood are best addressed in an individual consultation. Copper has been shown to impair the olfactory nervous system and olfactory-mediated behaviors in salmon and steelhead (Baldwin *et al.* 2003; Baldwin and Scholz 2005; Hecht *et al.* 2007; Linbo *et al.* 2006; McIntyre *et al.* 2008). Similarly, PAHs, which leach from wood treated with creosote, may cause cancer, reproductive anomalies, immune dysfunction, growth and development impairment, and other impairments to exposed fish (Carls *et al.* 2008; Collier *et al.* 2002; Incardona *et al.* 2005; Incardona *et al.* 2004; Incardona *et al.* 2006; Johnson 2000; Johnson *et al.* 2002; Johnson *et al.* 1999; Stehr *et al.* 2009). Alternatives to treated wood, such as silica-based wood preservation, improved recycled plastic technology, and environmentally safe wood sealer and stains are allowed.[37]

Any temporary water withdrawal will have a fish screen installed, operated, and maintained as described in NMFS (2011a). The USFWS and NOAA RC will require that all discharge water created by concrete washout, pumping for work area isolation, vehicle wash water, drilling fluids, or other construction work will be treated using the BMPs applicable to site conditions for removal of debris, heat, nutrients, sediment, petroleum products, metals and any other pollutants likely to be present (*e.g.*, green concrete, contaminated water, silt, welding slag, sandblasting abrasive, grout cured less than 24 hours), to ensure that no pollutants are discharged from the construction site. For bridge construction, all concrete will be poured in the dry, or within confined waters not connected to surface waters, and will be allowed to cure a minimum of 7 days before contact with surface water (Washington State Department of Transportation 2010).

Some of these adverse effects will abate almost immediately, such as increased total suspended solids caused by boulder or LW restoration. Others will be long-term conditions that may decline quickly but persist at some level for weeks, months, or years, until riparian and floodplain vegetation are fully reestablished. Failure to complete site restoration, or to prevent disturbance of newly restored areas by livestock or unauthorized persons will delay or prevent recovery of processes that form and maintain productive fish habitats.

All of the activities are designed to have long-term beneficial effects to critical habitat. However, as noted above, the long-term effectiveness of habitat restoration actions, in general, have not been well documented. In part, this is because they often concentrate on instream habitat without addressing the processes that led to the loss of the habitat (Cederholm *et al.* 1997; Doyle and Shields 2012; Fox 1992; Roper *et al.* 1997; Simenstad and Thom 1996; Zedler 1996). Nevertheless, the proposed actions are reasonably certain to lead to some degree of ecological recovery within each action area, including the establishment or restoration of environmental conditions associated with functional habitat and high conservation value. Fish passage improvement actions, in particular, are likely to have long-term beneficial effects at the watershed or designation-wide scale (Roni *et al.* 2002).

Site restoration. After each project is complete, the USFWS and NOAA RC will require any significant disturbance of riparian vegetation, soils, streambanks, or stream channel that was

[37] See, *e.g.*, American Plastic Lumber (Shingle Springs, California) and Resco Plastics (Coos Bay, Oregon) for structural lumber from recycled plastic; Plastic Pilings, Inc. (Rialto, California) for structurally reinforced plastic marine products; Timbersil (Springfield, Virginia) for structural lumber from wood treated with a silica-based fusion technology; and Timber Pro Coatings (Portland, Oregon) for non-petroleum based wood sealer and stains. The use of trade, firm, or corporation names in this opinion is for the information and convenience of the action agency and applicants and does not constitute an official endorsement or approval by the U.S. Department of Commerce or NMFS of any product or service to the exclusion of others that may be suitable.

caused by the construction to be cleaned up and restored to reestablish those features within reasonable limits of natural and management variation.

Thus, each restoration project will typically include replacement of natural materials or other geomorphic characteristics that were previously altered or degraded there in some way, so that ecosystem processes that form and maintain productive fish habitats are replaced and can function at those sites. The project footprint of any restoration project more complicated than simple site stabilization and revegetation will almost always occur in the riparian area or zone, or inside the active channel.

For actions that include a construction phase, the direct physical and chemical effects of site clean-up after construction is complete are essentially the reverse of the previous construction activities. Bare earth will be protected by various methods, including seeding, planting woody shrubs and trees, and mulching. This will immediately dissipate erosive energy associated with precipitation and increase soil infiltration and accelerate vegetative succession that is necessary to restore the delivery of LW to the riparian area and aquatic system, root strength necessary for slope and streambank stability, leaf and other particulate organic matter input, sediment filtering and nutrient absorption from runoff, and shade. Microclimate will become cooler and moister, and wind speed will decrease. Whether recovery occurs over weeks or years, the disturbance frequency, considered as the number of actions funded per year within a given recovery domain is likely to be extremely low, as is the intensity of the disturbance, considered as a function of the total number of miles of critical habitat present within each watershed.

Restoration of aquatic habitats is fundamentally about allowing stream systems to express their capacities, *i.e.*, the relief of human influences that have suppressed the development of desired habitat mosaics (Ebersole *et al.* 2001). Thus, the time necessary for recovery of functional habitat attributes sufficient to support species recovery following any disturbance, including construction necessary to complete a restoration action, will vary by the potential capacity of each habitat attribute. Recovery mechanisms such as soil stability, sediment filtering and nutrient absorption, and vegetation succession may recover quickly (*i.e.*, months to years) after completion of the project. Recovery of functions related to wood recruitment and microclimate may require decades or longer. Functions related to shading of the riparian area and stream, root strength for streambank stabilization, and organic matter input may require intermediate lengths of time. The rate and extent of functional recovery is also controlled in part by watershed context. Proposed actions will occur in areas where productive habitat functions and recovery mechanisms are absent or degraded.

Many authors have discussed the importance of riparian vegetation to stream ecosystems (Dosskey *et al.* 2010; Hicks *et al.* 1991; Murphy and Meehan 1991; Spence *et al.* 1996; Swanston 1991). Streambanks covered with well-rooted woody vegetation have an average critical sheer stress three times that of streambanks weakly vegetated or covered with grass (Millar and Quick 1998). Riparian vegetation also plays an important role in protecting streams from nonpoint source pollutants and in improving the quality of degraded stream water (Dosskey *et al.* 2010).

Planting in riparian areas may result in very minor fine sediment delivery to streams. It could also temporarily flush fish from hiding cover. In the long term, planting of riparian vegetation will increase shade, hiding cover, LW, and streambank stability. This will improve the survival of yearling and other juvenile salmonids by providing appropriate substrate for fry and an increase in cover from predators and high flows.

Beneficial effects to fish also include enhanced fitness through improved conditions for forage species and improved reproductive success for adult salmonids as a result of increased deep water cover and holding areas. As plantings mature, width-to-depth ratios of disturbed channels and fine sediment delivery will decrease.

Activity Category-Specific Effects

1. ***Fish Passage Restoration.*** For the USFWS and NOAA RC aquatic restoration programs, fish passage includes a broad range of activities to restore or improve juvenile and adult fish passage as described in the proposed action. Such projects will take place where fish passage has been partially or completely eliminated through road construction, stream degradation, creation of small dams and step structures, and irrigation diversions. Equipment such as excavators, bull dozers, dump trucks, front-end loaders and similar equipment may be used to implement such projects.

These activities usually require isolation of the work area from flowing water, relocation of fish, and significant instream construction. The construction-related effects described in the above section on restoration construction effects will occur at all culvert and bridge project sites. USFWS and NOAA RC propose to replace culverts and bridges using the stream simulation method, in which natural stream substrates will be placed in the bottom of these structures.

Under this activity category, artificial obstructions that block fish passage will be removed or replaced with facilities that restore or improve fish passage. The beneficial effects of this activity category include improved fish passage, restoration of natural bedload movement in streams, and restoration of tidal influence in estuarine areas. Removal of these structures requires instream construction with effects as described earlier. Culverts and bridges, other than stream simulation design crossings that meet the proposed action criteria, will require review and approval by NMFS fish passage engineers.

Culverts and Bridges. Long-term beneficial effects of culvert and bridge replacement or removal projects include restoration of fish passage and restoration of natural stream channel processes through removal of channel constricting structures. Removing fish-passage blockages will restore spatial and temporal connectivity of streams within and between watersheds where fish movement is currently obstructed. This, in turn, will permit fish access to areas critical for fulfilling their life history requirements, especially foraging, spawning, and rearing. At a larger scale this will improve population spatial structure.

However, the removal of fish passage barriers could have short-term (typically lasting less than one week, depending on the duration of instream work) temporary effects to fish and their habitat. Heavy equipment might be used in the stream for unblocking, removing and replacing culverts and bridges. In-water equipment use could temporarily affect salmonids and critical habitat, including impacts on redds, smothered or crushed eggs and alevins, increased suspended sediment and deposition, blocked migration, and disrupted or disturbed overwintering behavior. Salmon are particularly vulnerable during the fall and winter, when adult salmon are migrating and spawning, and the spring, when eggs and fry are still present in the substrate. The activities could move juveniles out of overwintering habitats such as side channels and deep pools, into inferior habitats or high velocity waters. However, because of the seasonal restrictions imposed by in-water work windows, these effects will be avoided.

Treated wood as a construction material is not allowed for bridge projects under this consultation. Copper and other toxic chemicals, such as zinc, arsenic, chromium, and PAHs, that leach from pesticide-treated wood used to construct a road, culvert or bridge are likely to adversely affect salmon, steelhead, and eulachon that spawn, rear, or migrate by those structures, and when they ingest contaminated prey (Poston 2001). These effects are unpredictable, with the intensity of effect depending on numerous factors. Effects from the use of treated wood as a material for structures placed in or over aquatic habitats that support ESA-listed species are best addressed in an individual consultation to consider material selection and site-specific considerations such as background concentrations, density of product installation, location of other treated wood structures, and environmental conditions (NOAA Fisheries - Southwest Region 2009).

Fish passage impediments are common throughout Oregon and Washington and restoration planning efforts have highlighted the need to restore fish passage, particularly when the blockage occurs low in a watershed.

Fish Screen Installation/Replacement. Unscreened or improperly screened irrigation diversion structures can entrain fish into canals where they become trapped and die. If approach velocities are too fast, fish can also be impinged against the screen surface. To avoid any effects from improperly designed screens, all proposed screen installations or replacements will meet NMFS fish passage criteria (NMFS 2011a). No additional water withdrawal points will be established and no greater rate or duty of water withdrawal will be authorized under this consultation.

Replacing, relocating, or construction of fish screens and irrigation diversions activities will require near or instream construction, so related effects as described above will occur. This consultation does not consider the effects of stream flow diminution caused by water withdrawals on listed salmon, steelhead, or their habitat. Installation of screens will occur only on existing diversion.

The primary long-term beneficial effect of properly screening diversions is decreased salmonid mortality. Although it is well accepted that screens prevent fish from dying, NMFS cannot predict exactly how many fish would be saved by installing screens in the Northwest. Despite millions of dollars spent on fish screening of water diversions in the Pacific Northwest and California, there have been few quantitative studies conducted on how screening actually affects fish populations (Moyle and Israel 2005). One recent study (Walters *et al.* 2012), examined potential losses of Chinook salmon juveniles to unscreened diversions and found that about 71%

of out-migrating smolts could be lost each year within a given river basin. The authors also found that screening was an effective mitigation strategy and reduced estimated mortality to less than 2% when all diversions within the basin were screened. Even though the effects of screening have not been well studied, NMFS recognizes the value of screening and supports the USFWS and NOAA RC's precautionary approach to screen diversions that may affect listed salmon and steelhead. The removal of unneeded diversion structures improves fish passage and restores natural bedload movement.

Head-cut and Grade Stabilization. The stabilization of active or potential head-cuts with LW, rock, or step structures primarily takes place in Rosgen (1994) C- and E-type channels in areas east of the Cascade Mountains. In these areas, historical land management such as heavy livestock grazing and road construction has destabilized stream channels and increased the chance of head-cut formation. Stabilization requires instream construction, so short-term construction related adverse effects as described earlier will occur.

The propagation of headcuts in an upstream direction is often arrested by buried wood or rock, a change in stream type, or infrastructure such as culverts. USFWS and NOAA RC propose aggressive treatments to prevent further incision of stream channels including use of rock and log step structures. Grade stabilization is often required for culvert removal projects where channel incision or erosion downstream of the road crossing has created a significant vertical discontinuity through the crossing. Bridge and culvert replacement designs often incorporate grade control components to protect footings and abutments, terminate or abate future channel instability, and protect critical or valuable upstream habitats.

These aggressive restoration techniques are sometimes necessary to stop the ongoing damage caused by migrating head-cuts. USFWS and NOAA RC also propose temporary head-cut stabilization, in which case fish passage may be blocked. In these circumstances, the fish passage will be reestablished during the subsequent in-water work period. This may block fish passage for several months, but without this treatment, head-cut formation might also block fish passage.

The beneficial effects of this proposed activity result primarily from the action's prophylactic nature. Left unchecked, head-cuts lead to channel incision, deposition of fine sediments in downstream substrates, and disconnection of a stream from its floodplain. Stabilizing head-cuts will stop the progression of these adverse effects. No matter where these activities occur, we expect an increase in habitat functions, improvements to VSP parameters, and a reduction in the risk of extinction to listed species.

Fish Ladders. Installation of a fish ladder and its subsequent operation increases the number of individual fish that are able to move upstream. This, in turn, will increase the number of fish that populate areas upstream from a dam, either because the fish continue to reside in the newly available habitat or because they reproduce in formerly unutilized spawning habitat. Short-term construction related adverse effects as described earlier will occur. Restoration of passage through constructing a ladder will improve population spatial structure and possible abundance and productivity if additional spawning habitat is made available.

Replace/Relocate Existing Irrigation Diversions. Under this activity subcategory, USFWS and NOAA RC will fund or implement the replacement of instream irrigation diversion structures with screened pump stations or remove unneeded irrigation diversion structures to benefit fish passage. This activity category requires significant in-water construction, so effects as described earlier will occur.

Beneficial effects of removing irrigation diversion structures such as small concrete dams, rock structures, and gravel push-up berms include improved fish passage and restoration of natural stream bedload movement. Many structures that would be removed provide only marginal fish passage and their removal will improve both adult and juvenile salmonid passage. The removal of unneeded structures also allows for the restoration of natural stream processes such as bedload movement and alleviates upstream and downstream scour that occurs at some diversion structures. Replacing a gravity diversion with a pump can eliminate the need for yearly construction of gravel push-up berms with heavy equipment and reduce water consumption.

Pump stations created under this subcategory will be screened to NMFS fish passage and screening criteria (NMFS 2011a). This will prevent juvenile fish from being entrained into the irrigation system. Actions involving effects to listed salmon, steelhead, or their habitat caused by lack of stream flow are not covered by this consultation.

2. ***Large Wood, Boulder, and Gravel Placement; Engineered Logjams (ELJs); Constructed Riffles; Porous Boulder Step Structures and Vanes; Tree Removal for Large Wood Projects.*** Installation of wood and boulder instream structures is likely to require entry of personnel into the riparian area and channel, and will result in unavoidable short-term construction related effects as described above, but will increase stream habitat complexity, increase overhead cover, increase terrestrial insect drop, and help reestablish natural hydraulic processes in streams over time. LW, in a stream, can accomplish multiple purposes by trapping gravel above the structure, creating pools, and increasing the connection with the floodplain vegetation. Wood placement is likely to cause minor damage to riparian soil and vegetation, and minor disturbance of streambank or channel substrate.

However, the intensity and duration of disturbance is unlikely to increase total suspended solids, or otherwise impair aquatic habitats or freshwater rearing and migration.

No matter where these activities occur, we expect an increase in habitat functions, improvements to VSP parameters, and a reduction in the risk of extinction to listed species. Numerous authors have highlighted the importance of LW to lotic ecosystems (Bilby 1984; Keller *et al.* 1985; Lassettre and Harris 2001; Spence *et al.* 1996). LW influences channel morphology, traps and retains spawning gravels, and provides food for aquatic invertebrates that in turn provide food for juvenile salmonids. LW, boulders, and other structures provide hydraulic complexity and pool habitats that serve as resting and feeding stations for salmonids as they rear or migrate upstream to spawn (Spence *et al.* 1996).

Land management actions such as logging, road building, stream clearing, and splash damming carried out over the last 150 years have greatly reduced the amount of LW and boulders in streams (McIntosh *et al.* 1994; Murphy 1995). USFWS and NOAA RC propose this activity category to return these important elements to stream ecosystems. Addition of LW is a common and effective restoration technique used throughout the Pacific Northwest (Roni *et al.* 2002). Roni and Quinn (2001a) found that LW placement can lead to higher densities of juvenile coho salmon during summer and winter and higher densities of steelhead and cutthroat trout in the winter. These authors also found that addition of LW to streams with low levels of wood can lead to greater fish growth and less frequent and shorter fish movements (Roni and Quinn 2001b).

ELJs, which are constructed either of timber, rock, or a combination that is engineered to create an interlocking composite structure, are an effective tool for restoring physical and biological conditions critical to salmon recovery in large alluvial rivers. Placement of a single log can provide benefits in certain situations but a log jam typically provides more habitat value. The mass of the structures and pilings are designed to provide the needed resistance to the expected forces of the river. These diverse bio-structures provide the base for different aquatic life to find food, shelter, and space to thrive. A log jam also changes water velocity and direction to sort gravels and create pool and riffle habitat. On the Elwha River, ELJs have proved to be stable with little significant change in position or surface area noted despite frequent inundation from floods including two peak floods that rank within the top 10% of floods recorded for over 100 years of record. The ELJs have also helped maximize habitat area by partially balancing flows between two major channels. During flood flows, ELJs have increased exchange of water with floodplain surfaces, primarily through backwatering. This has resulted in the expansion of side-channel habitats, including groundwater fed channels that provide critical habitats for multiple salmonid species. The ELJs developed scour pools, stored gravel, and reduced bed substrate grain size in the vicinity of several ELJs, with the mean particle size changing from large cobble to gravel. ELJs also had a measurable and significant positive effect on primary productivity, secondary productivity and juvenile fish populations (McHenry *et al.* 2007).

ELJs also retard streambank erosion as flow redirection structures that mimic stable log jams or bedrock outcrops that create “hard points” that form pools and cover, and increase overall channel complexity. Flow redirection structures are an effective means to control erosion and restore the quantity and quality of aquatic habitat by increasing channel length, pool frequency, and the amount of cover. Forested riparian buffers can be reestablished by first shifting the areas of high shear stress off the existing streambanks using structures to redirect flow away from streambanks. With properly spaced flow ELJs, sediment storage can be encouraged in between the structures to establish and sustain riparian buffers (Entrix 2009).

Live conifers and other trees can be felled or pulled/pushed over in the riparian zone, and upland areas for in-channel LW placement only when conifers and trees are fully stocked. This action will result in increased LW. If the riparian zone is fully stocked the action will not likely result in increased sedimentation or an increase in stream temperature.

As with LW, the addition of boulders, gravel, and properly designed rock structures can help restore natural stream processes and provide cover for rearing salmonids. Boulders can accomplish the retention of gravel by physically intercepting the bed load or slowing the water, and increase the interaction with the floodplain habitat by increasing the bed elevation and providing pool habitat. Boulders are most effective in high velocity or bedrock dominated streams. Roni *et al.* (2006) found that placement of boulder step structures in highly disturbed streams of Western Oregon led to increased pool area and increased abundance of trout and coho salmon. The addition of gravel in areas where it is lacking, such as below impoundments, will provide substrate for food organisms, fill voids in wood and boulder habitat structures to slow water and create pool habitat and provide spawning substrate for fish. Although little research has been conducted on the effectiveness of gravel augmentation in improving salmonid spawning, Merz and Chan (2005) found that gravel augmentation can result in increased macroinvertebrate densities and biomass, thus leading to more food for juvenile salmonids.

Constructed riffles will be installed in uniform, incised, or bedrock-dominated channels to enhance or provide fish habitat, or activate floodplain flow, in stream reaches where log placements are not practicable due to channel conditions (not feasible to place logs of sufficient length, bedrock dominated channels, deeply incised channels, artificially constrained reaches, *etc.*), where damage to infrastructure on public or private lands is of concern, or where private landowners will not allow log placements due to concerns about damage to their streambanks or property.

The proposed design criteria and conservation measures ensure that USFWS and NOAA RC will place LW, boulders, and gravel in a natural manner to avoid unintended negative consequences. This activity category will result in numerous long-term beneficial effects including increased cover and resting areas for rearing and migrating fish and restoration of natural stream processes.

3. ***Dam, and Legacy Structure Removal.*** This category of actions includes removal of small dams, channel-spanning step structures, legacy aquatic habitat structures, earthen embankments, subsurface drainage features, spillway systems, tide gates, outfalls, pipes, instream flow redirection structures (*e.g*., drop structure, gabion, groin), or similar devices used to control, discharge, or maintain water levels. Projects will be implemented to reconnect stream corridors, floodplains, and estuaries, reestablish wetlands, improve aquatic organism passage, and restore more natural channel and flow conditions. Any instream water control structures that impound substantial amounts of contaminated sediment are not proposed. Equipment such as excavators, bull dozers, dump trucks, front-end loaders and similar equipment may be used to implement such projects. A NMFS engineer will review design plans for the removal of a dams greater than 10 feet in height. A long-term monitoring and adaptive management plan will be developed between the NMFS and the action agency.

Dam Removal. In addition to the restoration construction effects discussed above, removing a water control structure (*e.g.,* small dam, earthen embankment, subsurface drainage features tide gate, gabion) using the proposed PDC is likely to have significant local and landscape-level effects to processes related to sediment transport, energy flow, stream flow, temperature, and biotic fragmentation (Poff and Hart 2002). The diversity of water control structures distributed on the landscape combined with the relative scarcity of knowledge about the environmental response to their removal makes it difficult to generalize about the ecological harm or benefits of their removal. However, many small water control structures are nearing the end of their useful life, due to sediment accumulation and general deterioration. They can either be removed intentionally by parties concerned about liability, or fail due to lack of maintenance. Thus, it is likely that in some cases the best outcome of these restoration actions will be a minimization of adverse effects that follow unplanned failures, such as reducing the size of a contaminated sediment release, preventing an unplanned sediment pulse, controlling undesirable species, or ensuring fish passage around remnants of the structure.

Removing a water control structure for restoration, safety, or economic reasons is unlikely to entirely restore pristine stream conditions. The legacy of flow control includes altered riparian soils and vegetation, channel morphology, and plant and animal species composition that frequently take many years or decades to fully respond to restoration of a more natural flow regime. The indirect effects or long-term consequences of water control structure removal will depend on the long-term progression of climatic factors and the success of follow-up management actions to manage sediments, exclude undesirable species, revegetate, and ensure that continuing water and land use impacts do not impair ecological recovery.

Removal of Legacy Structures. During the 1980s and early 1990s, many habitat-forming structures such as log, boulder and gabion structures were placed in streams to create pool habitat. Many of these structures were placed perpendicular to stream flow or placed in a manner that interfered with natural stream function. USFWS and NOAA RC propose to remove these structures to restore natural stream function. This activity type requires instream construction causing the short-term effects described earlier. Long-term beneficial effects of removing these structures include decreased streambank erosion, decreased stream width-to-depth ratios, and restoration of natural stream processes. Decreasing erosion will increase the survival of eggs and alevins and reduce interference with feeding, behavioral avoidance and the breakdown of social organization. Decreasing the stream width-to-depth ratios will increase adult holding areas and improve rearing sites for yearling and older juveniles.

4. Channel Reconstruction/Relocation. Channel straightening and dredging were extensively used in the 20th century to enhance agricultural drainage and facilitate crop maintenance and harvest. Channels were also straightened in response to flood events. Forested areas that have a legacy of timber harvest and log drives may also have simplified straightened channels with a scarcity of instream wood. In general, the level of intervention dictates the scale or magnitude of a stream restoration project.

As the streams were channelized or naturally returned to their original bed elevation, streambank heights increased so that greater water depth and discharge became required before the stream could spread onto the floodplain. The increase in streambank heights and bankfull discharge, which results in increased bank erosion, may be responsible for a significant portion of sediment loads in streams. Along many streams, this may cause channel spreading and, over decades, the re-establishment of a new "meander belt" (Knox 2006). The resistance of bed materials to stream incision is one of the major factors that determine how this process manifests itself along each stream course.

Mine tailings produced by placer mining nearly a century ago occupy the majority of the valley floor in some of the USFWS and NOAA RC's prospective project areas. These tailings piles have greatly altered fish and wildlife habitat within the project reach by confining and straightening the stream, creating a nearly continuous riffle with few pools or spawning gravel for fish. These tailings piles essentially function as dikes that cut off flood flows from the original floodplain. Water velocities accelerate as they are compressed through the constricted channel, concentrating the stream‘s energy on the streambed, simplifying substrate and degrading the channel. Sediment and nutrients are transported through the project area, depriving riparian areas of soil and nutrients, which in turn retard disturbance recovery and natural succession. The tailings piles prevent fine sediment and organics carried by floods from being deposited on the floodplain, preventing natural fertilization and soil augmentation needed to reestablish vigorous riparian communities. Tailings piles within the placer-mined reaches disconnect the stream from the historical floodplain and side channel habitat, which historically provided the flood flow refugia and over-wintering habitat, which were critical to salmonids. Mechanical manipulation and grading of thousands of cubic yards of mine tailings may be required to recover floodplain width and elevations.

Projects which involve significant channel reconfiguration over a considerable stream length or require extensive alteration of land management practices are likely to have more constraints, be more costly, and have a greater level of associated risk. For stream reaches that have evolved to a condition of greater instability, it may be necessary to adjust the channel's geometry. This may involve minor adjustments such as narrowing the channel cross-section and stabilizing the eroding stream banks. At the opposite end of the intervention scale, extremely unstable conditions with poor potential for natural recovery may require complete reconstruction of the stream channel to provide a stable channel pattern, profile, and cross-section; utilization of streambank stabilization techniques; and installation of flow diverting and grade control structures. Therefore, the short-term adverse and long-term beneficial effects of channel reconstruction will vary with the scale of the project. For some stream reaches, restoration may not be a realistic goal without intervention at the watershed level first.

Channel Reconstruction/Relocation will be implemented to improve aquatic and riparian habitat diversity and complexity, reconnect stream channels to floodplains, reduce bed and bank erosion, increase hyporheic exchange, provide long-term nutrient storage, provide substrate for macroinvertebrates, moderate flow disturbance, increase retention of organic material, and provide refuge for fish and other aquatic species. In addition to the restoration construction effects discussed above, channel reconstruction/ relocation projects using the proposed PDC are likely to have significant local and landscape-level effects to processes related to sediment transport, energy flow, stream flow, temperature, and biotic fragmentation.

Some potential negative physical and biological effects of channel modification include undesirable or unintended:

- Incision or aggradation within the project reach or in upstream, downstream or tributary reaches
- Bank erosion due to changes in hydraulic forces or bank stability
- Mid-channel bar formation and widening
- Channel avulsion (sudden shift in channel location across the intervening floodplain)
- Flanking of in-stream structures
- Increased sediment delivered to downstream reaches due to post-project channel adjustments
- Decreased sediment delivered to downstream reaches due to reduction of bank erosion rates to below natural levels

- Altered patterns of flooding
- Creation of fish-stranding hazards
- Shifts in composition and distribution of riparian plant and fish species, including establishment of non-native species (Cramer 2012).

Short-term risks associated with construction may also exist. These risks are increased if at-risk species are present. Construction related risks can be minimized by taking proper precautions and by anticipating potential outcomes. Some of the potential risks during or shortly following construction include:

- Mortality, physiological stress or displacement of aquatic macroinvertebrates, amphibians, and fish due to in-stream activity, increased turbidity, deposition of fine-sediment, and channel abandonment
- Increased sediment input to downstream reaches during construction or during channel re-watering, affecting pools and spawning gravels
- Increased sediment input to downstream reaches during the wet season following construction, affecting spawning gravels
- Loss of riparian vegetation
- Temporary loss or imbalance of nutrients and food supply (Cramer 2012).

Typically stream channel reconstruction /relocation projects are conducted in phases that will end with the full return of river flows to the historical channel and the filling of the old shortened channel. Fish passage is typically blocked until the restored channel can be activated. Mechanical manipulation and grading of thousands of cubic yards of mine tailings may be required to recover floodplain width and elevations. Mercury pollution is also a potential concern in creeks that were mined for gold, therefore a site assessment for contamination is a required PDC before a project is implemented.

Fish evacuation and relocation of juvenile fish from the old channel to the restored channel can be challenging because of the long transport distances required. Some fish mortality will also likely occur from predation, suffocation, or temperature stress in the old channel when it is dewatered, unless fish are relocated upstream or downstream promptly. Fish that are not relocated will also likely be stranded. Indirect mortality of aquatic species would be possible from high turbidities in the lower third of the reach and some distance downstream during channel relocation. In-water work windows, work area isolation, and fish capture and release PDC are intended to minimize handling and mortality.

With in-water work timing during low water periods and isolation of the work area, the release of suspended sediment is expected to be a short-term event. Sediment is likely to be carried by surface runoff when the newly configured channel(s) are reactivated and erosion control structures are removed. Localized suspended sediment increases are likely to cause some juveniles and adults to seek alternative habitat, which could contain suboptimal cover and forage and cause increases in behavioral stress (*e.g.,* avoidance, displacement), and sub-lethal responses (*e.g.,* increased respiration, reduced feeding success, reduced growth rates). Excessive sediment clogs the gills of juvenile fish, reduces prey availability, and reduces juvenile success in catching prey. However, the USFWS and NOAA RC's implementation procedures and pollution and erosion control plans will be designed to minimize suspended sediment. If turbidity is observed in the outflow, turbidity levels should be monitored downstream of the source with a hand-held turbidimeter. If measurements indicate violations of State water quality standards, USFWS and NOAA RC will work with the contractor to take appropriate corrective actions.

Disturbances associated with restoration have the potential to increase non-native plant abundance in the project area through influx of non-native species on equipment and by providing bare soil conditions. However, PDC for revegetation of native species and active removal/treatment of invasive plants will help to establish native species and reduce the overall presence of non-natives plants.

Effectiveness monitoring for channel reconstruction/relocation projects will be designed to measure progress toward achieving the project objectives, inform maintenance needs, and provide input into whether the restoration project is trending towards or away from achieving project goals. USFWS and NOAA RC will complete an existing conditions survey on the existing channel to determine the pre-project conditions and an as-built survey, which follows the same parameters, immediately upon completion of the new channel construction. This survey will compare as-built to proposed design metrics for channel length, substrate size, residual pool depth, pieces of LW, *etc*. Based on the project goals and compliance with this programmatic opinion, physical and biological parameters will be monitored using standard field techniques that will produce data compatible with the various protocols required by the RRT. Monitoring may include evaluation of stream length and channel complexity, riparian and floodplain vegetation, channel-floodplain connectivity, thermal regime, and fish passage.

Generally, post-project monitoring surveys will occur frequently enough to capture change that could result in a significant reduction in the desired habitat conditions. Surveys should occur during a similar timeframe each cycle, and should occur under similar flow conditions. The RRT will approve field methods that will be used to perform the monitoring surveys. Effectiveness of mitigation techniques for the restoration activities will be reviewed at the end of each construction season with NMFS, and any improvements will be incorporated into plans for the next season.

Post-project, hydrologic function of the stream channel will be restored to more natural conditions. Functional floodplains will promote riparian vegetation and stable banks. The restored corridor will provide an adequate riparian buffer zone. Aquatic habitat will be greatly improved in the short term and long term. Under this activity category streams that are made more self-sustaining and resilient to external perturbation will lead to improved aquatic habitat, which will help improve aquatic population abundance and productivity.

Although NMFS can predict the worse-case effects of this activity, with the proposed PDC and RRT review process we believe that the stream ecological condition will be measurably improved. The RRT will help to fine-tune the process to achieve the best possible outcome. However, for this opinion NMFS only analyzed the effects of carrying out projects as described by the proposed activity categories with application of the general and activity-specific conservation measures. We did not assume the RRT review process would result in a further reduction of the short-term adverse effects of any particular project. Our evaluation of the beneficial effects of the proposed actions is based on scientific literature and our past experience with similar types of actions. We also did not assume the RRT review would maximize the beneficial effects of any particular project.

5. Off- and Side-Channel Habitat Restoration. Many historical off- and side-channels have been blocked from main stream channels for flood control or by other land management activities, or have ceased functioning due to other in-stream sediment imbalances. The proposed action includes reconnecting existing stream channels to historical off- and side-channels, but not the creation of off- and side-channel habitats. These project types will increase habitat diversity and complexity, improve flow heterogeneity, provide long-term nutrient storage and substrate for aquatic macroinvertebrates, moderate flow disturbances, increase retention of leaf litter, and provide refuge for fish during high flows. Side channel wetlands and ponds provide important habitats for juvenile fish. When these areas are more regularly and permanently available, as in larger river basins, they can provide additional benefits such as high quality protected spawning habitat, especially for coho and chum salmon that actively seek these areas, and have high value as summer and winter rearing habitat for coho salmon (Cramer 2012).

The direct effects of reconnecting stream channels with historical river floodplain swales, abandoned side channels, and floodplain channels using the proposed PDC are likely to include relatively intense restoration construction effects, as discussed above. Side channel reconnections that contain more than 20% of the flow will be reviewed as a channel reconstruction/relocation project by the RRT (see PDC 5). Indirect effects are likely to include equally intense beneficial effects to habitat diversity and complexity (Cramer 2012), including increased overbank flow and greater potential for groundwater recharge in the floodplain; attenuation of sediment transport downstream due to increased sediment storage; greater channel complexity or increased shoreline length; increased floodplain functionality; reduction of chronic streambank erosion and channel instability due to sediment deposition; and increased width of riparian corridors. Increased riparian functions are likely to include increased shade and hence moderated water temperatures and microclimate; increased abundance and retention of wood; increased organic material supply; water quality improvement; filtering of sediment and nutrient inputs; more efficient nutrient cycling; and restoration of flood-flow refuge for ESA-listed fish (Cramer 2012). Wetlands, such as those created by off- and side-channel restoration are also cost-effective tools to sequester carbon to mitigate the effect of greenhouse gas emissions (Bernal and Mitsch 2013).

6. Streambank Restoration. In addition to restoration construction effects discussed above, the proposed streambank restoration action is likely to allow reestablishment of native riparian forests or other appropriate native riparian plant communities, that provide increased cover (LW, boulders, vegetation, and streambank protection structures) and a long-term source of instream wood, reduce fine sediment supply, increase shade, moderate microclimate effects, and provide more normative channel migration over time.

USFWS and NOAA RC propose to stabilize eroding streambanks using bioengineering methods. This requires instream construction with short-term effects as described above. Heavy equipment might be used in the stream for this activity. The use of equipment in-water could temporarily affect salmonids and critical habitat, including increased suspended sediment and deposition, blocked migration, disrupted or disturbed overwintering behavior, and smothered or crushed eggs and alevins in redds. Pacific salmonids are particularly vulnerable during the fall and winter, when adult salmonids are migrating and spawning, and the spring, when eggs and fry are still present in the substrate. However, because of the seasonal restrictions imposed by in-water work windows, these effects will be avoided.

The use of rock groins, weirs, rock toes, and riprap has been excluded by USFWS and NOAA RC to avoid the potential negative effects of using hard structures to stabilize streambanks. Long term beneficial effects of stabilizing eroding streambanks include reductions in fine sediment inputs. Eliminating a sediment source will help to increase the diversity and densities of aquatic macroinvertebrates, which are used as a food source by listed fish species. It will also maintain or increase the amount of interstitial cover available to juveniles and juvenile emergence success. Suffocation of fry and entombment caused by excessive siltation of spawning gravels will also be reduced or eliminated. Light penetration, which, in turn, affects the feeding abilities of covered fish species and juvenile growth rates, will improve.

By limiting streambank restoration to bioengineering methods such as the placement of LW and riparian plantings, overhead cover for fish will be increased and streambank stability will improve.

*7. **Set-back or Removal of Existing Berms, Dikes, and Levees.*** Channelization of streams through levee construction means that the floodplain no longer benefits from floods, producing many of the same changes to living communities and ecosystems as those resulting from dams. Levees, berms, and dikes are commonly found along mid- to large-sized rivers for flood control or infrastructure protection and can severely disrupt ecosystem function (Gergel *et al.* 2002) and fish community structure (Freyer and Healey 2003). Similarly, mine tailings left by dredging for precious metals can have comparable effects on small streams.

Floodplain heterogeneity is associated with the occurrence of a mosaic of food webs, all of which are utilized by anadromous salmonids, and all of which may be important to their recovery and persistence. In the long term, these and other fishes will likely benefit from restoring the processes that maintain floodplain complexity (Bellmore et al. 2013). Set-back or removal of existing berms, dikes, and levees increases habitat diversity and complexity, moderates flow disturbances, and provides refuge for fish during high flows. Other restored ecological functions include overland flow during flood events, dissipation of flood energy, increased water storage to augment low flows, sediment and debris deposition, growth of riparian vegetation, nutrient cycling, and development of side channels and alcoves.

Under this activity category, the USFWS and NOAA RC propose to remove dikes, berms, mine tailings or other floodplain overburden to restore river-floodplain interactions and natural channel-forming processes. This action category may often be combined with the stream channel reconstruction/relocation category above. The direct and indirect effects of this type of proposed action are also very similar to off- and side-channel habitat restoration discussed above, although the effects of this type of action may also include short-term or chronic instability of affected streams and rivers as channels adjust to the new hydrologic conditions. Moreover, this type of action is likely to affect larger areas overall because the area isolated by a berm, dike or levee is likely to be larger than that included in an off- or side-channel feature.

In the long term, removal of floodplain overburden will improve connection between the stream and its floodplain, and allow reestablishment of riparian vegetation. Over time, the removal of overburden will also allow for the restoration of natural channel forming processes. Over the course of many decades, degraded and incised channels will be able to regain meanders, aggrade to the proper elevation, and resume natural formation of habitat features. Ultimately, this will result in more functional fish habitat, *i.e.,* streams with overhead cover and undercut banks to provide protection for juvenile fish, low width-to-depth ratios that provide cool and deep refugia for migrating juveniles, and healthy riparian plant communities that provide allochthonous nutrient inputs that drive the food base that juvenile salmonids consume when rearing and migrating to the ocean. More immediate beneficial effects will result from the restoration of "flood pulses" that periodically deliver water, nutrients, and sediment to floodplains.

8. Reduction/Relocation of Recreation Impacts. USFWS and NOAA RC propose to close or better control recreational activities occurring along streams or within riparian areas. This activity category includes removal of campgrounds, toilets, and trails. It also includes placement of rocks or other barriers to limit access to streams and gravel surfacing of existing areas prone to erosion. Some construction activities such as removal of floodplain fill in campgrounds may occur, but construction activities within the bankfull stream width will not occur under this category. These actions will eliminate or reduce recreational impacts to restore riparian areas and vegetation, improve streambank stability, and reduce sedimentation into adjacent streams (Eubanks 2004).

Adverse effects of this action include minor riparian disturbance from construction. Long-term beneficial effects result primarily from exclusion of people and vehicles from streams and riparian areas. Reduced streambank damage and reduced chronic disturbance of riparian areas will result from implementation of this activity category.

Soil compaction in riparian areas will be reversed by providing a way for water and air to saturate the soil. Eliminating gravel-clogging sediment sources (*e.g.,* eroding streambanks) will help to increase the diversity and densities of aquatic macroinvertebrates used as a food source by covered fish species. It will also maintain or increase the amount of interstitial cover available to juveniles, and juvenile emergence success. Suffocation of fry and entombment caused by excessive siltation of spawning gravels will also be reduced or eliminated. Light penetration, which, in turn, affects the feeding abilities of fish species and juvenile growth rates, will improve. Graveling of areas inside established recreation sites reduces erosion, but also precludes the growth of riparian vegetation in these areas.

9. Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering Facilities. Such projects promote a balanced approach to livestock use in riparian areas, reducing livestock impacts to riparian soils and vegetation, streambanks, channel substrates, and water quality. The direct effects of constructing a livestock crossing or off-channel watering facility using the proposed PDC will be similar, though less intense, to the restoration construction effects discussed above. Although the net benefits of fencing streams to exclude livestock or humans are clear, some minor adverse effects can occur at watering or crossing sites. Concentration of livestock or human traffic at these areas can result in streambank damage and add fine sediment to stream substrates. Redds created by salmon or steelhead could be trampled if they are located in crossings. USFWS and NOAA RC propose several conservation measures to reduce the potential for these types of adverse effects from occurring. Crossings will be located in areas where streambanks are naturally low, crossing widths are limited to 15 feet, and areas of sensitive soils and vegetation will be avoided. Although these measures will reduce the potential for adverse effects, some minor streambank damage is likely to occur in these small areas and redds could occasionally be trampled.

Such projects promote a balanced approach to livestock use in riparian areas, reducing livestock impacts to riparian soils and vegetation, streambanks, channel substrates, and water quality. Indirect effects are likely to be beneficial, including reducing the likelihood that livestock, particularly cattle, will have unrestricted access to a riparian area or stream channel for shade, forage, drinking water, or to cross the stream. This, in turn, is likely to reduce the likelihood that livestock will disturb streambeds, spawning areas or redds, or erode streambanks, and will improve water quality by increasing riparian vegetation and reducing sediment and nutrient loading to streams.

10. Piling and Other Structure Removal. This category includes the removal of untreated and chemically treated wood pilings, piers, and boat docks as well as similar structures comprised of plastic, concrete and other material. Piling and other structure removal from waterways will improve water quality by eliminating chronic sources of toxic contamination and associated impacts to riparian dependent species. The proposed PDC mainly focus on the removal of intact and broken piles which are typically treated with a toxic preservative. Removal of piles using the proposed PDC will re-suspend sediments that are inevitably pulled up with, or attached to, the piles. If sediment in the vicinity of a pile is contaminated, or if the pile is creosote treated, those contaminants will be included with the re-suspended sediments, especially if a creosote-treated pile is damaged during removal, or if debris from a broken pile is allowed to re-enter or remain in the water. Due to the relatively small amount of sediment disturbed during pile removal, any effects to fish from the re-suspended sediments will be minor. The indirect effects of structure removal are likely to be beneficial and include reduction of resting areas for piscivorous birds, hiding habitat for aquatic predators such as large and smallmouth bass, and, in the case of creosote piles, a chronic source of PAH pollution.

11. Shellfish Bed/Nearshore Habitat Restoration. Pacific Northwest beaches provide habitat for shellfish (Dethier 2006) and forage fishes such as Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus),* and surf smelt (*Hypomesus pretiosus*), which are important food sources for salmon. Adjacent nearshore habitats are used as nursery grounds by all three species. Each of these species has particular habitat requirements for spawning; *e.g.*, relatively restricted sediment grain size, particular tidal heights, and specific vegetation types. Other forage fish species, *i.e.,* eulachon, Northern anchovy (*Engraulis mordax*), and longfin smelt (*Spirinchus thaleichthys*), do not spawn on Puget Sound beaches, but use nearshore ecosystems in other ways (Penttila 2007).

Five species of Pacific salmon use the nearshore ecosystems of Puget Sound: Chinook, coho, chum, sockeye, and pink (*O. gorbuscha*). Juvenile chum salmon abundance in nearshore areas peaks in May and June. Juvenile Chinook salmon abundance peaks in June and July, although some are present in shoreline habitats through October, but they may occupy nearshore habitat nearly year-round (Fresh 2006). Beaches and shallow waters provide shelter from predators and food for young salmon and trout as their bodies adapt to saltwater. These fish migrate and feed along these nearshore corridors as they move to open water and then as returning adults they use these same areas to re-acclimate to freshwater (Shared Strategy for Puget Sound 2007).

Nearshore habitat forming processes have been interrupted by shoreline armoring, development on top of and below banks, bluffs, and beaches, and changes in flow due to the diversion of rivers or streams. Bluff sediment input, primarily glacially deposited units, is the primary source of beach sediment in Puget Sound. Dams on rivers also hold back sediment important to processes downstream and the nourishment of shoreline beaches. Many beaches, particularly in the Puget Sound region, have been modified with bulkheads, jetties, and armoring to protect industrial or residential development, *i.e.*, roads, railroads, docks, piers, marinas, *etc.*, from erosion. These modifications have disrupted beach forming erosion processes and decreased access to juvenile salmon rearing habitats. Overwater structures and ramps also contribute to this loss of salmon habitat (Shared Strategy for Puget Sound 2007). Sea level is also expected to rise substantially in this century which will affect the amount, structure, and function of nearshore habitat in Puget Sound and elsewhere on the coast. The loss of small parcels of shoreline habitat from hardening may not have a large impact on the ecosystem, but the cumulative impact of the loss of many small parcels will at some point, alter the properties, composition, and values of the ecosystem. Approximately 34% of the Puget Sound and Northern Straits shoreline (more than 805 miles) has been modified (Johannessen and MacLennan 2007) and every year approximately 1.5 miles of new bulkheads are built and about 2.5 miles are replaced (Barnard 2010).

By re-connecting naturally eroding feeder bluffs to the marine environment, beaches will be nourished with a natural source of sediment, and by removing barriers like bulkheads, structures, and piers, wave action will again transport sediment to form beaches. Shoreline restoration measures may include gravel beach nourishment, grade control/slope support with large wood and/or rock, wood revetment or wood/rock revetment, and biotechnical slope support (vegetated geogrids, soil pillows, *etc*.) as described by Barnard (2009). However, removing some bank hardening structures may not be sufficient to create sandy beaches; there may also be a need to augment sediment supplies. Furthermore, beach nourishment has significant impacts on local ecosystems. Nourishment may cause direct mortality to sessile organisms in the target area by burying them in the new sand. Seafloor habitat in both source and target areas are disrupted, *e.g.*, when sand is deposited. Nourishment is also typically a repetitive process, since nourishment does not remove the physical forces that cause erosion; it simply mitigates their effects. Thus, this restoration measure will be accompanied by a monitoring plan and reviewed and approved by NMFS.

The placement of cultch, spat-on-shell, or live shellfish as part of shellfish restoration can negatively impact benthic organisms and submerged aquatic vegetation (SAV) due to burial, excessive turbidity, or space competition. Eelgrass (*Zostera marina*) is a particularly important habitat component of Pacific Northwest estuaries, and is susceptible to decline from physical disturbance. This is especially true if the rhizome matrix is disrupted (Boese *et al.* 2009). However, since shellfish restoration generally will not disturb the substrate, it is likely that shellfish restoration conducted under this Opinion will not disrupt rhizomes, but may reduce shoot density or percent cover.

Introduction of non-native species, predators, and pathogens is a potential mechanism for harmful effects of shellfish restoration. Although many safeguards are now in place to protect against such introductions, shellfish have historically been a vector for a variety of non-indigenous species. The proposed action will minimize this danger by ensuring that shell or other substance used for substrate enhancement will be procured from clean sources that are then steam cleaned, left on dry land for a minimum of 1 month, or both, before placement in the water.

In some cases, the planting of SAV is included as part of a shellfish restoration activity. During revegetation activities, workers may disturb the surrounding sediment locally by compacting sediment due to foot traffic, or may disturb existing vegetation. Harvest of SAV from donor beds may harm the donor SAV bed, and may increase turbidity temporarily. For kelp restoration projects, there is potential for damage from divers or equipment, disruption of bottom sediment from diving finds, and impacts resulting from the transplanting of kelp to restoration sites.

12. In-channel Nutrient Enhancement. USFWS and NOAA RC propose to add salmon carcasses, salmon carcass analogs (SCA), or inorganic fertilizers to replace missing nutrients. Many streams throughout the Pacific Northwest that once had large returns of salmon and steelhead are now lacking the nutrients that decomposing fish carcasses provided. This is especially true for trace marine nutrients (Compton *et al.* 2006; Murota 2003; Nagasaka *et al.* 2006; Thomas *et al.* 2003). SCA, dried, which are made of pasteurized and pelletized marine fishmeal, represent an inanimate nutrient treatment while spawning salmon represent an ecologically important source of bioturbation that physically disrupt the streambed and provide direct sources of metabolic waste products through excretion.

Nevertheless, benefits including trophic transfer pathways that include direct consumption of SCA particulates by stream-dwelling consumers (*i.e.,* macroinvertebrates and salmonids), a pasteurized product that reduces the risk of disease transfer, and the ability to recycle fish products into a usable and widely applicable nutrient amendment tool hold great potential utility (Pearsons *et al.* 2007).

The organisms in the base of the food chain that rely on those inputs are ultimately the food base that juvenile salmonids consume when rearing and migrating to the ocean. Studies conducted in British Columbia have shown that addition of inorganic fertilizers can increase salmonid production in oligotrophic streams (Slaney *et al.* 2003; Ward *et al.* 2003; Wilson *et al.* 2003). Pearsons *et al.* (2007) documented direct consumption of SCA material by rainbow/steelhead trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarki*) and juvenile Chinook salmon, and increased growth rates of rainbow trout in the Yakima River basin, Washington, and Wipfli *et al.* (2004) documented an increase in stream-resident salmonid condition, lipid level measures and production in the presence of SCA in southeast Alaska, U.S.A. artificial stream channels. Kohler *et al.* (2008) documented no significant change in dissolved nutrient concentrations following the addition of salmon carcass analogs in two Idaho streams. Ebel (2012) found that although biofilm standing crop and nutrient limitation did not respond to SCA, primary productivity and respiration increased in the subset of streams where they were measured.

SCA have only been applied in a research-oriented framework (Kohler *et al.* 2008); the effects of nutrient additions have not been studied in detail (Compton *et al.* 2006). Therefore, the USFWS and NOAA RC propose the above conservation measures (PDC 43) in conjunction with this activity type. In Oregon, fish carcasses will be certified as disease free by an ODFW fish pathologist and in Washington, placement of carcasses will follow WDFW's stream habitat restoration guidelines for distributing salmonid carcasses, salmon carcass analogs, and delayed release fertilizers (Cramer 2012). Following these steps will minimize the chance of introducing disease causing pathogens through carcass supplementation. USFWS and NOAA RC will not attempt nutrient enhancement in naturally oligotrophic systems where nutrient levels will be naturally low, and they will not add nutrients to eutrophic systems where nutrient levels are atypically high. Carcass additions will occur during normal spawning periods, so there is a more than negligible chance that some spawning activities could be temporarily interrupted by the addition activities. These interruptions will last for a maximum of a few hours, will only happen once, and are not likely to cause a measurable decrease in spawning success.

13. Road and Trail Erosion Control and Decommissioning. Road and trail erosion control and decommissioning typically includes one or more of the following actions:

- culvert removal in perennial and intermittent streams;
- removing, installing or upgrading cross-drainage culverts;
- upgrading culverts on non-fish-bearing steams;
- constructing water bars and dips; reshaping road prisms;
- vegetating fill and cut slopes; removing and stabilizing of side-cast materials;
- grading or resurfacing roads that have been improved for aquatic restoration with gravel, bark chips, or other permeable materials;
- contour shaping of the road or trail base;
- removing road fill to native soils; and
- soil stabilization and tilling of compacted surfaces to reestablish native vegetation.

A significant amount of information is available regarding the adverse effects of roads on aquatic habitats (Gucinski *et al.* 2001; Jones *et al.* 2000; Trombulak and Frissell 2000). Roads introduce invasive species and deliver fine sediment, which results in decreased fry emergence, benthic production, winter carrying capacity, and juvenile densities, and increased predation and algal production. Improper culvert placement can limit or eliminate fish passage. Moreover, roads can greatly increase the frequency of landslides, debris flows, and other mass movements.

Unfortunately, much less information is available on the specific effects of road and trail restoration or removal, and its effectiveness for reversing adverse habitat conditions attributed to the presence of road and trail systems. The short-term effects of these actions using the proposed PDC will include the restoration construction effects and, in the case of culvert removal, fish passage restoration, discussed above. The long-term effects of road and trail restoration or removal appear to include mitigation of many of the negative effects to aquatic habitats that have been associated with roads (Madej 2001; McCaffery *et al.* 2007), but the large variance between substrate conditions and other stream habitat characteristics that are important to fish make it difficult to assign measurable effects to road decommissioning (Madej 2001; McCaffery *et al.* 2007). Thus, road and trail erosion control and decommissioning are likely to result in restoration of riparian and stream functions as a result of reduced sediment yield and improved fish passage.

14. Juniper Removal. This action will help restore composition and structure of desired riparian species, thereby improving ground cover and water infiltration into soils. The direct adverse effects of juniper tree removal will include minor restoration construction effects (*i.e.*, soil compaction, erosion, loss of upland vegetation) caused by the movement of personnel over the action area. Moreover, this action will convert living trees to woody debris and slash that will be left within the action area at densities that are likely to range from less than 1 to more than 8 tons per acre (Azuma *et al.* 2005). This increase in fuel loading will increase the likelihood or intensity of fire, especially during the first 2 to 3 years while needles are still attached, although post-settlement reduction in the extent and return interval of fire is considered to be the most important factor allowing western juniper to expand into neighboring plant communities (Miller *et al.* 2005). Beneficial effects of the juniper removal and retention of slash residue will include increased soil cover that will reduce erosion, increased soil nutrients and organic matter content, and increased distribution and abundance of native vegetation than is otherwise typical for sites that have been degraded by increasing dominance of western juniper. The indirect effects of juniper tree removal using these methods will depend on the long-term progression of climatic factors and the success of follow-up management actions to address fire, livestock management, and other site-specific factors driving woodland succession.

15. Bull Trout Protection. This category includes the removal of brook trout or other non-native fish species via electrofishing or other manual means to protect bull trout from competition or hybridization. Brook trout, introduced throughout much of the range of bull trout, easily hybridize with them, producing sterile offspring. Brook trout also reproduce earlier and at a higher rate than bull trout, so bull trout populations are often supplanted by these non-natives. Hybridization with brown trout and lake trout is also a problem in some areas.

Removal methods, such as dip netting, spearing, and traps will be directed at brook trout or other non-native fish species. Minnow traps could capture nontarget ESA-listed salmon and steelhead species, but this capture method allows the capture and release of juvenile salmon and steelhead with very little harm to individuals. USFWS and NOAA RC also propose to electrofish for brook trout or other non-native fish species. Electrofishing can be an effective measure for controlling nonnative brook trout, thus paving the way to native trout recovery (Carmona-Catot *et al.* 2010). Bull trout spawn in headwater areas of streams from late-August to November, generally further upstream than ESA-listed salmon and steelhead species. On the Clackamas River where bull trout were recently reintroduced, the potential impact of bull trout was considered to be very low or moderately low for spring Chinook salmon, coho salmon, and winter steelhead and mostly none to very low for fall Chinook salmon (Marcot *et al.* 2012). Thus far, no bull trout have resided for a significant amount of time in areas where migrating juvenile salmon and steelhead are artificially concentrated and vulnerable to predation (*i.e*., Clackamas River hydroelectric facilities). In both years, reintroduced bull trout were observed spawning in a headwater tributaries (Allen and Koski 2013). Capture mortality to species other than species targeted for removal by electrofishing will be low. Mortality of fish captured by this method will be less than 2% given that NMFS (2000) electrofishing protocol is required.

Although this category has the potential to harass, kill, or injure listed salmon and steelhead, the overall result will be a reduction of non-native fishes that prey on listed species or compete for habitat and food resources. This type of activity will likely occur very infrequently. Therefore, the overall threat to listed salmon and steelhead will be insignificant.

16. Beaver Habitat Restoration. The long-term goal of this category is to restore linear, entrenched, simplified channels to their previously sinuous, structurally complex channels that were connected to their floodplains. This will result in a substantial expansion of riparian vegetation and improved instream habitat. Beavers, which were historically prevalent in many watersheds, build dams that, if they remain intact, will substantially alter the hydrology, geomorphology, and sediment transport within the riparian corridor. Beaver dams will entrain substrate, aggrade the bottom, and reconnect the stream to the floodplain; raise water tables; increase the extent of riparian vegetation; increase pool frequency and depth; increase stream sinuosity and sediment sorting; and lower water temperatures (Pollock *et al.* 2007; Pollock *et al.* 2012b).

The loss of beaver from small stream networks lowers water tables, hampering recovery of willows. Beschta and Ripple (2010) observed that the reintroduction of apex predators, such as wolves in Yellowstone National Park, helped to discourage browsing, allowing recovery of willows along streambanks. However, long-term experiments conducted in the park have shown that restoring physical structure to streams, as well as restoring the historical disturbance and hydrological regimes, requires beaver damming of stream channels (Marshall *et al.* 2013).

The installation of beaver dam support structures, to encourage dam building, may result in very minor fine sediment delivery to streams. Removal of vegetation mechanically will likely adversely affect stream habitat by removing shade trees, which could increase stream temperature in the short term. However, the streams where this action will occur are for the most part incised, lack adequate riparian vegetation, and contribute little to the conservation of the listed fish populations through demonstrated or potential productivity. Long term, the establishment of beavers in these stream reaches will result in the aforementioned benefits to listed fish habitat. To make habitat more suitable to beavers, USFWS and NOAA RC will also plant riparian hardwoods, protect hardwoods with enclosures until they are established, and control grazing to the extent possible.

17. Wetland Restoration. Wetland restoration projects using the proposed PDC are likely to have effects similar to those of restoration construction; off-and side channel restoration; set-back of existing berms, dikes, and levees; and removal of water control structures, as described above.

18. Tide/Flood Gate Removal, Replacement, or Retrofit. A tide gate is an opening through which water may flow freely when the tide sets in one direction (outgoing tide), but which closes automatically and prevents the water from flowing in the other direction (incoming tide). Flood gates, which are similar devices, consist of a valve or gate that controls the rate of water flow, or prevents water flow from entering behind the gate (WDFW 2009). Floodgate operation is similar to that of tide gates, except that they allow water to flow outward from the drainage system into a freshwater natural watercourse (*i.e.,* Columbia River) while preventing water in a natural watercourse from back-flooding into a drainage system when the water elevation in the natural watercourse is higher than the floodgate. These gates are only needed a few times each year or as little as once every several years, but typically remain closed all the time.

In the Skagit River, fish immigrate from estuaries into the lower reaches of the watercourses via culvert/tidegates to forage on available prey between February and July. The upstream distribution and duration of residence for these immigrating fish are limited by water quality, prey availability and their physiological affinity for salt water. In addition to salmonid species, forage fish species such as surf smelt and sand lance also use the estuary habitats for rearing and could potentially immigrate into the lower reaches of watercourses (Western Washington Agricultural Association *et al.* 2007). When tidegates are partially or completely closed they are barriers to fish migration, because they block adult salmonids from accessing upstream habitat on the incoming tide and limit passage for juvenile and adult salmonids at other times. Most are also a barrier to migration when they are open because they don't open far enough or frequently enough, they may be perched too high, and/or the water velocity is too high.

Flood gates are particularly harmful to fish that are denied access to tributary systems for spawning and rearing. Flood gates have been designed with hydraulic or electric control systems that bring the gate into action only when flood stage reaches a certain critical elevation. While these systems appear to have benefits that outweigh the impacts, there remain some major concerns that include:

- Juvenile fish seek off channel refuge during floods and flood gates exclude them from this type of habitat.
- Adult salmonids often move upstream into tributary systems during flood events. They are motivated to move on these freshets because the extra water depth created by floods allows them to penetrate deeply into a watershed.
- Some rivers flood for sustained periods, precisely at a time when fish are seeking access to off channel areas. If the gate was closed for several weeks during the fish passage season it would have a significant effect on the population.

Removal of Tide and Flood Gates. Removal of dikes and their tide/flood gates, regardless of how fish friendly their design and operation, will improve fish movement and positively alter the quality of their habitats. Even "fish friendly" automatic-type tide gates on tidal sloughs, which remain open for part of the flood tide, negatively affect the abundance and movement of juvenile Chinook salmon when compared to similar but un-gated sloughs.

NOAA Fisheries Science Center and the Skagit River Systems Cooperative (Barnard 2011; Greene *et al.* 2012) found the following preliminary findings:

- Juvenile Chinook salmon are present in lower numbers upstream of automatic tide gated sloughs than in un-gated sloughs
- These fish tended to spend less time behind the tide gate
- Tagged fish were shown to move less frequently across the gate and, in the case of larger fish released above the gate, to move only once downstream and out of the slough

- Indications are that the muted tidal cycle created by the automatic tide gate results in reduced habitat quality which may be reflected in lower abundance with fewer repeated visits by juvenile Chinook salmon
- Tide gates alter the salinity, temperature, dissolved oxygen, total suspended solids, *etc.* of the habitat upstream

Removal of tide gates or tidal levees is likely to result in restoration of estuarine functions related to regulation of temperature, tidal currents, and salinity; increased habitat abundance from distributary channels, that increase in size after tidal flows are allowed to inundate and scour on a twice daily basis; reduction of fine sediment in-channel and downstream; reduced estuary filling due to increased availability of low-energy, overbank storage areas for fine sediment; restoration of fish access into tributaries, off- and side-channel ponds and wetlands; restoration of saline-dependent plant species; increased primary productivity; increased estuarine food production; and restoration of an estuarine transition zone for fish and other species migrating through the tidal zone (Cramer 2012; Giannico and Souder 2004; Giannico and Souder 2005).

These findings suggest that (1) Tide gates designed to better accommodate fish passage may have only limited benefits for fish populations, (2) proper gate operation is an essential component in meeting project goals regardless of the gate design, (3) impacts of dikes and tide gates may not be completely mitigated with self-regulating tide gates (SRT) designs, (4) hydraulic modeling is an essential part of establishing both the feasibility and sustainability of project goals, and (5) continued monitoring and adaptive management is essential in meeting project goals.

Historically, tide and flood gates were constructed of cast iron or wood. Plastic, fiberglass and aluminum gates are also available and are preferred because the lighter gates open easier for better fish passage and for drainage. Today's designs include float-operated gates, such as self-regulating tide gates, automatic electric- or hydraulically-powered gates, and other mechanical systems that allow a specific and variable operating range of upstream water surface elevation. This class is collectively called *automatic* gates as opposed to *passive* gates that simply rely on the direction of flow to either close or open (Barnard 2011; Giannico and Souder 2005; Greene *et al.* 2012).

Replacement or Retrofit of Tide and Flood Gates. Replacement of tidegates is occasionally necessary, and usually involves the replacement of tubes to extend the life of the gate facility or to restore impaired function. Tubes typically collapse due to corrosion. A recent study by the NOAA Northwest Fisheries Science Center and the Skagit River System Cooperative (Greene *et al.* 2012) on "fish friendly" tide gates concluded:

a. The similarity of SRTs to flap- or side-hinged gates, or reference sites, depends upon which metrics are measured.
b. SRTs limit habitat use above the gates relative to natural channels, but perform slightly better than passive side hinged or flap gates.
c. Flap or side hinged gates that were held open during observation periods were consistently higher in cumulative Chinook salmon density ratio than purely passively operated gates.
d. SRT designs continue to limit tidal processes and habitat use.

e. SRT designs and operation standards that maximize connectivity, and site selection criteria that focus on reconnection of large amounts of habitat, may overcome some of the limitations of reduced habitat use associated with SRT installation.

In one instance, a passive side hinged gate was removed and replaced with an SRT -- the result was a nearly a 10-fold decline in cumulative density of juvenile Chinook salmon. It was observed that previous gate operations, which stipulated the former gate be manually held open during key migration periods for juvenile Chinook salmon, were not duplicated in the operation of the newly installed SRT. The unintended biological effects of the change in gate operation highlights the significance of operation plans, monitoring, maintenance, and adaptive management in meeting the goals for tidal restoration projects utilizing SRTs.

The potential for fish to be adversely affected is dependent upon small fish being present at the tidegate or floodgate sites. For many fish species, dependence on delta and estuary habitats is seasonal. The time of the year when juvenile fish utilize the delta and estuary habitats for rearing and refuge is different for different fish species and life histories. For salmonid species, small juveniles typically depend on the delta and estuary habitats between February and July, during which time they are at greatest risk of being adversely affected by tidegate and floodgate work. The velocity and depth in the barrel of the culvert may exceed the swimming ability of the fish that make it past the gate. There is often an increase in velocity at the inlet of the culvert as flow contracts into the smaller culvert. Head loss in excess of 0.5 feet (greater than 5 feet per second) is likely to be a barrier to juvenile and weak swimming fish.

The replacement of tide gates and flood gates using the proposed PDC are likely to have effects similar to those of the removal of water control structures or fish passage restoration, as described above, including impacts of work area isolation, fish capture, and release. The potential for fish to be adversely affected is also related to the size of fish. Larger fish are stronger swimmers and therefore better able to escape and avoid the potential impacts of replacement activities, whereas smaller fish are weaker swimmers and therefore at greater risk of being killed or injured. Additionally, the potential for fish to be adversely affected is greater in those habitats where small fish rear and seek refuge. Habitats typically associated with tidegates and floodgates in river deltas and estuaries provide optimal rearing and refuge habitat for smaller fish, whereas larger fish tend to seek optimal rearing and refuge conditions in deeper water and off shore habitats.

Tide and flood gate replacement or retrofit activities can result in direct and indirect impacts to fish. Replacement of tide gate “tubes” or culvert pipes is typically completed during the late summer to early fall months to coincide with the occurrence of extreme low tides during daylight hours behind cofferdams. Direct impacts include physical and/or chemical trauma to the fish that can result in injury or death. Whenever a watercourse is excavated with motorized equipment, fish can be killed or injured. Fish can be physically removed from the watercourse in the bucket of the excavator and discarded on the shoreline. The excavator bucket can also physically injure fish. Fish can also be chemically injured or killed through the inadvertent discharge of concrete leachate, or hydraulic fluid, gas, or diesel oil into the watercourse from the motorized equipment.

Indirect impacts are temporary and do not directly kill or injure fish. Indirect impacts disturb and/or alter the watercourse and shoreline habitats upon which fish depend for rearing and refuge, thus compromising their rearing ability and their potential to survive. Removing riparian and aquatic vegetation from the watercourse temporarily reduces detritus input into the watercourse and reduces the production of important epibenthic and benthic invertebrates and the availability of terrestrial insects that are important fish prey. The removal of riparian vegetation that provides shade to a watercourse also elevates water temperatures and can stress, displace or kill fish. Excavation of the watercourse (physically removing the aquatic vegetation) results in the temporary loss of refuge and cover habitat. Excavating the watercourse or disturbing the shoreline increases suspended sediments in the watercourse and temporarily reduces the light available for photosynthesis, thus reducing the production of aquatic vegetation. This activity also removes or buries epibenthic and benthic invertebrates that are important fish prey.

As described in section 2.2.2 of this opinion, coastal marsh lands have been extensively altered in the SONCC, OC, WLC, and PS recovery domains by the installation of dikes and tidegates to protect developments or to create pasturelands or land for development. In addition to the loss of these wetlands, fish passage into waterways has been adversely affected. While not a substitution for complete removal, replacing or retrofitting old tide gates with structures that are designed to increase the hydraulic connections between waterways will improve water quality, habitat conditions, and fish passage into coastal marsh habitat.

With NMFS oversight and approval, new tide gates and associated culverts and will be designed to allow fish passage through a substantially greater portion of the tidal cycle.

2.4.1 Effects of the Action on ESA-Listed Salmon and Steelhead

The most intense adverse effects of the proposed action result from in- or-near-water construction, *e.g.*, stream crossing replacement projects and channel reconstruction/relocation. Physical and chemical changes in the environment associated with construction, especially decreased water quality (*e.g*., increased total suspended solids, contaminants, and temperature, and decreased dissolved oxygen) likely affect a larger area than direct interactions between fish and construction personnel. PDC related to in-water work timing, sensitive area protection, fish passage, erosion and pollution control, choice of equipment, in-water use of equipment, and work area isolation have been proposed to avoid or reduce these adverse effects. Those measures will ensure that USFWS and NOAA RC will (1) not undertake restoration at sites occupied by spawning adult fish or where occupied redds are present, (2) defer construction until the time of year when the fewest fish are present, and (3) otherwise ensure that the adverse environmental consequences of construction are avoided or minimized.

It is unlikely that individual adult or embryonic salmon or steelhead will be adversely affected by the proposed action because all in-water construction will be deferred until after spawning season has passed and fry have emerged from gravel. However, in some locations, where adult salmon or steelhead may be present during part of the in-water work, and juvenile steelhead may still be emerging from the gravel. Therefore, a judgment call will need to be made by NMFS to determine the best timing. The use of heavy equipment in-stream in spawning areas will likely disturb or compact spawning gravel. Upland erosion and sediment delivery will likely increase substrate embeddedness. These factors make it harder for fish to excavate redds, and decrease redd aeration (Cederholm *et al.* 1997). However, the degree of instream substrate compaction and upland soil disturbance likely to occur under most of these actions is so small that significant sedimentation of spawning gravel is unlikely. If, for some reason, an adult fish is migrating in an action area during any phase of construction, it is likely to be able to successfully avoid construction disturbances by moving laterally or stopping briefly during migration, although spawning itself could be delayed until construction was complete (Feist *et al.* 1996; Gregory 1988; Servizi and Martens 1991; Sigler 1988). To the extent that the proposed actions are successful at improving flow conditions and reducing sedimentation, future spawning success, and embryo survival in the action area will be enhanced.

In contrast to adult and embryonic fish that will likely be absent during implementation of projects, juvenile salmonids will be present at many or most of the restoration sites. At in- or near-water construction projects (*e.g.*, stream crossing replacement projects, channel reconstruction/relocation*),* some direct effects of the proposed actions are likely be caused by the isolation of in-water work areas, although other combined lethal and sublethal effects would be greater without the isolation. An effort will be made to capture all juvenile fish present within the work isolation area and to release them at a safe location, although some juvenile fish will likely evade capture and later die when the area is dewatered. Fish that are captured and transferred to holding tanks can experience trauma if care is not taken in the transfer process.

Fish can also experience stress and injury from overcrowding in traps, if the traps are not emptied on a regular basis. The primary contributing factors to stress and death from handling are: (1) Water temperature difference between the river and holding buckets; (2) dissolved oxygen conditions; (3) the amount of time that fish are held out of the water; and (4) physical trauma. Stress from handling increases rapidly if water temperature exceeds 18ºC (64ºF), or if dissolved oxygen is below saturation. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis. PDC related to the capture and release of fish during work area isolation will avoid most of these consequences, and ensure that most of the resulting stress is short-lived (Portz 2007).

Rapid changes and extremes in environmental conditions caused by construction are likely to cause a physiological stress response that will change the behavior of juvenile fish (Moberg 2000; Shreck 2000). For example, reduced input of particulate organic matter to streams, addition of fine sediment to channels, and mechanical disturbance of shallow-water habitats are likely to cause displacement from, or avoidance of, preferred rearing areas. Actions that affect stream channel widths are also likely to impair local movements of juvenile fish for hours, days, or longer. Downstream migration will also likely be impaired. These adverse effects vary with the particular life stage, the duration and severity of the stressor, the frequency of stressful situations, the number and temporal separation between exposures, and the number of contemporaneous stressors experienced (Newcombe and Jensen 1996; Shreck 2000).

Juvenile fish compensate for, or adapt to, some of these disturbances so that they continue to perform necessary physiological and behavioral functions, although in a diminished capacity. However, fish that are subject to prolonged, combined, or repeated stress by the effects of the actions, combined with poor environmental baseline conditions, will likely suffer metabolic costs that are sufficient to impair their rearing, migrating, feeding, and sheltering behaviors and thereby increase the likelihood of injury or death. Because juvenile fish in the project areas are already subject to stress as a result of degraded watershed conditions, it is likely that a small number of those individuals will die due to increased competition, disease, and predation, and reduced ability to obtain food necessary for growth and maintenance (Moberg 2000; Newcombe and Jensen 1996; Sprague and Drury 1969). As explained more fully below in the *Amount or Extent of Take* section, approximately 499 juveniles are allowed to be injured or killed per year during in-water work area isolation across the region.

In addition to the short-term adverse effects of construction on listed species described above, each type of action will also have long-term effects to individual fish. Each proposed action will increase the amount of habitat available and promote the development of more natural riparian and stream channel conditions to improve aquatic functions and become more productive. This will allow more complete expression of essential biological behaviors related to reproduction, feeding, rearing, and migration. If habitat abundance or quality is a limiting factor for ESA-listed fish in streams, the long-term effects of access to larger or more productive habitat is likely to increase juvenile survival and adult reproductive success. However, individual response to habitat improvement will also depend on factors, such as the quality and quantity of newly available habitat, and the abundance and nature of the predators, competitors, and prey that reside there.

Instantaneous measures of population characteristics, such as population abundance, population spatial structure and population diversity, are the sum of individual characteristics within a particular area, while measures of population change, such as population growth rate, are measured as the productivity of individuals over the entire life cycle (McElhany *et al.* 2000). Thus, although the expected loss of a small number of individuals will have an immediate effect on population abundance at the local scale, the effect will not extend to measurable population change unless it reaches a scale that can be observed over an entire life cycle.

Because the juvenile-to-adult survival rate for salmon and steelhead is generally very low, the effects of a proposed action would have to kill hundreds or even thousands of juvenile fish in a single population before those effects would be equivalent even to a single adult, and would have to kill many times more than that to affect the abundance or productivity of the entire population over a full life cycle. Moreover, because the geographic area that will be affected by the proposed programmatic action is so large, juvenile fish that are likely to be killed are from more than 300 independent populations. The adverse effects of each proposed individual action will be too infrequent, short-term, and limited to kill more than a small number of juvenile fish at a particular site or even across the range of a single population, much less when that number is even partly distributed among all populations within the action area. Thus, the proposed actions will simply kill too few fish, as a function of the size of the affected populations and the habitat carrying capacity after each action is completed, to meaningfully affect the primary VSP attributes of abundance or population growth rate for any single population. This is also true for very small populations of endangered species considered in this opinion, *i.e*., UCR spring-run Chinook salmon and SR sockeye salmon, for which a combination of low abundance, river-type ecology, and a distribution within the action area that is restricted to the mainstem of the

Columbia River make it unlikely that individuals from those species will be injured or killed by the proposed action.

The remaining VSP attributes are within-population spatial structure, a characteristic that depends primarily on spawning group distribution and connectivity, and diversity, which is based on a combination of genetic and environmental factors (McElhany *et al.* 2000). Because the proposed actions are only likely to have short-term adverse effects to spawning sites, if any, and in the long term will improve spawning habitat attributes, they are unlikely to adversely affect spawning group distributions or within-population spatial structure. Actions that restore fish passage will improve population spatial structure. Similarly, because the proposed action does not affect basic demographic processes through human selection, alter environmental processes by reducing environmental complexity, or otherwise limit a population's ability to respond to natural selection, the action will not adversely affect population diversity.

At the species level, biological effects are synonymous with those at the population level or, more likely, are the integrated demographic response of one or more subpopulations (McElhany *et al.* 2000). Because the likely adverse effects of any action funded or carried out under this opinion will not adversely affect the VSP characteristics of any salmon or steelhead population, the proposed actions also will not have any a measurable effect on species-level abundance, productivity, or ability to recover.

Of the ESA-listed species considered in this opinion, only juvenile salmon and steelhead are likely to be captured during work area isolation. The effects of proposed action, as a whole, on the 19 species of salmon and steelhead considered in this opinion will be the combined effects of all of the individual actions that are funded or carried out under this opinion. Combining the effects of many actions does not change the nature of the effects caused by individual actions, but does require an analysis of the additive effects of multiple occurrences of the same type of effects at the individual fish, population, and species scales. If the adverse effects of one action are added to the effects of one or more additional actions in the same place and time, individual fish will likely experience a more significant adverse effect than if only one action was present. This would occur when the action area for two or more restoration actions overlap, *i.e.,* are placed within 100 to 300 feet of each other and are constructed at approximately the same time.

The peak number of projects reviewed under the USFWS and NOAA RC programmatic opinion was 25 in 2012. Over the period 2010-2012, the average number of projects per year authorized by the USFWS and NOAA RC has been about 21 projects, with 17 or fewer projects in any recovery domain. USFWS, which only does restoration projects in Oregon and Southwest Washington, and NOAA RC focused most of their attention on the IC and OC recovery domains. With several additional action categories (channel reconstruction, dam removal, beaver restoration) included in this opinion, we anticipate there will be 126 or fewer total restoration projects per year, with 62 or fewer projects in a single recovery domain, under this opinion. Based on past experience, in most domains far fewer projects will likely be implemented (Table 2).

Numbers of projects will likely decrease if funding becomes less available and the obvious restoration sites are completed and only more comprehensive large scale projects, such as channel reconstruction/relocation projects, are implemented. The likelihood of additive effects on species at the program level due to projects occurring in close proximity within the same watershed, or even within sequential watersheds, is very remote, whether those effects are adverse or beneficial. It is very unlikely that two or more projects will occur within 100 to 300 feet of each other. Measured as miles of streambank disturbance, the average physical impact of these projects combined is small compared to the total number of miles of critical habitat available in each recovery domain.

The strong emphasis on use of proposed PDC to minimize the short-term adverse effects of these actions, the small size of individual action areas, and the design of actions that are likely to result in a long-term improvement in the function and conservation value of each action area will ensure that individual fish will not suffer greater adverse effects if two or more action areas do overlap. Moreover, the rapid onset of beneficial effects from these types of actions is likely to improve the baseline for subsequent actions so that adverse effects are not likely to be additive at the population or watershed scale.

2.4.2 Effects of the Action on ESA-Listed Eulachon

Eulachon are limited to a relatively few subtidal and intertidal areas, but they return to those areas with a presumed fidelity that indicates close association between a particular stock and its spawning environment (Gustafson *et al.* 2011; Gustafson *et al.* 2010). In the Columbia, major spawning runs occur in the mainstem lower Columbia and Cowlitz rivers with periodic runs appearing in the Grays, Skamokawa, Elochoman, Kalama, Lewis, and Sandy rivers. Washington rivers outside the Columbia Basin where eulachon have been known to spawn include the Bear, Naselle, Nemah, Wynoochee, Quinault, Queets, and Nooksack rivers. Oregon waterbodies include the Winchuck, Chetco, Pistol, Rogue, Elk, Sixes, Coquille, Coos, Siuslaw, Umpqua, and Yaquina rivers; and Hunter, and Euchre rivers, Tenmile Creek (draining Tenmile Lake), and Tenmile Creek (near Yachats, Oregon) (Gustafson *et al.* 2010). Spawning occurs between December and June with the majority of the run occurring over a 20-day period. Eggs hatch in 3 to 8 weeks depending on temperature, and larvae are transported rapidly by spring freshets to estuaries. Normal timing of migration coincides with the rainy season when few activities will occur and exposure to suspended sediment and other polluted runoff will be diluted (Gustafson *et al.* 2011; Gustafson *et al.* 2010). Of the numerous potential threats throughout every stage of their life cycle that eulachon face, shoreline construction effects and water quality would be ranked low compared to other factors.

Effects to eulachon will primarily result from instream and streambank work on the few streams where they occur. Impacts will be similar to those described for salmon and steelhead that are listed above. Because the likely adverse effects of any action funded or carried out under this opinion will not adversely affect the VSP characteristics of any eulachon population, the proposed actions also will not have any measurable effect on species-level abundance, productivity, or ability to recover.

2.4.3 Effects of the Action on Designated Critical Habitat

Each individual project, completed as proposed, including full application of the design criteria for restoration, is likely to have effects on critical habitat PCEs or physical and biological features. These effects will vary somewhat in degree between actions because of differences in the scope of construction at each, and in the current condition of PCEs and the factors responsible for those conditions. This assumption is based on the fact that all of the actions are based on the same set of underlying restoration actions, and the PCEs and conservation needs identified for each species are also essentially the same. In general, ephemeral effects are likely to last for hours or days, short-term effects are likely to last for weeks, and long-term effects are likely to last for months, years or decades. The intensity of each effect, in terms of change in the PCE from baseline condition, and severity of each effect, measured as recovery time, will vary somewhat between projects because of differences in the scope of the work. However, no individual restoration project is likely to have any effect on PCEs that is greater than the full range of effects summarized here.

No more than 17 restoration actions in a single recovery domain (IC) were completed using the USFWS and NOAA RC opinions in a single year (2012). As noted above, we anticipate there will be 62 or fewer restoration projects completed under this opinion in a single recovery domain, in a single year, and most domains will have many fewer. This number of projects is already small compared to the total number of watersheds in each recovery domain, but the intensity of those project effects appears far smaller when considered as a function of their average streamside footprint. The streamside footprint that will be temporarily disturbed by the full program each year corresponds to the area where almost all direct construction impacts will occur.

Because the area affected for individual projects is small, the intensity and severity of the effects described is relatively low, and their frequency in a given watershed is very low, any adverse effects to PCE conditions and conservation value of critical habitat at the site level or reach level are likely to quickly return to, and improve beyond, critical habitat conditions that existed before the action. Moreover, projects completed under the proposed program are also reasonably certain to lead to some degree of ecological recovery within each action area, including the establishment or restoration of environmental conditions associated with functional aquatic habitat and high conservation value. This is because each action is likely to partially or fully correct improper or inadequate engineering designs in ways that will help to restore lost habitat, improve water quality, reduce upstream and downstream channel impacts, improve floodplain connectivity, and reduce the risk of structural failure. Improved fish passage through culverts and more functional floodplain connectivity, in particular, may have long-term beneficial effects.

As noted above, the indirect effects, or effectiveness, of habitat restoration actions, in general, have not been well documented, in part because they often concentrate on instream habitat without addressing the processes that led to the loss of the habitat (Cederholm *et al.* 1997; Fox 1992; Simenstad and Thom 1996; Zedler 1996). Nonetheless, the careful, interagency process used by the USFWS and NOAA RC to develop the proposed program ensures that it is reasonably certain to lead to some degree of ecological recovery within each project area, including the establishment or restoration of environmental conditions associated with functional habitat and high conservation value.

Summary of the effects of the action on salmon and steelhead critical habitat PCEs:

1. Freshwater spawning sites
    a. Substrate – Short-term reduction in quality due to increased compaction and sedimentation; long-term increase in quality due to gravel placement, and increased sediment storage from boulders and LW.
    b. Water quantity – Brief reduction in flow due to short-term construction needs, reduced riparian permeability and increased riparian runoff due to compaction, and reduced late season flows; slight longer-term increase based on improved riparian function and floodplain connectivity.
    c. Water quality – Short-term increase in total suspended solids, contaminants, dissolved oxygen demand, and temperature due to riparian and channel disturbance; longer-term improvement due to improved riparian function and floodplain connectivity.
2. Freshwater rearing sites
    a. Floodplain connectivity – Short-term decrease due to increased compaction and riparian disturbance; long-term improvement due to off- and side channel habitat restoration, set-back of existing berms, dikes, and levees, and removal of water control structures.
    b. Forage – Short-term decrease due to riparian and channel disturbance, and water quality impairments; long-term improvement due to improved habitat diversity and complexity, improved riparian function and floodplain connectivity, and increased litter retention.
    c. Natural cover – Short-term decrease due to riparian and channel disturbance; long-term increase due to improved habitat diversity and complexity, improved riparian function and floodplain connectivity, and off- and side channel habitat restoration.
    d. Water quantity – as above.
    e. Water quality – as above.
3. Freshwater migration corridors
    a. Free passage – Short-term decrease due to decreased water quality and in-water work isolation; long-term increase due to fish passage barrier removal, improved water quantity and quality, habitat diversity and complexity, forage to support juvenile migration, and natural cover.
    b. Natural cover – as above
    c. Water quantity – as above
    d. Water quality – as above
4. Estuarine areas
    a. Forage – as above
    b. Free passage – as above
    c. Natural cover – as above
    d. Salinity – no effect
    e. Water quality – as above
    f. Water quantity – as above

5. Nearshore marine areas
    a. Forage – Short-term decrease due to beach restoration activities. Long term increase as a result of beach restoration activities.
    b. Free passage – Short-term decrease due to beach restoration activities. Long term increase as a result of beach restoration activities.
    c. Natural cover – Short-term decrease due to beach restoration activities. Long term increase as a result of beach restoration activities.
    d. Water quantity – no effect
    e. Water quality – Short-term decrease due to beach restoration activities.
6. Offshore marine areas – These PCEs do not occur in the action area.

Summary of the effects of the action on eulachon critical habitat physical and biological features: Critical habitat for eulachon includes: (1) Freshwater spawning and incubation sites with water flow, quality and temperature conditions and substrate supporting spawning and incubation, and with migratory access for adults and juveniles; (2) freshwater and estuarine migration corridors associated with spawning and incubation sites that are free of obstruction and with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted; and, (3) nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. The effects on essential features for eulachon critical habitat are as follows:

1. Freshwater spawning sites and incubation
    a. Flow – Ephemeral reduction due to short-term construction needs, reduced riparian permeability and increased riparian runoff due to soil compaction; slight long-term increase based on improved riparian function and floodplain connectivity.
    b. Water quality – Short-term releases of suspended sediment, increased dissolved oxygen demand, and increased temperature due to riparian and channel disturbance; longer-term improvement due to improved riparian function and floodplain connectivity.
    c. Water temperature – Slight long-term increase based on improved riparian function and floodplain connectivity.
    d. Substrate – Short-term reduction in quality due to increased compaction, sedimentation and removal. Long-term benefit from the restoration of natural sediment transport.
    e. Free passage – Short-term decrease due to decreased water quality and in-water work isolation; long-term increase due to fish passage barrier removal, improved water quantity and quality, habitat diversity and complexity, and natural cover.
2. Freshwater and estuarine migration corridors
    e. Free passage – Short-term decrease due to decreased water quality and in-water work isolation; long-term increase due to fish passage barrier removal, improved water quantity and quality, habitat diversity and complexity, and natural cover.
    a. Flow – as above.
    b. Water quality – as above.
    c. Water temperature – no effect.

d. Food – no effect.

3. <u>Nearshore and offshore marine foraging areas</u>
   a. Food – no effect.
   b. Water quality – no effect.

Summary of effects to critical habitat for all listed species. USFWS and NOAA RC projects are likely to have some short-term impacts, but none of those impacts will be severe enough to impair the ability of critical habitat to support recovery. The frequency of disturbance will usually be limited to a single event or, at most, a few projects within the same watershed. It is also unlikely that several projects within the same watershed, or even within the same action area, will have a severe enough adverse effect on the function of PCEs (physical and biological features) to affect the conservation value of critical habitat in the action area, watershed, or designation area.

All of the activities are designed to have long-term beneficial effects to critical habitat. However, as noted above, the long-term effectiveness of habitat restoration actions, in general, have not been well documented. In part, this is because they often concentrate on instream habitat without addressing the processes that led to the loss of the habitat (Cederholm *et al.* 1997; Doyle and Shields 2012; Fox 1992; Roper *et al.* 1997; Simenstad and Thom 1996; Zedler 1996). Nevertheless, the proposed actions are reasonably certain to lead to some degree of ecological recovery within each action area, including the establishment or restoration of environmental conditions associated with functional habitat and high conservation value. Fish passage improvement actions, in particular, are likely to have long-term beneficial effects at the watershed or designation-wide scale (Roni *et al.* 2002).

Synthesis of Effects. The scope of each type of activity that could be authorized under the proposed restoration program is narrowly proscribed, and is further limited by PDC tailored to avoid direct and indirect adverse effects of those actions. Administrative PDC are in place to ensure that requirements related to the scope of actions allowed and the mandatory PDC operate to limit direct lethal effects on listed fish to a few deaths associated with isolation and dewatering of in-water work areas, an action necessary to avoid greater environmental harm. Most other direct adverse effects will likely be transitory and within the ability of both juvenile and adult fish to avoid by bypassing or temporarily leaving the action area. Such behavioral avoidance will probably be the only significant biological response of listed fish to the proposed restoration program. This is because areas affected by the specific projects undertaken are likely to be widely distributed (the frequency of the disturbance will be limited to a single event or, at most, a few projects within the same watershed) and small compared with the total habitat area.

As noted above (Table 2), the number of restoration actions in a single recovery domain using the prior versions of this opinion in a single year has varied greatly. During the period 2010-2012, the majority of the restoration projects (31, 49%) occurred in the IC recovery domain. However, few actions per year have occurred in a single 5th field watershed over this large region. Projects were even further separated in the other recovery domains. The intensity of the predicted effects within the action area, in terms of the total condition and value of PCEs after each action is completed, and the severity of the effects, given the recovery rate for those same PCEs, are such that the function of PCEs and the conservation value of critical habitat are likely to be only impaired for a short time due to restoration actions funded or carried out under this opinion. The PCE conditions in each action area are likely to quickly return to, or exceed, pre-action levels. Thus, it is unlikely that several actions within the same watershed, or even within the same action area, will have an important adverse effect on the function of PCEs or the conservation value of critical habitat at the action area, watershed, or designation scales. The intensity and severity of environmental effects for each project will be comprehensively minimized by targeted PDC.

2.5 Cumulative Effects

Cumulative effects are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

The contribution of non-Federal activities to the current condition of ESA-listed species and designated or proposed critical habitats within the program-level action area was described in the Status of the Species and Critical Habitats and Environmental Baseline sections, above. Among those activities were agriculture, forest management, mining, road construction, urbanization, water development, and river restoration. Those actions were driven by a combination of economic conditions that characterized traditional natural resource-based industries, general resource demands associated with settlement of local and regional population centers, and the efforts of social groups dedicated to river restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

Resource-based industries caused many long-lasting environmental changes that harmed ESA-listed species and their critical habitats, such as state-wide loss or degradation of stream channel morphology, spawning substrates, instream roughness and cover, estuarine rearing habitats, wetlands, riparian areas, water quality (*e.g.*, temperature, sediment, dissolved oxygen, contaminants), fish passage, and habitat refugia. Those changes reduced the ability of populations of ESA-listed species to sustain themselves in the natural environment by altering or interfering with their behavior in ways that reduce their survival throughout their life cycle. The environmental changes also reduced the quality and function of critical habitat PCEs that are necessary for successful spawning, production of offspring, and migratory access necessary for adult fish to swim upstream to reach spawning areas and for juvenile fish to proceed downstream and reach the ocean. Without those features, the species cannot successfully spawn and produce offspring. However, the declining level of resource-based industrial activity and rapidly rising industry standards for resource protection are likely to reduce the intensity and severity of those impacts in the future.

The economic and environmental significance of the natural resource-based economy is currently declining in absolute terms and relative to a newer economy based on mixed manufacturing and marketing with an emphasis on high technology (Brown 2011). Nonetheless, resource-based industries are likely to continue to have an influence on environmental conditions within the program-action area for the indefinite future. However, over time those industries have adopted management practices that avoid or reduce many of their most harmful impacts, as is evidenced by the extensive conservation measures included with the proposed action, but which were unknown or in uncommon use until even a few years ago.

In the Northwest, the percentage increase in population growth may provide the best estimate of general resource demands because as local human populations grow, so does the overall consumption of local and regional natural resources. For example, in Oregon natural resource extraction is declining, while general resource demands are increasing with growth in the size and standard of living of the local and regional human population (Metro 2010; Metro 2011). Between April 2010 and July 2012, the population of Oregon and Idaho both grew by 1.8% and the population of Washington State grew by 2.6%.[38] The NMFS assumes that private and state actions that have routinely occurred in the past will continue within the action area, increasing as population rises. The adverse effects of non-Federal actions stimulated by general resource demands are likely to continue in the future driven by changes in human population density and standards of living. These effects are likely to continue to a similar or reduced extent in the rural areas of the Northwest where counties are maintaining or losing population. Counties that are gaining population are likely to experience greater resource demands, and therefore more adverse environmental effects.

Oregon's land use laws and progressive policies related to long-range planning will help to limit those impacts by ensuring that concern for a healthy economy that generates jobs and business opportunities is balanced by concern for protection of farms, forests, rivers, streams and natural areas (Metro 2000; Metro 2008; Metro 2011). Washington's Growth Management Act (Washington Revised Code §§ 36.70A.010–36.70A.902) requires state and local governments to manage Washington's growth by identifying and protecting critical areas and natural resource lands, designating urban growth areas, preparing comprehensive plans and implementing them through capital investments and development regulations. The Idaho Local Land Use Planning Act (Idaho Code §§67.65) requires Idaho cities and counties to develop comprehensive plans and zoning ordinances, but Idaho does not have a state agency to ensure local implementation of comprehensive planning requirements or to provide technical assistance with local governmental planning. In addition to land use planning to minimize adverse environmental impacts, larger population centers may also partly offset the adverse effects of their growing resource demands with more river restoration projects designed to provide ecosystem-based cultural amenities, although the geographic distribution of those actions, and therefore any benefits to ESA-listed species or critical habitats, may occur far from the centers of human populations.

Similarly, demand for cultural and aesthetic amenities continues to grow with human population, and is reflected in decades of concentrated effort by Tribes, states, and local communities to restore an environment that supports flourishing wildlife populations, including populations of species that are now ESA-listed (CRITFC 1995; NMFS 2011g; NWPCC 2012; OWEB 2011). Reduced economic dependence on traditional resource-based industries has been associated with growing public appreciation for the economic benefits of river restoration, and growing demand for the cultural amenities that river restoration provides. Thus, many non-Federal actions have become responsive to the recovery needs of ESA-listed species. Those actions included efforts to

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[38] http://quickfacts.census.gov/qfd/states/16000.html, accessed April 8, 2013.

ensure that resource-based industries adopt improved practices to avoid, minimize, or offset their adverse impacts. Similarly, many actions are focused on completion of river restoration projects specifically designed to broadly reverse the major factors now limiting the survival of ESA-listed species at all stages of their life cycle. Those actions have improved the availability and quality of estuarine and nearshore habitats, floodplain connectivity, channel structure and complexity, riparian areas and LW recruitment, stream substrates, stream flow, water quality, and fish passage. In this way, the goal of ESA-listed species recovery has become institutionalized as a common and accepted part of the economic and environmental culture. We expect this trend to continue into the future as awareness of environmental and at-risk species issues increases among the general public.

It is not possible to predict the future intensity of specific non-Federal actions related to resource-based industries at this program scale due to uncertainties about the economy, funding levels for restoration actions, and individual investment decisions. However, the adverse effects of resource-based industries in the action area are likely to continue in the future, although their net adverse effect is likely to decline slowly as beneficial effects spread from the adoption of industry-wide standards for more protective management practices. These effects, both negative and positive, will be expressed most strongly in rural areas where these industries occur, and therefore somewhat in contrast to human population density. The future effects of river restoration are also unpredictable for the same reasons, but their net beneficial effects may grow with the increased sophistication and size of projects completed and the additive effects of completing multiple projects in some watersheds.

In summary, resource-based activities such as timber harvest, agriculture, mining, shipping, and energy development are likely to continue to exert an influence on the quality of freshwater and estuarine habitat in the action area. The intensity of this influence is difficult to predict and is dependent on many social and economic factors. However, the adoption of industry-wide standards to reduce environmental impacts and the shift away from resource extraction to a mixed manufacturing and technology based economy should result in a gradual decrease in influence over time. In contrast, the population of the Pacific Northwest is expected to increase in the next several decades with a corresponding increase in natural resource consumption. Additional residential and commercial development and a general increase in human activities are expected to cause localized degradation of freshwater and estuarine habitat. Interest in restoration activities is also increasing as is environmental awareness among the public. This will lead to localized improvements to freshwater and estuarine habitat.

When considered together, these cumulative effects are likely to have a small negative effect on salmon and steelhead population abundance, productivity, and some short-term negative effects on spatial structure (short-term blockages of fish passage). Similarly, the condition of critical habitat PCEs will be slightly degraded by the cumulative effects.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step of NMFS' assessment of the risk posed to species and critical habitat as a result of implementing the proposed program. In this section, we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) to formulate the agency's opinion as to whether the proposed program is likely to: (1) Result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2).

2.6.1 Species at the Population Scale

The status of each species addressed by this consultation varies considerably from very high risk (SR sockeye salmon) to moderate risk (*e.g.,* OC coho salmon, MCR steelhead). Similarly, the hundreds of individual populations affected by the proposed program vary considerably in their biological status. The species addressed in this opinion have declined due to numerous factors. The one factor for decline that all these species share is degradation of freshwater and estuarine habitat. Human development of the Pacific Northwest has caused significant negative changes to stream and estuary habitat across the range of these species. The environmental baseline varies across the program area, but habitat will generally be degraded at sites selected for restoration actions.

The programmatic nature of the action prevents a precise analysis of each action that eventually will be funded or carried out under this opinion, although each type of action will be carefully designed and constrained by comprehensive design criteria such that the proposed activities will cause only short-term, localized, and minor effects. Also, actions are likely to be widely distributed across all recovery domains in Oregon, Washington, and Idaho, so adverse effects will not be concentrated in time or space within the range of any listed species. In the long term, these actions will contribute to a lessening of many of the factors limiting the recovery of these species, particularly those factors related to fish passage, degraded floodplain connectivity, reduced aquatic habitat complexity, and riparian conditions, and improve the currently-degraded environmental baseline, particularly at the site scale. A very small number of individual fish, far too few to affect the abundance, productivity, distribution, or genetic diversity of any salmon or steelhead population, will be affected by the adverse effects of any single action permitted under the proposed action. Because the VSP characteristics at the population scale will not be affected, the likelihood of survival and recovery of the listed species will not be appreciably reduced by the proposed action.

As described in Section 2.2, individuals of many ESA-listed salmon and steelhead species and eulachon use the program action area to fully complete the migration, spawning and rearing parts of their life cycle; some salmon, steelhead, and eulachon migrate and rear in the program action area; and some species only migrate through, once as out-migrating juveniles and then again as adult fish on upstream spawning migration. The viability of the various populations that comprise the 20 species considered in this opinion ranges from extirpated or nearly so to populations that are a low risk for extinction. Southern eulachon population abundance has declined significantly since the early 1990s and there is no evidence to date of their returning to former population levels. Although NMFS considers variation in ocean productivity to be the most important natural phenomenon affecting the productivity of these species, NMFS identified many other factors associated with the freshwater phase of their life cycle that are also limiting the recovery of these species. These factors include, but are not limited to, elevated water temperatures; excessive sediment; reduced access to spawning and rearing areas; reductions in habitat complexity, instream wood, and channel stability; degraded floodplain structure and function, and reduced flow. Tributary habitat actions are typically geared to improving spawning and rearing habitat, providing habitat access, and enhancing in-stream flows. Estuary habitat actions are implemented with a goal of improving survival for all populations. Estuary actions include protecting and restoring riparian and off-channel habitat, reconnecting flood plains, increasing fish access to productive habitat, and reducing predation. In general, actions carried out under the proposed program will address and help to alleviate many of these limiting factors. Cumulative effects described in section 2.5 are likely to have a small short-term negative effect on salmon and steelhead population abundance, productivity, and some short-term negative effects on spatial structure (short-term blockages of fish passage).

2.6.2 Critical Habitat at the Watershed Scale

Many streams in the action area are designated as critical habitat for ESA-listed salmon, steelhead, and eulachon. The physical and biological features of salmon and steelhead critical habitat in the action area are freshwater spawning, freshwater rearing, adult and juvenile migration corridors, and estuarine habitat. The features of eulachon critical habitat that are likely to be affected by projects completed under the proposed program are freshwater spawning and incubation habitat, and freshwater migration. Climate change and human development have and continue to adversely affect critical habitat, creating limiting factors and threats to the recovery of the ESA listed species.

Information in Section 2.3 described the environmental baseline in the action area as widely variable but NMFS assumes that restoration projects will occur at sites where the environmental baseline does not fully meet the biological requirements of individual fish due to the presence of impaired fish passage, floodplain fill, streambank degradation, or degraded riparian conditions. Similarly, it is likely that the environmental baseline is also not meeting the biological requirements of individual fish of ESA-listed species at sites where restoration projects will occur due to one or more impaired aquatic habitat functions related to any of the habitat factors limiting the recovery of the species in that area, but the quality of critical habitat at those sites is likely to be improved due to completion of the restoration projects.

Habitat improvement projects are being actively implemented through salmon recovery efforts, the FCRPS, and a combination of Federal, tribal, state and local actions. At the same time population growth and development pressures on aquatic systems are increasing, particularly in the Willamette Valley. The extent to which these trends may further reduce populations, degrade the quality and function of critical habitat, or preclude some restoration actions, is unknown.

As described in Section 2.4, most short-term effects of restoration actions on ESA-listed fish and designated critical habitat include effects related to erosion and runoff from the construction site, work area isolation, and the use of herbicides. Each project that eventually will be implemented under this opinion will be carefully designed and constrained by conservation measures such that construction impacts of restoration projects will cause only short-term, localized, and minor effects. The longer-term impacts of restoration projects are likely to include corrections of engineering flaws in existing stream crossings that do not currently allow for adequate fish passage or the functional riparian area or floodplains.

Restoration projects will have short-term impacts due to construction, but long-term will contribute to reducing many of the factors limiting the recovery of these species including fish passage, floodplain connectivity and function, channel structure and complexity, and riparian vegetation and streambank conditions.

As noted in Sections 2.2 and 2.3, climate change is likely to affect all species considered in this opinion and their habitat in the program area. These effects are expected to be positive and negative, but are likely to result in a generally negative trend for stream flow and temperature.

As described in Section 2.5, the cumulative effects of state and private actions that are reasonably certain to occur within the action area are also variable across the program action area. In urban areas there will be continued population growth, but redevelopment will begin to improve negative baseline conditions. Agricultural and forestry practices in rural areas will also likely become restorative in nature. Federal efforts to improve aquatic habitat conditions throughout the action area will gradually improve habitat conditions overall.

In summary, projects completed under the proposed program will result in relatively intense but brief disturbances to a small number of areas distributed throughout each recovery domain, but these disturbances will not appreciably reduce or prevent the increase of abundance or productivity of the populations addressed by this consultation. This is because: (1) Effects from construction-related activities are short-term and temporary, (2) a very small portion of the total number of fish in any one population will be exposed to the adverse effects of the proposed action, and (3) the geographic extent of the adverse effects is small when compared to the size of any watershed where an action will occur or the total area occupied by any of the species affected. Similarly, projects completed under the proposed program will not affect the diversity of any populations or species because the effects of the action will not adversely affect factors that primarily influence population diversity such as management of hatchery fish or selective harvest practices. Projects that improve fish passage may improve population spatial structure. By contributing to improved habitat conditions that will, over the long term, support populations with higher abundance and productivity, projects completed under the proposed program are consistent with the recovery strategies of increasing productivity and spatial diversity, a critical step toward recovery of these species as whole.

The conservation value of critical habitat within the action area for salmon and steelhead varies by life history strategy, and is higher for species with stream-type histories than for the ocean-type. That is because the latter group is more reliant on shallow-water habitats and small tributaries that are easily affected by a wide range of natural and human disturbances.
In Oregon, critical habitat for eulachon is designated in the Lower Columbia River, Umpqua River, Ten Mile Creek, and the Sandy River. In Washington, critical habitat for eulachon is designated in the Grays River, Skamokawa Creek, Cowlitz River, Toutle River, Kalama River, Lewis River, Quinault River, and Elwha River. For habitat in the Columbia River, the size of the river helps to intercept and buffer the short-term impact of construction actions, and to attenuate

the benefits of local restoration, although it is likely that increasing the conservation function of estuaries will be a focus of future restoration projects.

For the most part, the conservation value of these critical habitats is high and the projects completed under the proposed program will have minor short-term effects on the quality and function of critical habitat PCEs. The full set of management measures proposed by the USFWS and NOAA RC will ensure that these short-term effects to PCEs remain minimal. As restoration projects accumulate over time, habitat conditions may improve and critical habitat will be able to better serve its intended conservation role, supporting viable populations of ESA-listed salmon, steelhead, and eulachon.

Thus, the proposed program is not likely to result in appreciable reductions in the likelihood of both survival and recovery of listed species by reducing their numbers, reproduction, or distribution; or reduce the value of designated or proposed critical habitat for the conservation of the species.

2.7 Conclusion

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of LCR Chinook salmon, UWR spring-run Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, PS Chinook salmon, CR chum salmon, Hood Canal summer-run chum salmon, LCR coho salmon, OC coho salmon, SONCC coho salmon, SR sockeye salmon, LO sockeye salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, PS steelhead, or southern DPS eulachon, or result in the destruction or adverse modification of critical habitat that has been designated for these species.

We also conclude that the proposed action will not adversely modify critical habitat proposed for LCR coho salmon and PS steelhead. You may ask NMFS to adopt the conference opinion as a biological opinion when critical habitat for LCR coho salmon and PS steelhead is designated. The request should be in writing. If we review the proposed action and find there have been no significant changes to the action that would alter the contents of the opinion and no significant new information has been developed (including during the rulemaking process), we may adopt the conference opinion as the biological opinion on the proposed action and no further consultation will be necessary.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take

is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.
For this consultation, we interpret "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behaviors to a point where such behaviors are abandoned or significantly altered.[39] Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

2.8.1 Amount or Extent of Take

Work necessary to construct and maintain the restoration projects that will be authorized or carried out each year under this opinion will take place beside and within aquatic habitats that are reasonably certain to be occupied by individuals of the 20 ESA-listed species considered in this opinion. As described below, each type of restoration action is likely to cause incidental take of one or more of those species. Juvenile life stages are most likely to be affected, although adults will sometimes also be present when the actions occur in coastal areas or the Willamette Valley, and when actions do not involve work within the active channel and therefore may not be constrained by application of an in-water work window.

Juvenile fish will be captured during work area isolation necessary to minimize construction-related disturbance of streambank and channel areas caused by fish passage restoration; dam, tide gate, and legacy structure removal; channel reconstruction/relocation; off- and side-channel habitat restoration; and set-back or removal of existing berms, dikes, and levees. In-stream disturbance that cannot be avoided by work area isolation will lead to short-term increases in suspended sediment, temperature, dissolved oxygen demand, or other contaminants, and an overall decrease in habitat function that harms adult and juvenile fish by denying them normal use of the action area for reproduction, rearing, feeding, or migration. Exclusion from preferred habitat areas causes increased energy use and an increased likelihood of predation, competition and disease that is reasonably likely to result in injury or death of some individual fish.

Similarly, adult and juvenile fish will be harmed by construction-related disturbance of upland, riparian and in-stream areas for actions related to LW, boulder, and gravel placement; streambank restoration; reduction/relocation of recreation impacts; livestock fencing, stream crossings and off-channel livestock watering; piling and other structure removal; in-channel nutrient enhancement; road and trail erosion control and decommissioning; non-native invasive plant control; juniper removal; riparian vegetation treatment (controlled burning); riparian vegetative planting; bull trout protection; beaver habitat restoration; physical and biological surveys; and related in-stream work.

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[39] NMFS has not adopted a regulatory definition of harassment under the ESA. The World English Dictionary defines harass as "to trouble, torment, or confuse by continual persistent attacks, questions, *etc*." The U.S. Fish and Wildlife Service defines "harass" in its regulations as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). The interpretation we adopt in this consultation is consistent with our understanding of the dictionary definition of harass and is consistent with the Service's interpretation of the term.

The effects of those actions will include additional short-term reductions in water quality, as described above, and will also harm adult and juvenile fish as described above. Herbicide applications will result in herbicide drift or transportation into streams that will harm listed species by chemically impairing normal fish behavioral patterns related to feeding, rearing, and migration. These effects are also reasonably likely to result in injury or death of some individual fish.

Projects that require two or more years of work to complete will cause adverse effects that last proportionally longer, and effects related to runoff from the project site may be exacerbated by winter precipitation. These adverse effects may continue intermittently for weeks, months, or years until riparian vegetation and floodplain vegetation are restored and a new topographic equilibrium is reached. Incidental take that meets the terms and conditions of this incidental take statement will be exempt from the taking prohibition.

Capture of Juvenile Fish During In-water Work Area Isolation

With the additional Partners programs in Washington and Idaho, as well as additional activity categories, NMFS assumes that a greater number of projects will be completed annually under this opinion than under the 2009 opinions. With the Washington and Idaho Partners programs covered by this opinion, additional aquatic restoration actions will occur in the PS, WLC, and IC recovery domains. Therefore, to account for an expected increase in projects we will assume that twice as many actions as the maximum number of projects per year from 2010-2012 will be funded or carried out in each of recovery domains per year under this opinion.

During the period 2010-2012, USFWS-Oregon and NOAA RC reported that they funded or carried out 63 restoration actions per year using the October 21 and 22, 2009, opinions. Those actions were distributed as follows: PS 5%, WLC 11%, IC 49%, OC 33%, and SONCC 2% (Table 2). With the Washington Partners Program projects added to the total we could see many more projects in the PS recovery domain (31). We estimate that there will be nearly as many aquatic restoration projects in Washington as there have been in all of Oregon. Therefore, with the programs combined under this opinion, the number of projects will likely double.

Under the 2009 opinions, over half of all the actions reported involve fish passage restoration (Table 3), and often secondary actions such as instream wood or streambank restoration. Thus, under this scenario, about 126 projects will likely be completed across the region per year. We assume that 60% of those projects (*i.e.*, 76 actions per year) will require inwater work with fish capture. USFWS (Oregon) and NOAA RC had an average capture of approximately 132 ESA-listed salmon and steelhead per project for the 35 projects where isolation and dewatering was required (NMFS 2009c; NMFS 2009d). No eulachon were captured in these fish salvage operations.

Of the ESA-listed salmonids to be captured and handled, less than 2% are likely to be injured or killed, including by delayed mortality, and the remaining 98% will likely survive with no long-term adverse effects. Thus, NMFS anticipates that no eulachon and up to 9,978 juvenile individuals of the salmon and steelhead species[40] considered in the consultation will be captured, per year, and up to 200 juvenile individuals will be injured or killed, per year, (*i.e*., 2% of 9,978 = 200) as a result of fish capture necessary to isolate in-water construction areas.

Nonetheless, a more expansive estimate of 5% average annual lethal take (*i.e.,* 5% of 9,978 = 499) will be used here to allow for variations in experience and work conditions. Because these fish are from different species that are similar to each other in appearance and life history, and to unlisted species that occupy the same area, it is not possible to assign this take to individual species. NMFS will, however, allocate this take proportionally across recovery domain areas, as it is more practical to predict which fish will be present in these defined areas. Consultation will be reinitiated if the amount or extent of take is exceeded for any domain.

An estimate of the maximum effect that capture and release operations for projects authorized or completed under this opinion will have on the abundance of adult salmon and steelhead in each recovery domain was obtained as follows: A = n(pct), where:

A = number of adult equivalents "killed" each year
n = number of projects likely to occur in a recovery domain each year
p = 132, *i.e.*, number of juveniles to be captured per project
c = 0.05, *i.e.*, rate of juvenile injury or death caused by electrofishing during capture and release, primarily steelhead and coho salmon. Consistent with observations by Cannon (2008; 2012) and data reported in McMichael *et al*. (1998).[41]
t = 0.02, *i.e.*, an estimated average smolt to adult survival ratio, see Smoker *et al*. (2004) and Scheuerell and Williams (2005). This is very conservative because many juveniles are likely to be captured as fry or parr, life history stages that have a survival rate to adulthood that is exponentially smaller than for smolts.

The number of projects (n) estimated to be implemented per recovery domain per year under this joint-opinion is expected to be greater than under the 2009 opinions because there are additional restoration categories and this opinion will include Partners Programs in Washington and Idaho. For this opinion, we doubled maximum number of projects completed from 2010 to 2012 under the 2009 opinions. We also doubled the number of projects in Puget Sound based on work by the USFWS-Washington Office Partner Program over that same period. About 60% of the 2010-2012 projects required work area isolation. The effects of work area isolation on the abundance of juvenile or adult salmon or steelhead in any population is likely to be small, no more than five adult-equivalent per year in any recovery domain (Table 33).

[40] 4,910 (PS) + 475 (WLC) + 2,693 (IC) +1,742 (OC) + 158 (SONCC) = 9,978

[41] In 2007, ODOT completed 36 work area isolation operations involving capture and release using nets and electrofishing; 12 of those operations resulted in capture of 0 Chinook salmon, 345 coho salmon, and 22 steelhead; with an average mortality of 5% (Cannon 2008). Cannon (2012) reported a mortality rate of 4.4% for 455 listed salmon and steelhead captures during 30 fish salvage operations in 2012. No sturgeon or eulachon have been captured as a result of ODOT salvage operations.

Table 33. Estimate of the amount of take by direct capture (*i.e.,* culvert replacements), per year, for projects authorized or carried out under PROJECTS, by NMFS recovery domain. "PS" means Puget Sound; "WLC" means Willamette/Lower Columbia; "IC" means Interior Columbia; "OC" means Oregon Coast; "SONCC" means Southern Oregon/Northern California Coasts; "n" means the estimated number of projects per year (126), 60% of which will require work area isolation.

Type of take	Recovery Domain				
	PS n=62	WLC n=6	IC n=34	OC n=22	SONCC n=2
Juvenile fish captured	4,910	475	2,693	1,742	158
Juvenile fish killed or injured	246	24	135	87	8
"Adult equivalents" killed or injured	4.9	0.5	2.7	1.7	0.2

NMFS does not anticipate that any adult salmon or steelhead or southern DPS eulachon will be captured as a result of work necessary to isolate in-water construction areas. SR sockeye salmon are only present in the mainstem Snake and Columbia rivers in Oregon and Washington. No members of this species will be captured while migrating through these large rivers. Therefore, no incidental take is anticipated or exempted for this species.

Harm due to habitat-related effects

Take caused by the habitat-related effects of this action cannot be accurately quantified as a number of fish because the distribution and abundance of fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by projects that will be completed under the proposed program. Thus, the distribution and abundance of fish within the program action area cannot be attributed entirely to habitat conditions, nor can NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by actions that will be completed under the proposed program. Additionally, there is no practical way to count the number of fish exposed to the adverse effects of the proposed action without causing additional stress and injury. In such circumstances, NMFS uses the causal link established between the activity and the likely changes in habitat conditions affecting the listed species to describe the extent of take as a numerical level of habitat disturbance.

Suspended sediment and contaminants. Near and instream construction activities required for many activities will result in an increase in suspended sediment and contaminants that will cause juvenile fish to move away from the action area.

Salmon, steelhead, and eulachon exposed to suspended sediment are likely to experience gill abrasion, decreased feeding, stress, or be unable to use the action area, depending on the severity of the suspended sediment release. Salmonids and eulachon exposed to petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, are likely to be killed or suffer acute and chronic sublethal effects. Construction activities will also cause a minor increase in fine sediment levels in downstream substrates, temporarily reducing the value of that habitat for spawning and rearing.

For projects involving near- and in-water construction, the extent of take due to suspended sediment and contaminants is best identified as the maximum extent of the turbidity plume generated by construction activities. The distance that take (turbidity) will extend downstream will be proportional to the size of the stream. A turbidity flux will likely be measureable downstream from a nonpoint discharge a proportionately shorter distance in small streams than large streams. Turbidity will also more likely be measureable for a greater distance for project areas that are subject to tidal or coastal scour (Rosetta 2005).

USFWS and NOAA RC will complete and record the following water quality observations to ensure that any increases in suspended sediment do not exceed background levels:

1. Take a turbidity sample using an appropriately and regularly calibrated turbidimeter, or a visual turbidity observation, every 4 hours when work is being completed, or more often as necessary to ensure that the in-water work area is not contributing visible sediment to water, at a relatively undisturbed area approximately 100 feet upstream from the project area, or 300 feet from the project area if it is subject to tidal or coastal scour. Record the observation, location, and time before monitoring at the downstream point.
2. Take a second visual observation, immediately after each upstream observation, approximately 50 feet downstream from the project area in streams that are 30 feet wide or less, 100 feet from the project area for streams between 30 and 100 feet wide, 200 feet from the discharge point or nonpoint source for streams greater than 100 feet wide, and 300 feet from the discharge point or nonpoint source for areas subject to tidal or coastal scour. Record the downstream observation, location, and time.
3. Compare the upstream and downstream observations. If more turbidity or pollutants is/are observed downstream than upstream, the activity will be modified to reduce pollution. Continue to monitor every 4 hours.
4. If the exceedance continues after the second monitoring interval (after 8 hours), the activity will stop until the levels returns to background.

The extent of take will be exceeded if the turbidity plume generated by construction activities is visible above background levels, about a 10% increase in natural stream turbidity, downstream from the project area source as follows: A visible increase in suspended sediment (as estimated using turbidity measurements) 50 feet from the project area in streams that are 30 feet wide or less, 100 feet from the discharge point or nonpoint source of runoff for streams between 30 and 100 feet wide, 200 feet from the discharge point or nonpoint source for streams greater than 100 feet wide, or 300 feet from the discharge point or nonpoint source for areas subject to tidal or coastal scour. If monitoring or inspections show that the pollution controls are ineffective, immediately mobilize work crews to repair, replace, or reinforce controls as necessary.

Construction-related disturbance of streambank and channel areas. The best available indicator for the extent of take due to construction-related disturbance of streambank and channel areas is the total length of stream reach that will be modified by construction each year. This variable is proportional to the amounts of harm that each action is likely to cause through short-term degradation of water quality and physical habitat. USFWS and NOAA RC reported for 2010 to 2012 that nearly 9 linear-miles of channel and stream banks were restored on 16 restoration projects, which is roughly 0.56 stream miles per project. These 16 projects represented approximately one-fourth (25%) of the 63 total projects.

In this opinion, about 32 stream bank- and channel-altering actions per year (25% of 126 total projects = 31.5; rounded up to 32) may be funded or carried out under this opinion. Therefore, extent of take for construction-related disturbance of streambank and channel areas is up to 17.92 linear-miles (32 projects x 0.56 miles = 17.92 miles) (94,618 stream-feet) per year.

Application of herbicides to control invasive and non-native plant species. Application of manual, mechanical, biological or chemical plant controls will result in short-term reduction of vegetative cover, soil disturbance, and degradation of water quality, which will cause injury to fish in the form of sublethal adverse physiological effects. This is particularly true for herbicide applications in riparian areas or in ditches that may deliver herbicides to streams occupied by listed salmonids. These sublethal effects, described in the effects analysis for this opinion, will include increased respiration, reduced feeding success, and subtle behavioral changes that can result in predation. Direct measurement of herbicide transport using the most commonly accepted method of residue analysis, *e.g.*, liquid chromatography–mass spectrometry (Pico *et al.* 2004) is burdensome and expensive for the type and scale of herbicide applications proposed. Thus, use of those measurements in this take statement as an extent of take indicator is likely to outweigh any benefits of using herbicide as a simple and economical restoration tool, and act as an insurmountable disincentive to their use for plant control under this opinion. Further, the use of simpler, indirect methods, such as olfactometric tests, do not correlate well with measured levels of the airborne pesticides, and may raise ethical questions (Brown *et al.* 2000) that cannot be resolved in consultation. Therefore, the best available indicator for the extent of take due to the proposed invasive plant control is the extent of treated areas, *i.e.*, less than, or equal to, 10% of the acres of riparian habitat within a 6^{th-}field HUC per year.

In summary, the best available indicators for amount and extent of take for these proposed actions are as follows. For actions that involve:

- ***Capture of juvenile fish during in-water work area isolation*** – The amount of take is 9,978 ESA-listed fish per year.
- ***Visible suspended sediment (turbidity)*** – The extent of take indicator for suspended sediments and contaminants is no more than a 10% increase in natural stream turbidity visible beyond the discharge point or nonpoint source of runoff.
- ***Streambank and channel alteration*** – The extent of take indicator is no more than 17.92 linear-miles (94,618 stream-feet) of streambank and channel alteration per year.
- A***pplication of herbicide for invasive and non-native plant control within the riparian area*** – The extent of take indicator is a treated area of up 10% of the acres of riparian habitat within a 6^{th-}field HUC per year.

NMFS assumes that the proposed actions will continue to be distributed among the recovery domains in the same proportion as in the past and has assigned this take to individual recovery domains whenever possible (Table 34).

Table 34. Extent of take indicators for actions authorized or carried out under the PROJECTS, by NMFS recovery domain. "WLC" means Willamette/Lower Columbia; "IC" means Interior Columbia; "OC" means Oregon Coast; "SONCC" means Southern Oregon/Northern California Coasts; "n" means the estimated number of projects per year.

	Recovery Domains				
Extent of Take Indicator	PS n=62	WLC n=6	IC n=34	OC n=22	SONCC n=2
ESA-listed fish captured (number salvaged)	4,910	475	2,693	1,742	158
Visible suspended sediment (turbidity)	10% increase in natural stream turbidity				
Streambank &channel alteration (linear feet)	46,558	4,506	25,532	16,521	1,502
Herbicide applications (acres)	10% of a riparian habitat within a 6^{th}-field HUC per year				

2.8.2 Effect of the Take

In Section 2.7, NMFS determined that the level of anticipated take, coupled with other effects of the proposed program, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). The following measures are necessary and appropriate to minimize the impact of incidental take of listed species from the proposed program.

The USFWS and NOAA RC shall:

1. Minimize incidental take due to authorizing or conducting restoration projects by ensuring that all such projects use the conservation measures described in this opinion, as appropriate.
2. Ensure completion of a comprehensive monitoring and reporting program regarding all restoration projects conducted by the USFWS and NOAA RC.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the USFWS and NOAA RC, or any other party affected by these terms and conditions must comply with them to implement the reasonable and prudent measures (50 CFR 402.14). The USFWS and NOAA RC have a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR

402.14). If the following terms and conditions are not complied with, the protective coverage of section 7(o)(2) will likely lapse.

1. To implement reasonable and prudent measure #1 (conservation measures for restoration projects), the USFWS and NOAA RC shall ensure that:
    a. Every action funded or carried out under this opinion will be administered by the USFWS and NOAA RC consistent with conservation measures 1 through 12.
    b. For each action involving construction, conservation measures 13 through 32, as appropriate, will be added as conditions of funding.
    c. For specific types of actions, the USFWS and NOAA RC will apply criteria 33 through 50 as appropriate.

2. To implement reasonable and prudent measure #2 (monitoring and reporting), the USFWS and NOAA RC shall ensure that:
    a. The following notifications and reports (Appendix A) are submitted to NMFS for each project to be completed under this opinion. USFWS notifications and reports are to be submitted electronically to NMFS at usfws.biop.nwr@noaa.gov. NOAA RC's notifications and reports are to be submitted electronically to NMFS at noaarc.biop.nwr@noaa.gov.
        i. Project notification at least 30-days before start of construction (Part 1).
        ii. Project completion within 60-days of end of construction (Part 1 with Part 2 completed).
        iii. Fish salvage within 60-days of work area isolation with fish capture (Part 1 with Part 3 completed).
    b. The USFWS and NOAA RC will each submit a monitoring report to NMFS by February 15 each year that describes the USFWS and NOAA RC efforts to carry out this opinion. The report will include an assessment of overall program activity, a map showing the location and type of each action authorized and carried out under this opinion, and any other data or analyses the USFWS and NOAA RC deem necessary or helpful to assess habitat trends as a result of actions authorized under this opinion.
    c. The USFWS and NOAA RC will each attend an annual coordination meeting with NMFS by March 31 each year to discuss the annual monitoring report and any actions that will improve conservation under this opinion, or make the program more efficient or more accountable.
    d. Failure to provide timely reporting may constitute a modification of this biological opinion that has an effect to listed species or critical habitat that was not considered in the opinion and thus may require reinitiation of this consultation.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). The following conservation recommendations are discretionary measures that NMFS believes are consistent with this obligation and therefore should be carried out by the USFWS and NOAA RC:

- The effectiveness of some types of stream restoration actions are not well documented, partly because decisions about which restoration actions deserve support do not always address the underlying processes that led to habitat loss. NMFS recommends that the USFWS and NOAA RC use species' recovery plans to help ensure that their actions will address those underlying processes that limit fish recovery.
- NMFS also recommends that the USFWS and NOAA RC evaluate web-based reporting to lessen the administrative burden, with the goal of improving completion reporting and tracking of incidental take.

Please notify NMFS if the USFWS or NOAA RC carries out these recommendations so that we will be kept informed of actions that minimize or avoid adverse effects and those that benefit the listed species or their designated critical habitats.

2.10 Reinitiation of Consultation

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) The amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.11 "Not Likely to Adversely Affect" Determination

In this biological opinion, NMFS concludes that the proposed action is not likely to adversely affect southern green sturgeon, southern resident killer whales, or their designated critical habitat. Additionally, the proposed action is not likely to adversely affect Puget Sound/Georgia Basin DPSs of yelloweye rockfish (*Sebastes ruberrimus*), canary rockfish (*Sebastes pinniger*), and bocaccio rockfish (*Sebastes paucispinis*) (and their critical habitat where it has been designated). These conclusions are based on the following considerations:

Puget Sound/Georgia Basin DPSs Yelloweye Rockfish, Canary Rockfish, and Bocaccio Determination. Rockfish fertilize their eggs internally and the young are extruded as larvae. Rockfish larvae are pelagic, often found near the surface of open waters, under floating algae, detached seagrass, and kelp. Juvenile bocaccio and canary rockfish settle into shallow nearshore water on rocky or cobble substrate that support kelp and other macroalgae at 3 to 6 months of age, and move to progressively deeper waters as they grow (Love *et al.* 2002). Juvenile yelloweye rockfish do not typically occupy shallow waters (Love *et al.* 1991) and are very unlikely to be within the action area. Adult yelloweye rockfish, canary rockfish, and bocaccio typically occupy waters deeper than 120 feet (Love *et al.* 2002).

Larval yelloweye rockfish, canary rockfish or bocaccio could occur within the project and action area, though they are readily dispersed by currents after they are born, making the concentration or probability of presence of larvae in any one location extremely small (Kendall and Picquelle 2003). The size of the project and action area where effects could occur to larval ESA-listed rockfish, combined with the short duration of project activities, make it extremely unlikely, and therefore discountable, that a larvae will be present and exposed to project activities. Because all potential adverse effects are discountable, the NMFS concludes that the action may affect, but will not likely adversely affect yelloweye rockfish, canary rockfish, and bocaccio.

Southern DPS Green Sturgeon Determination. Two DPSs have been defined for green sturgeon: a northern DPS (spawning populations in the Klamath and Rogue rivers) and a southern DPS (spawners in the Sacramento River). The southern DPS of green sturgeon was listed as threatened in 2006, and includes all naturally-spawned populations of green sturgeon that occur south of the Eel River in Humboldt County, California. When not spawning, this anadromous species is broadly distributed in nearshore marine areas from Mexico to the Bering Sea. Although it is commonly observed in bays, estuaries, and sometimes the deep riverine mainstem in lower elevation reaches of non-natal rivers along the west coast of North America, the distribution and timing of estuarine use are poorly understood.

The principal factor for the decline of southern green sturgeon is the reduction of its spawning area to a single known population limited to a small portion of the Sacramento River. It is currently at risk of extinction primarily because of human-induced ‘‘takes’’ involving elimination of freshwater spawning habitat, degradation of freshwater and estuarine habitat quality, water diversions, fishing, and other causes (USDC 2010). Adequate water flow and temperature are issues of concern. Water diversions pose an unknown but potentially serious threat within the Sacramento and Feather Rivers and the Sacramento River Delta. Poaching also poses an unknown but potentially serious threat because of high demand for sturgeon caviar. The effects of contaminants and nonnative species are also unknown but potentially serious threats. Retention of green sturgeon in both recreational and commercial fisheries is now prohibited within the western states, but the effect of capture/release on these fisheries is unknown. There is evidence of fish being retained illegally, although the magnitude of this activity likely is small (NOAA Fisheries 2011). Climate change, as described in Section 2.2, is likely to reduce the conservation value of designated critical habitats in the Pacific Northwest.

Critical habitat for the southern DPS of green sturgeon was designated in 2009, and the designation includes coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington. Within the action area, this includes the Lower Columbia River estuary and certain coastal bays and estuaries in Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) (USDC 2009b). Table 35 delineates physical and biological features for southern DPS green sturgeon.

Table 35. Physical and biological features of critical habitat for southern green sturgeon and corresponding species life history events.

Physical or Biological Features		Species Life History Event
Site Type	**Site Attribute**	
Freshwater riverine system	Food resources Migratory corridor Sediment quality Substrate type or size Water depth Water flow Water quality	Adult spawning Embryo incubation, growth and development Larval emergence, growth and development Juvenile metamorphosis, growth and development
Estuarine areas	Food resources Migratory corridor Sediment quality Water flow Water depth Water quality	Juvenile growth, development, seaward migration Subadult growth, development, seasonal holding, and movement between estuarine and marine areas Adult growth, development, seasonal holding, movements between estuarine and marine areas, upstream spawning movement, and seaward post-spawning movement
Coastal marine areas	Food resources Migratory corridor Water quality	Subadult growth and development, movement between estuarine and marine areas, and migration between marine areas Adult sexual maturation, growth and development, movements between estuarine and marine areas, migration between marine areas, and spawning migration

Large estuaries are clearly important habitats for green sturgeon (Lindley *et al.* 2011). Southern green sturgeon subadults and adults may enter the action area for non-breeding, non-rearing purposes. Tagged adults and subadults in the San Francisco Bay Estuary occupied shallow depths during directional movements but stayed close to the bottom during non-directional movements, presumably because they were foraging in depths as shallow as 1.7 m (Kelly *et al.* 2007). However, information from fisheries-dependent sampling suggests that green sturgeon only occupy large estuaries during the summer and early fall, and would not be present during the in-water work period (Moser and Lindley 2007), which is generally late-fall to spring in Oregon estuaries (ODFW 2008).

NMFS does not expect green sturgeon to be present in the vicinity of most of the actions covered by this opinion. Impacts from construction to green sturgeon are the same as those described above for salmonids. From 2010 to 2012, the USFWS and NOAA RC only conducted two projects in estuaries (Table 3). Most restoration projects authorized or carried out under this opinion will occur in the upper reaches and tributaries of the larger rivers, or in riparian and wetland areas along the water's edge for estuarine and coastal areas. Green sturgeon congregate in deeper mid-channel areas. Potential projects in estuaries might include fish passage projects, such as tide gate removals, or the removal or setback of existing berms, dikes, and levees, and the removal of pilings. While these projects may release a small amount of suspended sediment temporarily, the long-term effects on water quality are beneficial.

Because of their age, location, and life history, green sturgeon individuals are relatively distant from, and insensitive to, the effects of the actions described above, and those effects are unrelated to the principal factor for the decline of this species, *i.e.*, the reduction of its spawning area in the Sacramento River. Adult and subadult green sturgeon are likely to be far less sensitive to suspended sediment and deposition than salmonids, and will not be present in the tributaries where the vast majority of the activities will occur. The NMFS is also reasonably certain that elevated suspended sediment concentrations will result in insignificant behavioral and physical responses in green sturgeon due to its higher tolerance of these effects, since green sturgeon usually inhabit much more turbid environments than salmonids.

NMFS believes that it is unlikely that green sturgeon will be encountered during work area isolation and fish salvage for implementation of these projects based on: 1) monitoring information from previous fish salvage operations associated with similar projects; 2) the large size of subadult and adult southern green sturgeon; and 3) the type and location of projects typically funded.

Effects to green sturgeon would primarily result from impacts associated with general disturbance related to in-water construction. However, green sturgeon are unlikely to occur in the vicinity of any projects implemented under this opinion, and are accustomed to the level of background activity associated with the proposed action. NMFS does not expect impacts to accrue from the other activities considered in this opinion.

Based on this analysis, NMFS finds that the effects of the proposed action are expected to be insignificant and/or discountable, and thus are not likely to adversely affect the southern DPS of green sturgeon or their critical habitat.

Southern Resident Killer Whale Determination. Southern Resident killer whales spend considerable time in the Georgia Basin from late spring to early autumn, with concentrated activity in the inland waters of Washington State around the San Juan Islands, and typically move south into Puget Sound in early autumn (NMFS 2008d). Pods make frequent trips to the outer coast during this season. In the winter and early spring, Southern Resident killer whales move into the coastal waters along the outer coast from the Queen Charlotte Islands south to central California, including coastal Oregon and off the Columbia River, although they do not have critical habitat designated in Oregon (NMFS 2008d).

No documented sightings exist of Southern Resident killer whales in coastal bays, and there is no documented pattern of predictable Southern Resident occurrence along the outer coast, and any potential occurrence would be infrequent and transitory. Southern Residents primarily eat salmon and prefer Chinook salmon (Hanson *et al.* 2010; NMFS 2008d).

The proposed program may affect the quantity of the Southern Resident killer whale's preferred prey, Chinook salmon. Any salmonid take including Chinook salmon up to the aforementioned amount and extent of take will result in an insignificant reduction in adult equivalent prey resources for Southern Resident killer whales that may intercept these species within their range.

NMFS finds that any affect the proposed program may have on Southern Resident killer whales, including indirect effects on their prey, is likely to be discountable, insignificant or beneficial. Therefore, NMFS finds that the proposed program may affect, but is not likely to adversely affect Southern Resident killer whales.

3.0 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effects include the direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside EFH, and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

3.1 Essential Fish Habitat Affected by the Project

This analysis is based, in part, on the EFH assessment provided by the Federal action agency and descriptions of EFH contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce for EFH species, including groundfish (PFMC 2005); coastal pelagic species (PFMC 1998); and Chinook salmon, coho salmon, and Puget Sound pink salmon (PFMC 1999). The proposed action and action area for this consultation are described in the Introduction to this document. The action area includes areas designated as EFH for various life-history stages of Chinook and coho salmon; groundfish; and coastal pelagic species. In addition, the following HAPCs are present in the action area: estuarine and seagrass areas.

3.2 Adverse Effects on Essential Fish Habitat

While the ESA portion of this document determined that water quality and physical habitat effects were discountable or insignificant to salmon, groundfish, and coastal pelagic species habitat, we conclude that the proposed action may adversely affect EFH for these species. We conclude that the following adverse effects on EFH designated for 49 species of Pacific Coast groundfish, five coastal pelagic species, pink, coho, and Chinook salmon are reasonably certain to occur:

1. Freshwater EFH quantity will be reduced due to short-term construction effects, including increased riparian soil compaction and runoff. Freshwater EFH quantity will increase slightly over the long-term due to improved riparian function and floodplain connectivity.
2. Freshwater EFH quality will be reduced due to a short-term release of suspended sediment, increased dissolved oxygen demand, and increased water temperature due to

riparian and channel disturbance. These conditions will improve over the long term due to improved riparian function and floodplain connectivity.

3. The quality of tributary substrate will be reduced in the short term due to increased compaction and sedimentation, and will increase over the long term due to gravel placement, and increased sediment storage from boulders and LW.
4. Floodplain connectivity will decrease in the short-term due to increased compaction and riparian disturbance during construction, and a will improve over the long term due to off- and side channel habitat restoration, set-back of existing berms, dikes, and levees, and removal of water control structures.
5. Forage availability will decrease in the short term due to riparian and channel disturbance, and improve over the long term due to improved habitat diversity and complexity, and improved riparian function and floodplain connectivity.
6. Natural cover will decrease in the short term due to riparian and channel disturbance, and increase in the long term due to improved habitat diversity and complexity, improved riparian function and floodplain connectivity, and off- and side channel habitat restoration.
7. Fish passage will be impaired in the short term due to decreased water quality and in-water work isolation, and improved over the long-term due to improved water quantity and quality, habitat diversity and complexity, forage, and natural cover.
8. Estuarine and nearshore EFH quality will be temporarily reduced due to short-term releases of suspended sediment, benthic disturbance, and damage to submerged aquatic vegetation.
9. Localized, short-term increase in creosote-associated contaminants from the removal of treated-wood materials, including piles. Affected habitat includes:
    - water column
    - substrate
    - benthic productivity
    - prey
    - estuary (HAPC)
10. Short-term decrease in water quality, fish passage, and natural cover from the shellfish bed restoration, beach nourishment, and piling and structure removal activities in estuary and nearshore habitat. Affected habitat includes:
    - water column
    - estuary (HAPC)

3.3 Essential Fish Habitat Conservation Recommendations

The following three conservation recommendations are necessary to avoid, mitigate, or offset the impact of the proposed action on EFH:

1. The effectiveness of some types of stream restoration actions are not well documented, partly because decisions about which restoration actions deserve support do not always address the underlying processes that led to habitat loss. NMFS recommends that the USFWS and NOAA RC use species recovery plans to help ensure that their actions will address the underlying processes that limit fish recovery.

2. NMFS also recommends that the USFWS and NOAA RC evaluate whether the regulatory streamlining provided by this opinion influences the design of restoration actions, or acts as an incentive that increases the likelihood that restoration actions will be completed.
3. As appropriate to each action issued a regulatory permit under this opinion, NMFS recommends that the USFWS and NOAA RC include the PDC for administration, construction, and types of actions as enforceable permit conditions.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Federal action agencies must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation from NMFS. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations, unless NMFS and the Federal action agency have agreed to use alternative time frames for the Federal action agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS Conservation Recommendations, the Federal action agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects, 50 CFR 600.920(k)(1).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Federal action agencies (USFWS and NOAA RC) must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations, 50 CFR 600.920(l).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) (Data Quality Act) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these Data Quality Act (DQA) components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users are the Federal action agencies (USFWS and NOAA RC). An individual copy was provided to the USFWS and NOAA RC. This consultation will be posted on the NMFS West Coast Region website (http://www.westcoast.fisheries.noaa.gov/). The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

***Information Product Category*:** Natural Resource Plan.

***Standards*:** This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA Regulations, 50 CFR 402.01, *et seq*., and the MSA implementing regulations regarding EFH, 50 CFR 600.920(j).

***Best Available Information*:** This consultation and supporting documents use the best available information, as referenced in the Literature Cited section. The analyses in this opinion/EFH consultation contain more background on information sources and quality.

***Referencing*:** All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

***Review Process*:** This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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Appendix A: PROJECTS Programmatic Email Guidelines and Implementation Forms

Use the USFWS or NOAA RC Programmatic email box (usfws.biop.nwr@noaa.gov or noaarc.biop.nwr@noaa.gov) to transmit the following information to NMFS regarding use of this Programmatic Biological Opinion (opinion):

Send only one project per email submittal, attach all related documents preferably in *pdf* format; and ensure the final project is being submitted to avoid multiple submittals and withdrawals. Please send:

1. Action Implementation Form, containing Action Notification and Action Completion and Fish Salvage reports (if fish salvage is conducted).
2. Map(s) and project design drawings (if applicable)
3. Final project plan.

If a withdrawal is necessary, please specify in the email subject line that the project is being withdrawn. Simply state the reason for the withdrawal and submit to the email box, following the email titling conventions. If a previously-withdrawn notification is resubmitted later, this resubmittal will be regarded as a new action notification.

An automatic reply will be sent upon receipt, but no other communication will be sent from the programmatic email box; this box is used for **Incoming Only**. All other pre-decisional communication should be conducted **outside** the use of the usfws.biop.nwr@noaa.gov and noaarc.biop.nwr@noaa.gov email boxes.

In the subject line of the email (see below for requirements), clearly identify the specific submittal category (action notification, project completion, withdrawal, or salvage report), and the Restoration Center Database number. The submitted documents will contain identifying information, including the Applicant Name, County, Waterway, and State.

Email Titling Conventions

Use caution when entering the necessary information in the subject line. **If these titling conventions are not used, the email will not be accepted.** Ensure that you clearly identify:

1. The specific submittal category: (a) Action Notification; (b) Action Completion Report; (c) Fish Salvage Report; or (d) Annual Report
2. USFWS or Restoration Center Database number
3. Applicant Name
4. County
5. Waterway
6. State

PROJECTS Implementation Forms

NMFS Review and Approval. USFWS or NOAA RC project managers shall submit this form with the Action Notification portion completed to NMFS at usfws.biop.nwr@noaa.gov and noaarc.biop.nwr@noaa.gov for notification or approval.

The Following Actions Require Approval from NMFS as consistent with PROJECTS before that action is authorized:

- Modification or variance of any requirement for fish passage restoration (PDC 7)
- Fish screen review for pump intakes that exceeds 3 cfs (PDC 27)
- Installation of pilings (PDC 30)
- Culverts and bridges that do not meet width standards (PDC 33c)
- Grade control, stream stability, or headcut countermeasures (PDC 33d.ii)
- Fish ladders and channel-spanning non-porous structures (PDC 33e)
- Irrigation diversion replacement/relocation (PDC 33f)
- Fish screen installation/replacement (PDC 33f)
- Engineered log jams (ELJs) that occupy > 25% of the bankfull area (PDC 34 b)
- Constructed or engineered riffles (PDC 34c)
- Dam removal projects (35a)
- Channel reconstruction/relocation (36)
- Off- and side-channel reconstruction >20% of the bankfull flow (37)
- Alluvium placement that occupies >25% of the channel bed or >25% of the BF cross sectional area (38d)
- LW placement that occupies >25% of the bankfull cross section (38e)
- Beach nourishment projects (43c)
- Tide/flood gate removal, replacement or retrofit projects (50)

NMFS will notify the USFWS or NOAA RC within 30 calendar days if the action is approved or disqualified. When requested, NMFS will provide an estimate of the time necessary to complete the review based on the complexity of the proposed action and work load considerations at the time of the request. Approval may be delayed if a substandard design is submitted for review during the post-design or action implementation stage and significant revision is necessary. These reviews are best initiated in the context of informal consultation during the preliminary development project phase, when project team members are developing goals and objectives with stakeholders.

Attach information to e-mail message if required or relevant to NMFS' review, such as:

- Erosion and pollution control plan
- Engineering designs

Project Reporting. The project manager shall submit the following reports as necessary:
Action Completion Reporting. Submit this form to NMFS within 60 days of completing all work below ordinary high water (OHW).
Fish Salvage Reporting. Submit this form to NMFS within 60 days of completing a capture and release as part of an action completed under PROJECTS.

The usfws.biop.nwr@noaa.gov and noaarc.biop.nwr@noaa.gov email boxes are to be used for **incoming only**.

PROJECTS Action Notification Form

DATE OF REQUEST:		**NMFS TRACKING #: NWR-2013-9717**	
TYPE OF REQUEST:	☐ ACTION NOTIFICATION (NO APPROVAL) ☐ ACTION NOTIFICATION (APPROVAL REQUIRED)		
Statutory Authority:	☐ ESA-ONLY	☐ EFH-ONLY	☐ ESA & EFH COMBINED
Lead Action Agency:	☐ **USFWS**	☐ **NOAA RC**	
Action Agency Contact:		Action ID #:	
Project Name:			
6th Field HUC & Name:			
Latitude & Longitude **Longitude** (in signed degrees format: DDD.dddd)			
Proposed Construction Period:	***Start Date:***	***End Date:***	
Proposed Length of Channel and/or Riparian Modification in linear feet:			
Proposed Area of Herbicide Application in acres:			

Project Description:

Type of Action: *Identify the type of action proposed.*

- ☐ Fish Passage Restoration (Stream Simulation Culvert and Bridge Projects; Headcut and Grade Stabilization; Fish Ladders; Irrigation Diversion Replacement/Relocation and Screen Installation/Replacement)
- ☐ Large Wood (LW), Boulder, and Gravel Placement; Engineered Logjams (ELJ); Constructed Riffles, Porous Boulder Weirs and Vanes; Gravel Augmentation; Tree Removal for LW Projects
- ☐ Dam and Legacy Structure Removal
- ☐ Channel Reconstruction/Relocation
- ☐ Off- and Side-Channel Habitat Restoration
- ☐ Streambank Restoration
- ☐ Set-Back or Removal of Existing Berms, Dikes, and Levees
- ☐ Reduction/Relocation of Recreation Impacts
- ☐ Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering
- ☐ Piling and other Structure Removal
- ☐ Shellfish Bed/Nearshore Habitat Restoration
- ☐ In-channel Nutrient Enhancement
- ☐ Road and Trail Erosion Control and Decommissioning
- ☐ Juniper Removal
- ☐ Riparian Vegetative Planting
- ☐ Bull Trout Protection
- ☐ Beaver Habitat Restoration
- ☐ Wetland Restoration
- ☐ Tide Gate Removal, Replacement, or Retrofit

NMFS Species/Critical Habitat Present in Action Area: *Identify the species and critical habitats present in the action area (N/A means not applicable):*

Species	*Critical Habitat*			*EFH Species*
☐	☐	LCR Chinook salmon	☐	Salmon, Chinook
☐	☐	UWR Chinook salmon	☐	Salmon, coho
☐	☐	UCR spring-run Chinook salmon	☐	Salmon, pink
☐	☐	SR spring/summer-run Chinook salmon	☐	Coastal Pelagics
☐	☐	SR fall-run Chinook salmon	☐	Groundfish
☐	☐	PS Chinook salmon		
☐	☐	CR chum salmon		
☐	☐	HC summer-run chum salmon		
☐	N/A	LCR coho salmon		
☐	☐	OC coho salmon		
☐	☐	SONCC coho salmon		
☐	☐	LO sockeye salmon		
☐	☐	SR sockeye salmon		
☐	☐	LCR steelhead		
☐	☐	UWR steelhead		
☐	☐	MCR steelhead		
☐	☐	UCR steelhead		
☐	☐	SRB steelhead		
☐	N/A	PS steelhead		
☐	☐	Southern DPS eulachon		

Terms and Conditions: *Check the terms and conditions from the biological opinion that will be included as conditions for any action funded or carried out under this opinion.*

Administration

- ☐ USFWS/NOAA RC review
- ☐ Restoration Review Team review
- ☐ Request for NMFS review
- ☐ Site access
- ☐ Site assessment for contaminants
- ☐ Funding conditions
- ☐ Fish Salvage notice

General Construction Measures

- ☐ Flagging sensitive areas
- ☐ Temporary access roads and paths
- ☐ In-water work period
- ☐ Fish Capture and release
- ☐ Construction water
- ☐ Vehicle staging and use
- ☐ Work from top of bank
- ☐ Staging, Storage, and Stockpile Areas
- ☐ Dust Abatement
- ☐ Surveys
- Piling installation or removal
- ☐ Temporary erosion controls
- ☐ Fish passage
- ☐ Work area isolation
- ☐ Electrofishing
- ☐ Fish screens
- ☐ Choice of equipment
- ☐ Stationary power equipment
- ☐ Site restoration
- ☐ Temporary Stream Crossings
- ☐ Revegetation

Invasive and non-native plant control

- ☐ Non-herbicide methods
- ☐ Required herbicide buffer distances
- ☐ Herbicide transportation and safety plan
- ☐ Approved herbicide adjuvants
- ☐ Approved dye
- ☐ Approved herbicide application rates
- ☐ Approved application methods
- ☐ Power equipment
- ☐ Herbicide applicator qualifications
- ☐ Approved herbicides
- ☐ Approved herbicide carriers
- ☐ Herbicide mixing
- ☐ Minimize herbicide drift and leaching

Types of Restoration Actions

Fish Passage Restoration

- ☐ Stream Crossing
- ☐ Stabilize Headcut
- ☐ Irrigation Diversion
- ☐ Fish Ladder
- ☐ Screen Installation/Replacement
- ☐ Grade Stabilization

Large Wood, Boulder, and Gravel Placement

- ☐ Large Wood or Boulders
- ☐ Constructed Riffles
- ☐ Gravel Augmentation
- ☐ Engineered Logjams
- ☐ Porous Boulder Structures and Vanes
- ☐ Tree Removal for LW Projects

Dam and Legacy Structure Removal

- ☐ Dam Removal
- ☐ Legacy Structure Removal

Channel Reconstruction/Relocation

- ☐ Design Guidance
- ☐ Monitoring and adaptive plan
- ☐ Project documentation

Off- and Side Channel Habitat Restoration

- ☐ Review and approve
- ☐ Data requirements
- ☐ Allowable excavation

Streambank Restoration

- ☐ Streambank shaping
- ☐ Soil reinforcement
- ☐ Large wood
- ☐ Use of rock in streambank restoration
- ☐ Planting or installing vegetation
- ☐ Fertilizer
- ☐ Fencing

Set-Back or Removal of Existing Berms, Dikes, and Levees

- ☐ Floodplains and Freshwater Deltas
- ☐ Estuary Restoration

Livestock Stream Crossings and Off-Channel Livestock Watering Facilities

- ☐ Livestock stream crossings
- ☐ Off-channel watering facilities
- ☐ Livestock Fencing

Shellfish Bed/Nearshore Habitat Restoration

- ☐ Replace shoreline armor
- ☐ Beach nourishment plan approved by NMFS
- ☐ Shell source and methods
- ☐ Minimize impact to aquatic vegetation

Road and Trail Erosion Control and Decommissioning

- ☐ Road Decommissioning/ Stormproofing
- ☐ Road Relocation

Juniper Tree Removal

- ☐ Approved juniper tree removal methods
- ☐ Management of juniper slash

Beaver Habitat Restoration

- ☐ In-channel structures
- ☐ Habitat Restoration

Tide/Flood Gate Removal, Replacement, or Retrofit

- ☐ Removal
- ☐ Replacement
- ☐ Retrofit
- ☐ Dike breach or setback
- ☐ Culvert or bridge
- ☐ Monitoring/Adaptive Management Plan
- ☐ Design Approved by NMFS

PROJECTS Action Completion Reporting Form

Within 60 days of completing all work below ordinary high water (OHW) as part of an action completed under PROJECTS, submit the completed Action Completion Form with the following information to NMFS at usfws.biop.nwr@noaa.gov or noaarc.biop.nwr@noaa.gov.

Actual Start and End Dates for the Completion of In-water Work:	***Start***:	***End***:
Actual Linear-feet of Riparian and/or Channel Modification:		
Actual Acreage of Herbicide Treatment		
Turbidity Monitoring/Sampling Completed	☐ Yes (include details below)	☐ No

Please include the following:

1. Photos of habitat conditions before, during, and after action completion.
2. A summary of the results of pollution and erosion control inspections, including any erosion control failure, contaminant release, and correction effort.
3. Records of turbidity monitoring (visual or by turbidimeter) including dates, times and location of monitoring. Include any exceedances and steps taken to reduce turbidity observed.

PROJECTS Fish Salvage Reporting Form

If applicable: Within 60 days of completing a capture and release as part of an action completed under PROJECTS, submit a complete Salvage Reporting Form, with the following information to NMFS at usfws.bio.nwr@noaa.gov or noaarc.biop.nwr@noaa.gov.

Date(s) of Fish Salvage Operation(s):	
Supervisory Fish Biologist:	
Address	
Telephone Number	

Describe methods that were used to isolate the work area and remove fish

Fish Salvage Data

Water Temperature:

Air Temperature:

Time of Day:

ESA-Listed Species	Number Handled		Number Injured		Number Killed	
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult
Lower Columbia River Chinook salmon						
Upper Willamette River Chinook salmon						
Upper Columbia River spring-run Chinook salmon						
Snake River spring/summer run Chinook salmon						
Snake River fall-run Chinook salmon						
Puget Sound Chinook salmon						
Lake Ozette sockeye salmon						
Columbia River chum salmon						
Lower Columbia River coho salmon						
Oregon Coast coho salmon						
Southern Oregon/Northern California Coasts coho salmon						
Snake River sockeye salmon						
Lake Ozette sockeye salmon						
Lower Columbia River steelhead						
Upper Willamette River steelhead						
Middle Columbia River steelhead						
Upper Columbia River steelhead						
Snake River Basin steelhead						
Eulachon						

AGENDA ITEM NO. 6.

MARYSVILLE
WASHINGTON
EST. 1891

Agenda Bill

CITY COUNCIL AGENDA ITEM REPORT

DATE: May 27, 2025

SUBMITTED BY: Valorie Cross, Engineering

ITEM TYPE: Agreement

AGENDA SECTION: **New Business**

SUBJECT: Revised Local Agency Agreement and Prospectus with WSDOT for the 67th Ave NE (Grove St to 88th St NE) project

SUGGESTED ACTION: Recommended Motion: I move to ratify the Mayor's execution of the revised Local Agency Agreement and Prospectus with WSDOT for the 67th Ave NE (Grove ST to 88th St NE) project.

SUMMARY:

Council approved the WSDOT Local Agency Agreement (LAA) and Prospectus for the 67th Ave NE (Grove St to 88th St NE) project on April 14th, 2025. Although the documents were reviewed and approved by WSDOT Local Programs staff prior to Council action, WSDOT Headquarters required some minor edits to the agreement.

The following edits to the LAA were made:

- Shift Ad date forward to at least the 4th or 5th week of the month of May.
- Remove PE amounts from funding table in LAA.
- Show funding amount to the nearest whole dollar.
- For line k. Adjust the amounts to maximize the pro rata rate.
- Use line l for other “Contract” amounts covered by Local Agency that do not fit within line k.
- For line n, move line o as Construction Management.
- For line o, add an amount for monthly billings when other items of the agreement cannot be billed.
- For line p, add an estimate for State services to capture services provided by WSDOT staff.
- Adjust the totals as needed for lines q and r. Prospectus
- Adjust funding amounts to the nearest hundred per LAA revisions

In order to keep the project on track and ensure obligation of funds, the Mayor signed the revised LAA and Prospectus.

ATTACHMENTS:

Revised LAA & Prospectus 67th Ave NE to 88th St NE--City Executed.pdf

Docusign Envelope ID: 290D6DC9-1831-4BF8-8B9D-1FF312896F3B

Washington State Department of Transportation

Local Agency Agreement

Agency City of Marysville

Address 501 Delta Ave, Marysville, WA 98270

ALN 20.205 - Highway Planning and Construction
(Assistance Listing Number)

Project Number

Agreement Number

For WSDOT Use Only

The Local Agency having complied, or hereby agreeing to comply, with the terms and conditions set forth in (1) Title 23, U.S. Code Highways, (2) the regulations issued pursuant thereto, (3) 2 CFR Part 200, (4) 2 CFR Part 180 – certifying that the local agency is not excluded from receiving Federal funds by a Federal suspension or debarment, (5) the policies and procedures promulgated by the Washington State Department of Transportation, and (6) the federal aid project agreement entered into between the State and Federal Government, relative to the above project, the Washington State Department of Transportation will authorize the Local Agency to proceed on the project by a separate notification. Federal funds which are to be obligated for the project may not exceed the amount shown herein on line r, column 3, without written authority by the State, subject to the approval of the Federal Highway Administration. All project costs not reimbursed by the Federal Government shall be the responsibility of the Local Agency.

Project Description

Name 67th Ave NE (Grove St to 88th St NE) Length 0.69

Termini 88th St NE

Description of Work

This is a preservation project that will include minor pavement repair, grinding and overlay on 67th Ave NE from Grove Street to 88th St NE. The project will also include the necessary ADA ramp upgrades, pavement markings and replacing traffic control loops.

Project Agreement End Date 12/31/2028

Advertisement Date 05/28/2025

Indirect Cost Rate
☐ Yes ✓ No

Type of Work		Estimate of Funding		
		(1) Estimated Total Project Funds	(2) Estimated Agency Funds	(3) Estimated Federal Funds
PE 0 % Federal Aid Participation Ratio(s) for PE	a. Agency			
	b. Other			
	c. Other			
	d. State Services			
	e. Total PE Cost Estimate	0.00	0.00	0.00
Right of Way 0 % Federal Aid Participation Ratio(s) for RW	f. Agency			
	g. Other			
	h. Other			
	i. State Services			
	j. Total R/W Cost Estimate	0.00	0.00	0.00
Construction 86.5 % Federal Aid Participation Ratio(s) for CN	k. Contract	929,261.00	125,450.00	803,811.00
	l. Other Agency CN	582,437.00	582,437.00	
	m. Other			
	n. Other Agency CM	105,819.00	105,819.00	
	o. Agency	1,000.00	1,000.00	
	p. State Services	2,200.00	297.00	1,903.00
	q. Total CN Cost Estimate	1,620,717.00	815,003.00	805,714.00
	r. Total Project Cost Estimate	1,620,717.00	815,003.00	805,714.00

Agency Official

By DocuSigned by: Jon Nehring A8AE51528DE9478...

Title Mayor

Agency Date 5/20/2025

Washington State Department of Transportation

By

Director, Local Programs

Date Executed

Construction Method of Financing (Check Method Selected)

State Ad and Award

Method A - Advance Payment - Agency Share of total construction cost (based on contract award)

Method B - Withhold from gas tax the Agency's share of total construction coast (line 5, column 2) in the amount of

$ at $ per month for months.

Local Force or Local Ad and Award

✓ Method C - Agency cost incurred with partial reimbursement

The Local Agency further stipulates that pursuant to said Title 23, regulations and policies and procedures, and as a condition to payment of the federal funds obligated, it accepts and will comply with the applicable provisions set forth below. Adopted by official action on April 14 , 2025 , Resolution/Ordinance No.

Provisions

I. Scope of Work

The Agency shall provide all the work, labor, materials, and services necessary to perform the project which is described and set forth in detail in the "Project Description" and "Type of Work."

When the State acts for and on behalf of the Agency, the State shall be deemed an agent of the Agency and shall perform the services described and indicated in "Type of Work" on the face of this agreement, in accordance with plans and specifications as proposed by the Agency and approved by the State and the Federal Highway Administration.

When the State acts for the Agency but is not subject to the right of control by the Agency, the State shall have the right to perform the work subject to the ordinary procedures of the State and Federal Highway Administration.

II. Delegation of Authority

The State is willing to fulfill the responsibilities to the Federal Government by the administration of this project. The Agency agrees that the State shall have the full authority to carry out this administration. The State shall review, process, and approve documents required for federal aid reimbursement in accordance with federal requirements. If the State advertises and awards the contract, the State will further act for the Agency in all matters concerning the project as requested by the Agency. If the Local Agency advertises and awards the project, the State shall review the work to ensure conformity with the approved plans and specifications.

III. Project Administration

Certain types of work and services shall be provided by the State on this project as requested by the Agency and described in the Type of Work above. In addition, the State will furnish qualified personnel for the supervision and inspection of the work in progress. On Local Agency advertised and awarded projects, the supervision and inspection shall be limited to ensuring all work is in conformance with approved plans, specifications, and federal aid requirements. The salary of such engineer or other supervisor and all other salaries and costs incurred by State forces upon the project will be considered a cost thereof. All costs related to this project incurred by employees of the State in the customary manner on highway payrolls and vouchers shall be charged as costs of the project.

IV. Availability of Records

All project records in support of all costs incurred and actual expenditures kept by the Agency are to be maintained in accordance with local government accounting procedures prescribed by the Washington State Auditor's Office, the U.S. Department of Transportation, and the Washington State Department of Transportation. The records shall be open to inspection by the State and Federal Government at all reasonable times and shall be retained and made available for such inspection for a period of not less than three years from the final payment of any federal aid funds to the Agency. Copies of said records shall be furnished to the State and/or Federal Government upon request.

V. Compliance with Provisions

The Agency shall not incur any federal aid participation costs on any classification of work on this project until authorized in writing by the State for each classification. The classifications of work for projects are:

1. Preliminary engineering.
2. Right of way acquisition.
3. Project construction.

Once written authorization is given, the Agency agrees to show continuous progress through monthly billings. Failure to show continuous progress may result the Agency's project becoming inactive, as described in 23 CFR 630, and subject to de-obligation of federal aid funds and/or agreement closure.

If right of way acquisition, or actual construction of the road for which preliminary engineering is undertaken is not started by the close of the tenth fiscal year following the fiscal year in which preliminary engineering phase was authorized, the Agency will repay to the State the sum or sums of federal funds paid to the Agency under the terms of this agreement (see Section IX).

If actual construction of the road for which right of way has been purchased is not started by the close of the tenth fiscal year following the fiscal year in which the right of way phase was authorized, the Agency will repay to the State the sum or sums of federal funds paid to the Agency under the terms of this agreement (see Section IX).

The Agency agrees that all stages of construction necessary to provide the initially planned complete facility within the limits of this project will conform to at least the minimum values set by approved statewide design standards applicable to this class of highways, even though such additional work is financed without federal aid participation.

The Agency agrees that on federal aid highway construction projects, the current federal aid regulations which apply to liquidated damages relative to the basis of federal participation in the project cost shall be applicable in the event the contractor fails to complete the contract within the contract time.

VI. Payment and Partial Reimbursement

The total cost of the project, including all review and engineering costs and other expenses of the State, is to be paid by the Agency and by the Federal Government. Federal funding shall be in accordance with the Federal Transportation Act, as amended, 2 CFR Part 200. The State shall not be ultimately responsible for any of the costs of the project. The Agency shall be ultimately responsible for all costs associated with the project which are not reimbursed by the Federal Government. Nothing in this agreement shall be construed as a promise by the State as to the amount or nature of federal participation in this project.

The Agency shall bill the state for federal aid project costs incurred in conformity with applicable federal and state laws. The agency shall minimize the time elapsed between receipt of federal aid funds and subsequent payment of incurred costs. Expenditures by the Local Agency for maintenance, general administration, supervision, and other overhead shall not be eligible for federal participation unless a current indirect cost plan has been prepared in accordance with the regulations outlined in 2 CFR Part 200 - Uniform Admin Requirements, Cost Principles and Audit Requirements for Federal Awards, and retained for audit.

The State will pay for State incurred costs on the project. Following payment, the State shall bill the Federal Government for reimbursement of those costs eligible for federal participation to the extent that such costs are attributable and properly allocable to this project. The State shall bill the Agency for that portion of State costs which were not reimbursed by the Federal Government (see Section IX).

1. Project Construction Costs

Project construction financing will be accomplished by one of the three methods as indicated in this agreement.

Method A – The Agency will place with the State, within (20) days after the execution of the construction contract, an advance in the amount of the Agency's share of the total construction cost based on the contract award. The State will notify the Agency of the exact amount to be deposited with the State. The State will pay all costs incurred under the contract upon presentation of progress billings from the contractor. Following such payments, the State will submit a billing to the Federal Government for the federal aid participation share of the cost. When the project is substantially completed and final actual costs of the project can be determined, the State will present the Agency with a final billing showing the amount due the State or the amount due the Agency. This billing will be cleared by either a payment from the Agency to the State or by a refund from the State to the Agency.

Method B – The Agency's share of the total construction cost as shown on the face of this agreement shall be withheld from its monthly fuel tax allotments. The face of this agreement establishes the months in which the withholding shall take place and the exact amount to be withheld each month. The extent of withholding will be confirmed by letter from the State at the time of contract award. Upon receipt of progress billings from the contractor, the State will submit such billings to the Federal Government for payment of its participating portion of such billings.

Method C – The Agency may submit vouchers to the State in the format prescribed by the State, in duplicate, not more than once per month for those costs eligible for Federal participation to the extent that such costs are directly attributable and properly allocable to this project. Expenditures by the Local Agency for maintenance, general administration, supervision, and other overhead shall not be eligible for Federal participation unless claimed under a previously approved indirect cost plan.

The State shall reimburse the Agency for the Federal share of eligible project costs up to the amount shown on the face of this agreement. At the time of audit, the Agency will provide documentation of all costs incurred on the project. The State shall bill the Agency for all costs incurred by the State relative to the project. The State shall also bill the Agency for the federal funds paid by the State to the Agency for project costs which are subsequently determined to be ineligible for federal participation (see Section IX).

VII. Audit of Federal Consultant Contracts

The Agency, if services of a consultant are required, shall be responsible for audit of the consultant's records to determine eligible federal aid costs on the project. The report of said audit shall be in the Agency's files and made available to the State and the Federal Government.

An audit shall be conducted by the WSDOT Internal Audit Office in accordance with generally accepted governmental auditing standards as issued by the United States General Accounting Office by the Comptroller General of the United States; WSDOT Manual M 27-50, Consultant Authorization, Selection, and Agreement Administration; memoranda of understanding between WSDOT and FHWA; and 2 CFR Part 200.501 - Audit Requirements.

If upon audit it is found that overpayment or participation of federal money in ineligible items of cost has occurred, the Agency shall reimburse the State for the amount of such overpayment or excess participation (see Section IX).

VIII. Single Audit Act

The Agency, as a subrecipient of federal funds, shall adhere to the federal regulations outlined in 2 CFR Part 200.501 as well as all applicable federal and state statutes and regulations. A subrecipient who expends $1,000,000 or more in federal awards from all sources during a given fiscal year shall have a single or program-specific audit performed for that year in accordance with the provisions of 2 CFR Part 200.501. Upon conclusion of the audit, the Agency shall be responsible for ensuring that a copy of the report is transmitted promptly to the State.

IX. Payment of Billing

The Agency agrees that if payment or arrangement for payment of any of the State's billing relative to the project (e.g., State force work, project cancellation, overpayment, cost ineligible for federal participation, etc.) is not made to the State within 45 days after the Agency has been billed, the State shall effect reimbursement of the total sum due from the regular monthly fuel tax allotments to the Agency from the Motor Vehicle Fund. No additional Federal project funding will be approved until full payment is received unless otherwise directed by the Director, Local Programs.

Project Agreement End Date - This date is based on your projects Period of Performance (2 CFR Part 200.309).

Any costs incurred after the Project Agreement End Date are NOT eligible for federal reimbursement. All eligible costs incurred prior to the Project Agreement End Date must be submitted for reimbursement within 60 days after the Project Agreement End Date or they become ineligible for federal reimbursement.

X. Traffic Control, Signing, Marking, and Roadway Maintenance

The Agency will not permit any changes to be made in the provisions for parking regulations and traffic control on this project without prior approval of the State and Federal Highway Administration. The Agency will not install or permit to be installed any signs, signals, or markings not in conformance with the standards approved by the Federal Highway Administration and MUTCD. The Agency will, at its own expense, maintain the improvement covered by this agreement.

XI. Indemnity

The Agency shall hold the Federal Government and the State harmless from and shall process and defend at its own expense all claims, demands, or suits, whether at law or equity brought against the Agency, State, or Federal Government, arising from the Agency's execution, performance, or failure to perform any of the provisions of this agreement, or of any other agreement or contract connected with this agreement, or arising by reason of the participation of the State or Federal Government in the project, PROVIDED, nothing herein shall require the Agency to reimburse the State or the Federal Government for damages arising out of bodily injury to persons or damage to property caused by or resulting from the sole negligence of the Federal Government or the State.

XII. Nondiscrimination Provision

No liability shall attach to the State or Federal Government except as expressly provided herein.

The Agency shall not discriminate on the basis of race, color, national origin, or sex in the award and performance of any USDOT-assisted contract and/or agreement or in the administration of its DBE program or the requirements of 49 CFR Part 26. The Agency shall take all necessary and reasonable steps under 49 CFR Part 26 to ensure nondiscrimination in the award and administration of USDOT-assisted contracts and agreements. The WSDOT's DBE program, as required by 49 CFR Part 26 and as approved by USDOT, is incorporated by reference in this agreement. Implementation of this program is a legal obligation and failure to carry out its terms shall be treated as a violation of this agreement. Upon notification to the Agency of its failure to carry out its approved program, the Department may impose sanctions as provided for under Part 26 and may, in appropriate cases, refer the matter for enforcement under 18 U.S.C. 1001 and/or the Program Fraud Civil Remedies Act of 1986 (31 U.S. C. 3801 et seq.).

The Agency hereby agrees that it will incorporate or cause to be incorporated into any contract for construction work, or modification thereof, as defined in the rules and regulations of the Secretary of Labor in 41 CFR Chapter 60, which is paid for in whole or in part with funds obtained from the Federal Government or borrowed on the credit of the Federal Government pursuant to a grant, contract, loan, insurance, or guarantee or understanding pursuant to any federal program involving such grant, contract, loan, insurance, or guarantee, the required contract provisions for Federal-Aid Contracts (FHWA 1273), located in Chapter 44 of the Local Agency Guidelines.

The Agency further agrees that it will be bound by the above equal opportunity clause with respect to its own employment practices when it participates in federally assisted construction work: Provided, that if the applicant so participating is a State or Local Government, the above equal opportunity clause is not applicable to any agency, instrumentality, or subdivision of such government which does not participate in work on or under the contract.

The Agency also agrees:

(1) To assist and cooperate actively with the State in obtaining the compliance of contractors and subcontractors with the equal opportunity clause and rules, regulations, and relevant orders of the Secretary of Labor.

(2) To furnish the State such information as it may require for the supervision of such compliance and that it will otherwise assist the State in the discharge of its primary responsibility for securing compliance.

(3) To refrain from entering into any contract or contract modification subject to Executive Order 11246 of September 24, 1965, with a contractor debarred from, or who has not demonstrated eligibility for, government contracts and federally assisted construction contracts pursuant to the Executive Order.

(4) To carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by the State, Federal Highway Administration, or the Secretary of Labor pursuant to Part II, subpart D of the Executive Order.

In addition, the Agency agrees that if it fails or refuses to comply with these undertakings, the State may take any or all of the following actions:

(a) Cancel, terminate, or suspend this agreement in whole or in part;

(b) Refrain from extending any further assistance to the Agency under the program with respect to which the failure or refusal occurred until satisfactory assurance of future compliance has been received from the Agency; and

(c) Refer the case to the Department of Justice for appropriate legal proceedings.

XIII. Liquidated Damages

The Agency hereby agrees that the liquidated damages provisions of 23 CFR Part 635, Subpart 127, as supplemented, relative to the amount of Federal participation in the project cost, shall be applicable in the event the contractor fails to complete the contract within the contract time. Failure to include liquidated damages provision will not relieve the Agency from reduction of federal participation in accordance with this paragraph.

XIV. Termination for Public Convenience

The Secretary of the Washington State Department of Transportation may terminate the contract in whole, or from time to time in part, whenever:

(1) The requisite federal funding becomes unavailable through failure of appropriation or otherwise.

(2) The contractor is prevented from proceeding with the work as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense, or an Executive Order of the President or Governor of the State with respect to the preservation of energy resources.

(3) The contractor is prevented from proceeding with the work by reason of a preliminary, special, or permanent restraining order of a court of competent jurisdiction where the issuance of such order is primarily caused by the acts or omissions of persons or agencies other than the contractor.

(4) The Secretary is notified by the Federal Highway Administration that the project is inactive.

(5) The Secretary determines that such termination is in the best interests of the State.

XV. Venue for Claims and/or Causes of Action

For the convenience of the parties to this contract, it is agreed that any claims and/or causes of action which the Local Agency has against the State of Washington, growing out of this contract or the project with which it is concerned, shall be brought only in the Superior Court for Thurston County.

XVI. Certification Regarding the Restrictions of the Use of Federal Funds for Lobbying

The approving authority certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any federal agency, a member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with the awarding of any federal contract, the making of any federal grant, the making of any federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any federal agency, a member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit the Standard Form - LLL, “Disclosure Form to Report Lobbying,” in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, and contracts and subcontracts under grants, subgrants, loans, and cooperative agreements) which exceed $100,000, and that all such subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification as a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

XVII. Assurances

Local agencies receiving Federal funding from the USDOT or its operating administrations (i.e., Federal Highway Administration, Federal Transit Administration, Federal Aviation Administration) are required to submit a written policy statement, signed by the Agency Executive and addressed to the State, documenting that all programs, activities, and services will be conducted in compliance with Section 504 and the Americans with Disabilities Act (ADA).

Additional Provisions

Instructions

1. **Agency Name and Billing Address –** Enter the Agency of primary interest which will become a party to the agreement.
2. **Project Number** – Leave blank. This number will be assigned by WSDOT. Not including all fund program prefixes (ex. “STBGR”), Project Number is defined as the Federal Award Identification Number (FAIN).
3. **Agreement Number** – Leave blank. This number will be assigned by WSDOT.
4.
    a. **Project Description** – Enter the project name, total length of the project (in miles), and a brief description of the termini. Data entered here must be consistent with the name, length, and termini noted in the STIP and Project Prospectus

    Example: (Name) “Regal Road”, (Length) “1.2 miles”, (Termini) “Smith Road to Main Street”

    b. **Description of Work** – Enter a concise statement of the major items of work to be performed. Statement must be consistent with the description of work noted in the STIP and Project Prospectus.

    Example: “Overlay Regal Road; install curb, gutter, and sidewalk; illumination; and traffic signal at the intersection of Regal Road and Dakota Avenue.”

    c. **Project Agreement End Date** – Enter the Project Agreement End Date (mm/dd/yy). This date is based on the project’s Period of Performance (2 CFR 200.309).

    For Planning Only projects **–** WSDOT recommends agencies estimate the end of the project’s period of performance and add three years to determine the “Project Agreement End Date”.

    For PE and RW **–** WSDOT recommends agencies estimate when the phase will be completed and add three years to determine the “Project Agreement End Date”. For Construction **–** WSDOT recommends agencies estimate when construction will be completed and add three years to determine the “Project Agreement End Date”.

    d. **Advertisement Date –** At construction authorization only, enter the proposed project advertisement date (mm/dd/yy).

    e. **Claiming Indirect Cost Rate –** Check the Yes box if the agency will be claiming indirect costs on the project. For those projects claiming indirect costs, supporting documentation that clearly shows the indirect cost rate being utilized must be provided with the local agency agreement. Indirect cost rate approval by your cognizant agency or through your agency’s self-certification and supporting documentation is required to be available for review by FHWA, WSDOT and /or State Auditor. Check the No box if the agency will not be claiming indirect costs on the project. See section 23.5 for additional guidance.

4. **Type of Work and Funding (Round all dollar amounts to the nearest whole dollar)**

    a. **PE –** Lines a through d show Preliminary Engineering costs for the project by type of work (e.g., consultant, agency, state services, etc.).

    *Federal aid participation ratio for PE **–** enter ratio for PE lines with amounts in column 3.

    - **Line a –** Enter the estimated amount of agency work in columns 1 through 3.
    - **Line b & c** – Identify user, consultant, etc., and enter the estimated amounts in columns 1 through 3.
    - **Line d –** State Services. Every project must have funding for state services. Enter the estimated amounts in columns 1 through 3.
    - **Line e –** Total of lines a + b + c + d.

    b. **Right of Way** – If a Right of Way phase is authorized on the project, the appropriate costs are shown in lines f through i.

    *Federal aid participation ratio for RW **–** enter ratio for RW lines with amounts in column 3.

    - **Line f –** Enter the estimated amount of agency work in columns 1 through 3.
    - **Line g & h** – Identify user, consultant, etc., and enter the estimated amounts in columns 1 through 3.
    - **Line i –** State Services. Every project must have funding for state services. Enter the estimated amounts in columns 1 through 3.
    - **Line j –** Total of lines f + g + h + i.

    c. **Construction –** Lines k through p show construction costs for the project by type of work (e.g., contract, consultant, agency, state services, etc.).

*Federal aid participation ratio for CN – enter ratio for CN lines with amounts in column 3.

- **Line k –** Enter the estimated cost of the contract.
- **Lines l, m, & n –** Enter other estimated costs such as utility and construction contracts or non-federally matched contract costs.
- **Line o –** Enter estimated costs of all construction related agency work.
- **Line p –** State Services. Every project must have funding for state services. Enter the estimated amounts in columns 1 through 3.
- **Line q –** Total Construction Cost Estimate. Total of lines k + l + m + n + o +p.

d. **Total Project Cost Estimate**

- **Line r –** Total Cost Estimate of the Project. Total of lines e + j + q.

*Please remember, if the federal aid participation rate entered is not the maximum rate allowed by FHWA, then the participation rate entered becomes the maximum rate allowed.

6. **Signatures –** An authorized official of the local agency signs the agreement and enters their title and date of signature (mm/dd/yy). ***Note:*** Do NOT enter a date on the Date Executed line.
7. **Method of Construction Financing –** Choose the method of financing for the construction portion of the project.

a. **Method "A"** is used when the state administers the contract for the agency.

b. **Method "B"** is also used when the state administers the contract for the agency.

c. **Method "C"** is used with projects administered by the local agency. The agency will submit billings monthly through the state to FHWA for all eligible costs. The billings must document the payment requests from the contractor. If state-force work, such as audit and construction engineering, is to receive federal participation, it will be billed to the agency and FHWA simultaneously at the indicated ratio. To show continuous progress agencies should bill monthly until agreement is closed.

8. **Resolutions/Ordinances –** When someone other than the County Executive/Chairman, County Commissioners/Mayor is authorized to sign the agreement, the agency must submit to WSDOT with the agreement a copy of the Resolution/Ordinance designating that individual.

Washington State Department of Transportation

Local Agency Federal Aid Project Prospectus

	Prefix	Route	( )	Date	5/12/2025
Federal Aid Project Number				DUNS Number	
Local Agency Project Number		(WSDOT Use Only)		Federal Employer Tax ID Number	

Agency: City of Marysville	CA Agency: ☑ Yes ☐ No	Federal Program Title: ☑ 20.205 ☐ Other
Project Title: 67th Ave NE (Grove St to 88th St NE)	Start Latitude N 48.0643 End Latitude N 48.0752	Start Longitude W -122.1409 End Longitude W -122.1399
Project Termini From-To: Grove St — 88th St NE	Nearest City Name: Marysville	Project Zip Code (+4): 98270+7700

Begin Mile Post	End Mile Post	Length of Project	Award Type
		0.69	☑ Local ☐ Local Forces ☐ State ☐ Railroad

Route ID	Begin Mile Point	End Mile Point	City Number	County Number	County Name
			0745	31	Snohomish

WSDOT Region	Legislative District(s)	Congressional District(s)	Urban Area Number
Northwest Region	38,39	1	1

Phase	Total Estimated Cost (Nearest Hundred Dollar)	Local Agency Funding (Nearest Hundred Dollar)	Federal Funds (Nearest Hundred Dollar)	Phase Start Date Month	Year
P.E.	85,500	85,500		June	2024
R/W					
Const.	1,620,700	815,000	805,700	June	2025
Total	1,705,200	900,500	805,700		

Description of Existing Facility (Existing Design and Present Condition)

Roadway Width	Number of Lanes
42-ft	3

Description of Proposed Work

Description of Proposed Work (Attach additional sheet(s) if necessary)

This is a preservation project that will include minor pavement repair, grinding and overlay on 67th Ave NE from Grove Street to 88th St NE. The project will also include the necessary ADA ramp upgrades, pavement markings and replacing traffic control loops.

Local Agency Contact Person	Title	Phone	
Valorie Cross	Project Engineer	360-363-8254	
Mailing Address: 501 Delta Ave	City: Marysville	State: WA	Zip Code: 98270

Project Prospectus

By Signed by: Jeff Laycock 278A8D8A087C439... Approving Authority

Title Engineering Services Director   Date 5/20/2025

Agency	Project Title	Date
City of Marysville	67th Ave NE (Grove St to 88th St NE)	5/12/2025

Type of Proposed Work

Project Type (Check all that Apply)	Roadway Width	Number of Lines
☐ New Construction ☐ Path / Trail ☑ 3-R ☑ Reconstruction ☐ Pedestrian / Facilities ☐ 2-R ☐ Railroad ☐ Parking ☐ Other ☐ Bridge	42	3

Geometric Design Data

Description	Through Route	Crossroad
Federal Functional Classification	☑ Urban ☐ Rural ☐ NHS ☐ Principal Arterial ☑ Minor Arterial ☐ Collector ☐ Major Collector ☐ Minor Collector ☐ Local Access	☑ Urban ☐ Rural ☐ NHS ☑ Principal Arterial ☑ Minor Arterial ☐ Collector ☑ Major Collector ☐ Minor Collector ☑ Local Access
Terrain	☑ Flat ☐ Roll ☐ Mountain	☑ Flat ☐ Roll ☐ Mountain
Posted Speed	35	25, 35
Design Speed	35	25, 35
Existing ADT		
Design Year ADT		
Design Year		
Design Hourly Volume (DHV)		

Performance of Work

	Others	Agency
Preliminary Engineering Will Be Performed By City of Marysville	%	100 %

	Contract	Agency
Construction Will Be Performed By Low-Bid Contractor	100 %	%

Environmental Classification

☐ Class I - Environmental Impact Statement (EIS)

- ☐ Project Involves NEPA/SEPA Section 404 Interagency Agreement

☑ Class II - Categorically Excluded (CE)

- ☑ Projects Requiring Documentation (Documented CE)

☐ Class III - Environmental Assessment (EA)

- ☐ Project Involves NEPA/SEPA Section 404 Interagency Agreements

Environmental Considerations

No environmental impacts as no additional impervious area are planned and the existing storm water conveyance will be handled with a SWPPP.

Agency	Project Title	Date
City of Marysville	67th Ave NE (Grove St to 88th St NE)	5/12/2025

Right of Way

- ☑ No Right of Way Needed
  * All construction required by the contract can be accomplished within the existing right of way.
- ☐ Right of Way Needed
  - ☐ No Relocation
  - ☐ Relocation Required

Utilities	Railroad
☑ No utility work required	☑ No railroad work required
☐ All utility work will be completed prior to the start of the construction contract	☐ All railroad work will be completed prior to the start of the construction contract
☐ All utility work will be completed in coordination with the construction contract	☐ All the railroad work will be completed in coordination with the construction contract

Description of Utility Relocation or Adjustments and Existing Major Structures Involved in the Project

No major utility relocations are planned, and that irons and monuments will be adjusted/protected.

FAA Involvement

Is any airport located within 3.2 kilometers (2 miles) of the proposed project? ☐ Yes ☑ No

Remarks

This project has been reviewed by the legislative body of the administration agency or agencies, or it's designee, and is not inconsistent with the agency's comprehensive plan for community development.

Agency City of Marysville

DocuSigned by:

By Jon Nehring

A8AE51528DE9478...

Date

Mayor/Chairperson

AGENDA ITEM NO. 7.

MARYSVILLE
WASHINGTON

Agenda Bill

CITY COUNCIL AGENDA ITEM REPORT

DATE:	May 27, 2025
SUBMITTED BY:	Stephen Doherty, Information Systems
ITEM TYPE:	Agreement
AGENDA SECTION:	**New Business**
SUBJECT:	Interlocal Agreement between City of Marysville and Snohomish County to Provide Information Technology Services
SUGGESTED ACTION:	Recommended Motion: I move to authorize the Mayor to sign and execute the interlocal agreement with Snohomish County for IT Services.
SUMMARY:	Our existing 5-year IT services ILA with Snohomish County is set to expire on July 1st, 2025. This request is for the approval of a new 5-year ILA with Snohomish County for the same IT services with the addition of RAVE emergency response alerting. Currently the city manages a stand-alone RAVE environment and by purchasing our RAVE services through Snohomish County, the city and its residents will benefit from a cost savings in excess of $10,000 annually. Additionally, the overall efficiency within the city's Emergency Preparedness services will be realized by decreasing city staff overhead required to support and manage a stand-alone environment. The annual cost for this agreement is $14,354.55 with the first 12-month cycle starting on July 1st, 2025.

ATTACHMENTS:
Marysville ILA 2025 with WO_final AATF.pdf
Snohomish County_City of Marysville_25-26 GL, Ex, Cyber, Stop_5-21-2025.pdf

COUNTY DEPARTMENT:	Department of Information Technology
CONTACT PERSON:	Viggo Forde, Director
ADDRESS:	3000 Rockefeller Ave. Everett, WA 98201
TELEPHONE/EMAIL:	(425) 388-3703 / viggo.forde@snoco.org
PUBLIC AGENCY:	City of Marysville
AGENCY CONTACT PERSON:	Stephen Doherty, Director
ADDRESS:	501 Delta Avenue Marysville, WA 98270
TELEPHONE/EMAIL:	(360) 363-8028 / sdoherty@marysvillewa.gov
PROJECT:	Information Technology Services
AMOUNT:	As specified in Work Orders Not to exceed $100,000 for the five (5) year life of the Agreement
FUND SOURCE:	City of Marysville
CONTRACT DURATION:	July 1, 2025 through June 30, 2030

INTERLOCAL AGREEMENT BETWEEN CITY OF MARYSVILLE AND SNOHOMISH COUNTY TO PROVIDE INFORMATION TECHNOLOGY SERVICES

THIS AGREEMENT is entered into by and between SNOHOMISH COUNTY, a political subdivision of the State of Washington, through its Department of Information Technology (hereinafter "County" or "SCIT") and City of Marysville (hereinafter "Agency") for the purpose of SCIT providing information technology services to Agency.

WHEREAS, this Agreement is made pursuant to the authority granted by Chapter 39.34 RCW, the Interlocal Cooperation Act; and

WHEREAS, Chapter 2.350 of the Snohomish County Code (SCC) provides for SCIT to provide for information services, information processing, software and purchased information services to public agencies and cash-on-delivery customers; and

WHEREAS, Agency is a "public agency" as that term is defined in SCC 2.350.020(13) and RCW 39.34.020; and

WHEREAS, Agency requires information technology services, which may include maintenance and support, assistance in the planning, management, control, operation, and use of information services, network, telecommunications, information processing, equipment, purchased services and proprietary software.

NOW, THEREFORE, and in consideration of the respective agreements set forth below and for other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the County and Agency agree as follows:

1. <u>Scope of Information Technology Services:</u>

   a. The County will provide information technology goods and information processing services as agreed upon in Work Order (WO). Each WO shall be executed by the County Executive, or his designee, and an authorized agent for Agency, and subject to the general terms and conditions of this Agreement. Each WO will include a description of the specific services to be provided, the term, and the costs of such service from quotation or from the published rate or fee schedule, and any other terms or conditions applicable to that service. The scope of information technology goods and information services to be provided are limited to the following:

      A. Provide space in the Meet-Me-Room rack to mount Agency's network equipment in the SCIT data center;

      B. Provide cross-connects to connect to other agencies or services located in the SCIT data center;

      C. Assist in the planning, management, control, operation and use of integrated city, jurisdictional, government and County networks, telecommunications, information processing, systems and equipment required by Agency; provide Internet Service Provider (ISP) services;

      D. Coordination of the planning, management, control, operation, and use of information services, backbone network, telecommunications, information processing, equipment, purchased services and proprietary software required by Agency;

      E. Provide Orthoimagery through Snohomish County's agreement with EagleView (Pictometry International Corp.);

      F. Provide hourly Geographic Information Systems as requested by Agency;

      G. Provide access and support for software platform providing alert services.

2. <u>Contract Maximum</u>: All Work Orders executed under this ILA shall not exceed an aggregate total of $100,000.00.

3. TREATMENT OF ASSETS: COMPUTER APPLICATION PROGRAMS AND OTHER SOFTWARE SYSTEMS FURNISHED TO Agency BY THE COUNTY ARE FURNISHED ON AN "AS IS" BASIS WITH NO REPRESENTATIONS OR WARRANTIES REGARDING USE OR RESULTS INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, UNLESS INDICATED IN A WO FOR SERVICE.

Agency Data: "Agency Data" means the data provided or input by or on behalf of Agency, and User or Affiliate of Agency or any authorized Third-Party User for use with the services. Agency shall own all rights, title and interest in and be completely responsible for the Agency Data, which shall never be deemed to be property of the County, even if delivered or incorporated therewith into any custom software or service provided by the County. The County shall have no responsibility whatsoever for the accuracy, quality, integrity, legality, reliability, appropriateness, and intellectual property ownership of Agency Data, and the County shall not review, monitor or check the Agency Data except as necessary to provide the service to Agency. The County shall not be responsible for, or liable, in any way, for the deletion, destruction, damage, breach or loss of any Agency Data through no fault of the County or its providers.

Property: Title to all property furnished by the County shall remain in the County. Title to all property purchased by Agency for which Agency is not reimbursed by the County shall remain the property of Agency. Title to all property purchased by Agency for which Agency is reimbursed by the County and is used as a component of services provided under this Agreement shall pass to and vest in the County upon completion, termination, or cancellation of the relevant WO or this Agreement.

Any property of the County furnished to Agency shall, unless otherwise provided in this Agreement, or approved by the County, be used only for the performance of this Agreement or a WO. Agency shall be responsible for any loss or damage to County property that County furnishes to Agency.

If County property is lost, destroyed, or damaged, Agency shall immediately notify the County and shall take all reasonable steps to protect the property from further damage.

Surrender of Property: Agency shall surrender to County all property belonging to County upon completion, termination, or cancellation of this Agreement. Conversely, County shall surrender to Agency all property of Agency upon completion, termination, or cancellation of this Agreement.

4. Time of Performance: Pursuant to RCW 39.34.040 this Agreement shall become effective upon signature by both parties and either (a) listing of the Agreement by subject on either party's web site or (b) recording of the Agreement with the Snohomish County Auditor. The Agreement shall remain in force for a period up to five (5) years, unless terminated earlier by either party upon ninety (90) days prior written notice to the other party.

5. Compensation: At no additional cost to Agency, Agency may request an estimate or quotation of cost for proposed information technology goods or information processing services from County. Specific agreements addressing costs, term, schedules, and other factors will be described in an associated WO developed from initial estimates or quotations.

Agency will pay County for services provided hereunder and as set out in WOs.

Charges for information technology, goods and information processing services under this Agreement shall be based on the current published rate or fee schedule of the County in effect on the date of execution of this Agreement, unless the specific quotation described in the WO provides otherwise. Rate and Fee schedules are subject to change. The most current rate and fee schedule supersedes and replaces all previous published rate and fee schedules.

The County will submit an invoice or advice of charge to Agency annually in advance, or as defined in a WO, detailing charges for services rendered. Payment is due in full 30 days after receipt of the invoice by Agency and becomes delinquent sixty (60) days thereafter.

A late payment fee may be applied to any remaining balance sixty (60) days after receipt of invoice. Late payment charges, if any, will be imposed on the unpaid balance at a rate of one percent (1%) per month. If Agency fails to pay a WO invoice more than ninety (90) days past due, and fails to cure the same within 5 days written notice of the County, the County may terminate this Agreement or an applicable WO. Amounts disputed by Agency under Section 8 of this Agreement are not subject to late payment charges.

6. Obligations of Agency are as follows: As to all new Agency acquisitions of any information technology equipment, software or systems to be serviced under this Agreement, Agency shall undertake such acquisitions in accordance with guidelines, standards or procedures established by SCIT and shall secure written concurrence for any such procurement from the County Executive or his/her designee.

Agency shall make payment to County of all submitted invoices or advices of charge pursuant to Section 5 of this Agreement.

7. Mutual Covenants: Agency will promptly notify the County in writing of issues regarding invoices, or of services which Agency believes do not conform with the agreed upon terms of this Agreement and/or WO, within thirty (30) days of receipt of invoice or performance of services, whichever occurs later. Failure to give written notice within thirty (30) days after receipt of invoice or performance of services constitutes waiver of any objection to services or invoices.

Except as set forth in Section 5 of this Agreement, the parties shall attempt to resolve any issues arising under this Agreement and/or any applicable WO through negotiation and consultations. If that fails, the parties will seek to resolve disputes through the aid of a mutually selected, independent third party.

This Agreement may only be modified by a written amendment executed with the same formalities as are required for execution of this Agreement.

Both parties understand the County retains discretion regarding the operation and allocation of the aggregate information processing capacity at its disposal, including the capacity covered by this Agreement. County agrees to allocate sufficient capacity to meet the existing processing requirements of Agency during the term of this Agreement.

8. County Review and Approval: Upon submittal of any request to execute a WO or to perform optional services under any executed WO, the County may, following review by the SCIT, agree to perform such work or reject it, or request such modification or additions as it deems appropriate.

   At the outset of performance of each WO, or during performance of the WO to the extent the same is modified by the Parties, the County will either accept or reject Agency's systems and services as listed in the WO. The County will not invoice Agency until the County has accepted service and/or system delivery responsibility, and the WO has been approved per Section 1 of this Agreement. Agency is not required to pay for services or systems until the County accepts delivery responsibility for those services and/or systems.

9. Access to Books/Records: Each Party may, at reasonable times, and upon prior notification inspect the records of the other party relating to performance of this Agreement. County and Agency shall keep all records required by this Agreement in accordance with statutory archival requirements.

10. Indemnification and Hold Harmless: Subject to the liability limitation stated in Section 11 of this Agreement, Agency shall hold harmless, indemnify, and defend, at its own expense, SCIT, its elected and appointed officials, officers, employees and agents, from any loss or claim for damages of any nature whatsoever, arising out of Agency's collection, disclosure, maintenance, use or the breach of Agency Data, or its performance of this Agreement, including claims by Agency's employees or third parties, except for those losses or claims for damages solely caused by the negligence or willful misconduct of the County, its elected and appointed officials, officers, employees or agents.

    Subject to the liability limitations stated in Section 11 of this Agreement, County shall hold harmless, indemnify, and defend, at its own expense Agency, its elected and appointed officials, officers, employees and agents, from any loss or claim for damages of any nature whatsoever, except loss for data breach, arising out of County's performance of this Agreement, including claims by County employees or third parties, except for those losses or claims for damages solely caused by the negligence or willful misconduct of Agency, its elected and appointed officials, officers, employees or agents.

    Subject to the liability limitations stated in Section 11 of this Agreement, in the event of liability for damages of any nature whatsoever arising out of the performance of this Agreement by Agency and County, including claims by Agency's and County's own officers, officials, employees, agents, volunteers, or third parties, caused by or resulting from the concurrent negligence of Agency and the County, their officers, officials, employees, agents and volunteers, each party's liability hereunder shall only be to the extent of that party's negligence.

11. Limitation of Liability: In no event will County or Agency be liable for any special, consequential, indirect, punitive or incidental damages, including but not limited to loss of data, loss of revenue, or loss of profits, arising out of or in connection with the performance of the County or Agency under this Agreement or any WO hereunder, even if the County or Agency has been advised of the possibility of such damages. IN NO EVENT WILL THE COUNTY BE LIABLE FOR ANY STATUTORY OBLIGATIONS, CONSEQUENTIAL, INDIRECT, PUNITIVE OR INCIDENTAL DAMAGES, INCLUDING BUT NOT LIMITED TO BREACH AND/OR LOSS OF DATA NOT CAUSED BY THE COUNTY, LOSS OF REVENUE, LOSS OF GOODWILL OR LOSS OF PROFITS, ARISING OUT OF OR IN CONNECTION WITH THE PERFORMANCE OF THE COUNTY UNDER THIS AGREEMENT OR ANY SUPPLEMENTAL WORK ORDER HEREUNDER, WHETHER BASED IN CONTRACT, TORT, INTENDED CONDUCT OR OTHERWISE, INCLUDING WITHOUT LIMITATION COSTS INCURRED AS A RESULT OF DECISIONS MADE IN RELIANCE ON THE SERVICES, LOSS OF THE SERVICES, OR ANY OTHER LOSS OF DATA, THE COSTS OF RECOVERING OR RECONSTRUCTION SUCH DATA OR CLAIMS BY THIRD PARTIES.

12. Insurance:

12.1 Agency may self-insure against such risks in such amounts as are consistent with good practice or shall obtain a coverage agreement through a Risk Pool authorized by Chapter 39.24 RCW, which shall provide liability coverage for the liabilities contractually assumed. by Agency in this Agreement. **OR**

12.2

a. Agency shall maintain continuously for the duration of this Agreement the following insurance minimum limits of liability and meet the requirements below:

(i) **Commercial General Liability** written on an occurrence form at least as broad as ISO CG 00 01 with minimum limits of liability of $1,000,000 each occurrence, $2,000,000 General Aggregate, $2,000,000 Products/Completed Operations Aggregate, $1,000,000 Personal/Advertising Injury Liability, $1,000,000 Damage to Premises, $1,000,000 each accident/disease—policy limit/disease—each employee stop gap/Employer's Liability;

(ii) **Cyber Liability** Insurance, with limits not less than **$2,000,000** per occurrence or claim, **$2,000,000** aggregate. Coverage shall include, but not be limited to, claims involving security breach, system failure, data recovery, business interruption, cyber extortion, social engineering, infringement of intellectual property, including but not limited to infringement of copyright, trademark, trade dress, invasion of privacy violations, information theft, damage to or destruction of electronic information, release of private information, and alteration of electronic information. The policy shall provide coverage for breach response costs, regulatory fines and penalties, as well as credit monitoring expenses.

b. Insurance Provisions and Requirements.

1. The insurance coverages required in this Agreement for all liability policies except Professional Liability, if applicable, must contain, or must be endorsed to contain, the following provisions:

(i) The County, its officers, officials, employees and agents are to be covered as additional insureds as respects liability arising out of activities performed by or on behalf of Agency in connection with this Agreement. Such coverage shall be primary and non-contributory insurance as respects the County, its officers, officials, employees and agents.

(ii) Agency's insurance coverage shall apply separately to each insured against whom a claim is made and/or lawsuit is brought, except with respect to the limits of the insurer's liability.

12.3.

a. The deductible and/or self-insured retention of the policies shall not limit or apply to Agency's liability to the County and shall be the sole responsibility of Agency.

b. Agency's maintenance of insurance or self-insurance as required by this Agreement shall not be construed to limit the liability of Agency to the coverage provided by such insurance, or otherwise limit the County's recourse to any remedy available at law or in equity.

c. The insurance requirements contained herein shall not in any manner be deemed to limit or qualify the liabilities or obligations assumed by Agency under this Agreement.

d. Agency shall insure that any Subcontractor and all others performing any work under this Agreement shall obtain insurance appropriate to the services being provided and in amounts sufficient to cover the risks posed by such work.

13. <u>Compliance with Laws</u>: The County and Agency shall comply with all applicable federal, state, and local laws, rules, and regulations in performing this Agreement. Agency will comply with SCIT procedures and policies related to technology management and use of applicable County systems, applications and services, including but not limited to ensuring all users complete annual cyber security training.

14. <u>Non-assignment</u>: The County and Agency shall not assign any of the rights, duties, or obligations covered by this Agreement without the prior express written request and consent of the other party.

15. <u>Conflicts between Attachments and Text</u>: Should any conflicts exist between any attached exhibit or WO and the text of this Agreement, the text of this Agreement shall prevail.

16. <u>Interlocal Cooperation Act</u> (Chapter 39.34 RCW): The purpose of this Agreement is to allow

the County to provide a variety of information technology services to Agency as needed over a five (5) year term. WOs will be executed by both parties as necessary and will describe the services to be provided and their associated costs. The parties agree that no separate legal or administrative entities are necessary to carry out this Agreement. The parties agree that it is not necessary to appoint an administrator or joint board to oversee the implementation of this Agreement. However, should a court of competent jurisdiction deem such an administrator or joint board necessary for purposes of the Interlocal Cooperation Act, Ch. 39.34 RCW, an administrator or joint board will be established by mutual agreement of the parties. Except as expressly provided to the contrary in this Agreement, any real or personal property used or acquired by either party in connection with the performance of this Agreement will remain the sole property of such party, and the other party shall have no interest therein.

17. Governing Law and Venue: This Agreement shall be governed by the laws of the State of Washington and any lawsuit regarding this Agreement must be brought in Snohomish County Superior Court, Washington.

18. Severability: Should any clause, phrase, sentence or paragraph of this Agreement be declared invalid or void, the remaining provisions of this Agreement shall remain in full force and effect.

19. Recording: The parties may file this Agreement with the Snohomish County Auditor pursuant to RCW 39.34.040 or list the Agreement by subject on either party's web site.

20. No Separate Legal Entity: To accomplish the purposes of this Agreement, the parties do not create a separate legal entity nor do the parties form a joint board.

21. Public Records: This Agreement and all public records associated with this Agreement shall be available from the County for inspection and copying by the public where required by the Public Records Act, Chapter 42.56 RCW (the "Act"). To the extent that public records then in the custody of Agency are needed for the County to respond to a request under the Act, as determined by the County, Agency agrees to make them promptly available to the County. If Agency considers any portion of any record provided to the County under this Agreement, whether in electronic or hard copy form, to be protected from disclosure under law, Agency shall clearly identify any specific information that it claims to be confidential or proprietary. If the County receives a request under the Act to inspect or copy the information so identified by Agency and the County determines that release of the information is required by the Act or otherwise appropriate, the County's sole obligations shall be to notify Agency (a) of the request and (b) of the date that such information will be released to the requester unless Agency obtains a court order to enjoin that disclosure pursuant to RCW 42.56.540. If Agency fails to timely obtain a court order enjoining disclosure, the County will release the requested information on the date specified. To the extent that public records then in the custody of the County are needed for Agency to respond to a request under the Act, as determined by Agency, the County agrees to make them promptly available to Agency. If the County considers any portion of any record provided to Agency under this Agreement, whether in electronic or hard copy form, to be protected from disclosure under law, the County shall clearly identify any specific information that it claims to be confidential or proprietary. If Agency receives a request under

the Act to inspect or copy the information so identified by the County and Agency determines that release of the information is required by the Act or otherwise appropriate, Agency's sole obligations shall be to notify the County (a) of the request and (b) of the date that such information will be released to the requester unless the County obtains a court order to enjoin that disclosure pursuant to RCW 42.56.540. If the County fails to timely obtain a court order enjoining disclosure, Agency will release the requested information on the date specified.

Neither the County nor Agency has, and by this section assumes, any obligation on behalf of the other party to claim any exemption from disclosure under the Act. Each party shall not be liable to the other for releasing records not clearly identified as confidential or proprietary. Neither party shall be liable to the other for any records that it releases in compliance with this section or in compliance with an order of a court of competent jurisdiction.

22. Non-discrimination. It is the policy of the County to reject discrimination which denies equal treatment to any individual because of his or her race, creed, color, national origin, families with children, sex, marital status, sexual orientation, age, honorably discharged veteran or military status, or the presence of any sensory, mental, or physical disability or the use of a trained dog guide or service animal by a person with a disability as provided in Washington's Law against Discrimination, Chapter 49.60 RCW, and the Snohomish County Human Rights Ordinance, Chapter 2.460 SCC. These laws protect against specific forms of discrimination in employment, credit transactions, public accommodation, housing, county facilities and services, and county contracts.

    Agency shall comply with the substantive requirements of Chapter 2.460 SCC, which are incorporated herein by this reference. Execution of this Agreement constitutes a certification by Agency of Agency's compliance with the requirements of Chapter 2.460 SCC. If Agency is found to have violated this provision, or to have furnished false or misleading information in an investigation or proceeding conducted pursuant to this Agreement or Chapter 2.460 SCC, this Agreement may be subject to a declaration of default and termination at the County's discretion. This provision shall not affect Agency's obligations under other federal, state, or local laws against discrimination.

23. Authorization: Each individual executing this Agreement represents that he/she has been duly authorized to do so on behalf of the party by the governing body as required under RCW 39.34.030(2).

24. Prior Agreements: Any and all prior agreements of the parties related to the same subject matter as this Agreement shall be replaced and superseded by this Agreement.

Signature page follows.

"County"
SNOHOMISH COUNTY

By: ______________________________
County Executive Date

"Agency"
CITY OF MARYSVILLE

By:______________________________
Title: ____________________________ Date

Agency Attorney Date

____

Approved as to indemnification provisions:

____
Risk Management Date

Approved only as to form:

Wendling, Rebecca Digitally signed by Wendling, Rebecca
Date: 2025.05.09 09:10:00 -07'00'
____
Deputy Prosecuting Attorney Date

Exhibit A - Work Order (WO 25-01)

Network, Internet & GIS Support Services

This Work Order (WO) is executed between Snohomish County, through its Department of Information Technology (the "County" or "SCIT") and City of Marysville ("Agency") pursuant to the terms and conditions of that certain Interlocal Agreement ("ILA") between Agency and Snohomish County to Provide Information Services effective upon signature by both parties. The parties acknowledge that they have read and understand the terms and conditions therein. All rights and obligations of the parties shall be subject to and governed by the terms of the ILA. This WO sets forth the obligations of the parties with respect to SCIT's provision of information services to Agency. This WO also serves as the Service Level Agreement, (See Section 9 Service Levels and Designated Points of Contact and Escalation Points Table of this WO) between Agency and SCIT.

1. **Purpose:** The purpose of this WO is for SCIT to provide to Agency information services as specified in Appendix A.

2. **Scope of Work:** The specific services covered by this WO includes the "Primary" items listed in Appendix A – Services Listing and any item directly "associated" with the Primary items after acceptance by SCIT.

3. **Rates and Adjustments:** Rates under this WO shall be updated annually by the County, with counts and rate cost data negotiated as part of Snohomish County's annual budget and service rate model. As required, County, in conjunction with Agency, will perform inventories of all equipment, standard desktop software licenses, and services covered under this WO and the inventories will be adjusted as necessary. The County will invoice Agency based on these inventories unless additional equipment or services are added or deleted, in which case cost adjustments may occur.

4. **Payment for Services:** County will invoice Agency for the Services per Section 5, Compensation, of the Interlocal Agreement (ILA). Agency will be billed in full for Services rendered up to and including the date County receives Agency's cancellation or change request.

5. **Term and Termination:** The term of this WO is effective upon the date of execution by both parties unless terminated upon written notification to the other party. Either party may terminate this WO upon ninety (90) day's written notification to the other party. In the event the ILA is terminated, this WO shall also terminate on the ILA termination date.

6. **GIS Term, Termination, Payment**: If the County's agreement with the GIS provider is terminated or otherwise not renewed, the GIS services provided to the Agency under this ILA shall also be terminated. The County shall provide a minimum of sixty (60) days written notice of GIS services termination to the Agency. If the Agency is invoiced by the County for services in advance on an annual basis and GIS services are terminated at a time other than at annual renewal, the Agency may elect to 1) receive a discount for the next annual invoice in the amount

of the unused portion of pre-paid GIS services or, 2) receive a refund for the unused portion of pre-paid GIS services.

7. **Prohibited Use of Services:**
   a. Agency shall not use any Service in a manner that Snohomish County reasonably determines may adversely affect Snohomish County systems, Snohomish County customers, the integrity and operations of Snohomish County's business, or Snohomish County's ability to provide services to Snohomish County customers.
   b. By executing this WO, Agency acknowledges and agrees that Snohomish County may monitor any activity and content associated with the use of the Services. Snohomish County may cooperate with law enforcement agencies in any investigation related to the use of a Snohomish County Service and investigate any complaint or reported violation of law or Snohomish County policy. Snohomish County may take action in response to requests Snohomish County reasonably deems to be legally enforceable. Action may include, but is not limited to, issuing warnings, suspension, or termination of a Service; removal of materials on a Snohomish County-hosted web site; or disclosure of information agencies, such as user contact details, IP addressing and traffic information, usage history, posted content, to law enforcement.

8. **Resale of Snohomish County Services:** Agency shall not resell or provide free of charge any Service to any third party without first entering into a Contract for Service with Snohomish County that permits these activities.

9. **Service Levels and Designated Points of Contact and Escalation Points:** SCIT's designated point of contact for Agency to request Support Services, contact Service personnel, request problem status updates, and receive problem resolutions is via the SCIT Help Desk at (425) 388-3378, Monday – Friday, 8:00 a.m. – 5:00 p.m., excluding holidays. Schedule is subject to change by written notice from SCIT.

   SCIT Contacts and Escalation Points:

Service Desk	425-388-3378
Systems and Network Engineering Supervisor	425-388-7171
GIS Supervisor	425-262-2150
Customer & Workstation Supervisor	425-388-3899
Infrastructure & Security Manager	425-388-3998
Deputy Director	425-388-3022
Director	425-388-3739

   Agency's designated point of contact for SCIT to send invoices, problem-solve and otherwise conduct business shall be:

Agency Primary Contact:	Stephen Doherty, Director (360) 363-8028 sdoherty@marysvillewa.gov

Agency Secondary Contact:	Chris Brown, I.T. Operations Supervisor (360) 363-8036 cbrown@marysvillewa.gov
Marysville GIS Services Contact:	Jacob Milner, GIS Manager (360) 363-8247 jmilner@marysvillewa.gov
Marysville Alert Services Contact:	Sarah Lavelle, EM Admin (360) 363-8096 slavelle@marysvillewa.gov
Agency Billing Contact:	Jeremiah Nyman, I.T. Services Supervisor (360) 363-8033 ISPurchasing@marysvillewa.gov

Service Level Response Table

Response Level	Condition	Response Time	Escalation Path
Emergency Response	Network outage, multi-user outage/ critical event, or when Agency is unable to conduct business.	2 hours	SCIT's assigned primary response contact will make contact within two (2) hours of receiving notification from either the Help Desk or Management. If contact is not made within 2 hours the call receiver will contact the secondary support contact. If still unable to contact, the appropriate supervisor will be contacted. The assigned response contact will schedule network operations access as necessary.
Priority Problem Response	Network is impaired, Agency is still able to conduct business, but no practical workaround exists.	3 Hours	SCIT's primary response contact will make contact with Agency's designated primary contact. If contact is not made within three (3) hours, the call receiver will contact the designated secondary contact. If still unable to contact, the appropriate supervisor will be contacted. The assigned response contact will schedule network operations access as necessary.
Routine Response	User is inconvenienced, or non-mission-critical application is impaired. Practical workaround exists.	3 Days	SCIT's primary response contact will respond to this category of call when all other service requests of higher priority have been answered. Every effort will be made to respond within three (3) business days. This category of call includes but is not limited to: training issues, minor operational issues, and minor system inconveniences.

10. **Declined Equipment:** No equipment is provided by this WO. All equipment maintenance is the responsibility of Agency.

11. **Pricing and Service Fees:** The pricing and fee schedule for services provided by SCIT are outlined in Appendix A of this WO.

12. **Modifications / Changes:** Services may be modified at any time upon mutual written agreement of the parties. Modifications that remain within the ILA Contract Maximum will be made through the issuance of a new WO, which will take precedence over the original WO.

13. **Assignment:** Neither party shall assign any of the rights, duties, or obligations covered by this WO without the prior express written request and consent of each party.

14. **Notices:** Notices and other communications between Snohomish County and Agency where delivery is not otherwise specified in the ILA may be delivered by electronic mail. Communications related to the ILA may be directed to Snohomish County Department of Information Technology at: DIS.Admin@snoco.org. Agency shall provide Snohomish County with a valid email address to be used by the County for communications for the ILA and shall update that address as needed. The County shall fulfill its obligations under the ILA providing Agency with notice at the email address most recently provided to the County by Agency for use in providing notices pursuant to the ILA.

15. **Responsibilities:**
    a. **SCIT Responsibilities:**
        i. Provide services listed in Appendix A.
        ii. Configure, maintain, provide warranty and repair all County-owned equipment and transports.
        iii. Provide IT Service Desk (425-388-3378) as initial point of contact for suspected problems or to request Data Center access.
        iv. In the event SCIT determines a request for assistance is outside the scope of this WO, SCIT will work with the Agency to develop and recommend approaches to meet Agency requirements.
        v. Provide Agency's fiber vendor a termination point for a single pair of single mode fiber.
        vi. Provide Agency one (1) unit of rack space and UPS power in SCIT's Data Center for an ethernet switch.
        vii. Provide path for fiber or single mode fiber between termination point and Agency's equipment.
        viii. SCIT takes no ownership regarding the repair of Agency owned equipment.
        ix. Provide escorted access to the Network Operations Center (NOC) between the hours of 8:00 am and 5:00 pm Pacific Time, Monday through Friday, excluding holidays. Access to Network Operations Center after hours will result in an additional per-incident fee as detailed in Appendix A to Exhibit A. Contact 425-388-3378 for access to the facility.
        x. Provide internet service on a per-megabyte use basis.
        xi. Provide a /29 address range to support Agency's public IP addressing needs.
        xii. Upon completion of the 2024, 2026 and 2028 EagleView regional aerial imagery acquisition projects and receipt of imagery by County, County will provide Agency with orthogonal imagery for Agency's identified area of interest, which includes aerial imagery within the Agency city limits and additional surrounding area. County will deliver Orthogonal imagery tiles via a hard drive or FTP. County will also provide to Agency up to ten (10) EagleView CONNECTExplorer accounts based on staff names and emails provided by the Agency. Agency executed an Authorized Subdivision Agreement with

EagleView on February 4, 2021. County will maintain Agency's CONNECTExplorer accounts for Agency and provide orthogonal imagery pursuant to this Agreement so long as the Agency's fully executed Authorized Subdivision Agreement between Agency and EagleView remains in force.

xiii. Rave alert services as defined in Appendix B.

b. **<u>Agency Responsibilities:</u>**

i. Provide fiber connectivity between Agency and County data facilities.

ii. Provide Ethernet Switching equipment for 1 unit of rack space within County Data Center.

iii. Provide maintenance of Ethernet Switching equipment.

iv. Provide to County a fully executed Subdivision Agreement between Agency and EagleView.

v. Use of Rave alert services as described in Appendix B.

16. **Scheduled Maintenance:** Each Saturday between 12:00 am and 12:00 pm and Wednesday between 5:30 pm and 12:00 am Pacific Time are Snohomish County's regularly scheduled maintenance windows. Regular maintenance is essential to overall network health. If maintenance that will disrupt contracted services is scheduled by Snohomish County, the County will notify Agency two (2) business days prior to the scheduled action.

17. **Work Order Management**: Unless otherwise indicated, all correspondence regarding this WO should be directed to:

Agency Primary Contact:	Stephen Doherty, Director City of Marysville 501 Delta Avenue Marysville, WA 98270 (360) 363-8028
SCIT Primary Contact:	JD Braathen, Systems & Network Engineering Supervisor Snohomish County Dept. of Information Technology 3000 Rockefeller Avenue, M/S 709 Everett, WA 98201 (425) 388-7171
SCIT Primary Contact: GIS Support Services	Ed Whitford, GIS & Data Supervisor Snohomish County Dept. of Information Technology 3000 Rockefeller Avenue, M/S 709 Everett, WA 98201 (425) 262-2150

By their signatures, County and Agency hereby acknowledge and accept the terms and conditions of this WO.

Approved

City of Marysville

Signature

Print or Type Name

Title *Date*

Approved

Snohomish County

Snohomish County Executive

Print or Type Name

Title *Date*

Appendix A to Exhibit A
Work Order Services and Summary of Costs

SCIT will provide the following Services at the prepaid support rate identified below.

Annual invoice for all Services shall be issued in May.

Note: Access during normal business hours will be covered under the Network Equipment Hosting service.

TABLE 1 – SCIT SERVICES AND RATES

Service	2025 Service Rate	Metric	2025 Annual Fee
Network Equipment Hosting 2-Rack Unit Space First 4 cross connects	$600/Space ($50/month)	n/a	$600.00
State IGN Access	$148/Month	n/a	$1,776.00
Alert Services (Rave)	n/a	n/a	$6,645.00
Network Services Administrative Fee	5% of total	Total $9,021.00 x 0.05	$451.05
NETWORK SERVICES TOTAL			**$9,472.05**
Imagery Data 3" AccuPlus (annual)	$150/sq mile	31 sq miles	$4,650.00
Imagery Administrative Fee	5% of total	Total $4,650 x 0.05	$232.50
GEOGRAPHIC INFORMATION SERVICES TOTAL			**$4,882.50**
		GRAND TOTAL	**$14,354.55**

TABLE 2 - PER USE BILLABLE SUPPORT SERVICES

Service	2025 Annual Rate
Net Equipment Access After Hours Access to Equipment Includes 5% Administrative Fee	$100.00/hour
GIS Analyst Direct Support	$87.00/hour
Senior GIS Analyst Direct Support	$95.00/hour

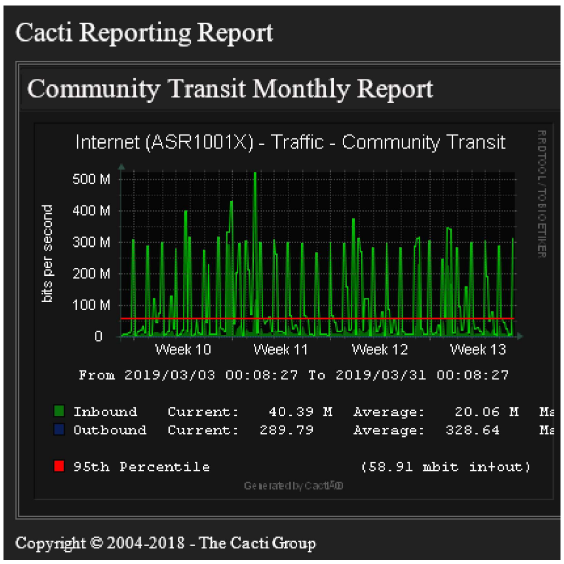
Support Services:

Each after-hours request to access the Data Center has an hourly fee of $100, with a three-hour minimum charge. The hourly fee will be assessed for each major portion of an hour that access is needed, until the earlier of either 1) the incident resolution, or 2) resuming of County normal business hours. Once the after-hours access has exceeded twelve hours in duration, an additional $200 flat fee will be assessed. After-hours access that exceeds 12 hours in duration will continue to incur a $100 per hour fee.

Additional hardware and software requested by Agency may be acquired by the County under this Agreement, and the actual costs will be passed along to Agency on their monthly invoice following County payment for goods and/or services.

Internet usage to be reviewed by SCIT and Agency will be billed on the 95th percentile. Bandwidth data is measured from the customer's activated network interface port on SCIT internet colocation, gateway switch, and recorded in a log file every 1 minute. At the end of each month, the samples are sorted from highest to lowest, and the top 5% of bandwidth utilization data is discarded. The next highest measurement (95th percent) becomes the billable utilization for the month.

These graphs will be made available upon customer request.   See example chart below:



Per the SCIT enterprise service model adopted by Snohomish County for all central IT services, the definition of the services are detailed in the 2024 IT Service catalog, located here: https://snohomishcountywa.gov/DocumentCenter/View/113063

Appendix B To Exhibit A
Rave Mobile Safety Alert Services

Snohomish County subscribes to Rave Mobile Safety (Rave) for alert services. Snohomish County (County) shall provide the City of Marysville (Marysville) with access to and support of the Rave software platform beginning on January 1, 2026, or upon first access by Marysville. Marysville shall only have access to accounts within Marysville city limits.

1. City of Marysville Responsibilities

Marysville shall:

a. Pay for any costs associated with the migration of their data into the Snohomish County platform (This cost will be paid directly by Marysville to Rave Mobile Safety).
b. Pay for Marysville's own Operational Messaging number (this is an additional 10-digit phone number with a quota of messages purchased against that number).

2. Snohomish County Responsibilities

County shall:

a. Facilitate the following migration: (at additional cost to County's contract with Rave which shall be charged to Marysville as shown in Table 1 of Appendix A):
    - Two opt-in keywords
    - 10-digit number and associated quota of alert messages

3. City of Marysville Cost for Rave Alert Services

Marysville shall pay the initial cost for alert services as described below and as stated in Table 1 of Appendix A.

Initial cost is calculated as follows:

500 Internal Users at $2.25 each:	$1,125.00	
3000 Opt-in Users at $0.13 each:	$ 390.00	
Keywords:	$4,880.00	
1 10-digit number:	$ 250.00	Total annual cost: $6,645.00

4. Access/Control Requirements

a. Sarah LaVelle and Kassidy Aldrich (Marysville EM Admins) shall be granted access to create users/profiles, lists, and alerts (with access only to Marysville profiles, lists, alerts). The named Marysville EM Admins may be revised upon request by Marysville.
b. Additional admin profiles shall be created by County DEM for other Marysville employees with access only to city users, lists, and alert templates.

c. Marysville EM Admins shall have permissions to create new admin profiles only with those admin profiles that County DEM has previously set up.
d. Marysville EM Admins shall only be able to send from the operational numbers paid for by Marysville.
e. Marysville staff shall not be able to send emergency public alerts (reverse911, wireless emergency alerts, emergency alert system)
f. Marysville shall continue to work through Sno911 and/or SCDEM for emergency public alerts.
g. Marysville shall have input in future alert/warning platform bids (providing subject-matter expertise in the bid write-up and participate in the grading of submissions).
h. Marysville shall not have any permissions to make system-wide changes. These changes shall be requested by Marysville through County DEM.
i. Marysville will not incorporate desktop alerting at this time, but may wish to add it in the future.
j. Marysville staff do not need to coordinate with the County to send out any internal alerts (internal only to city of Marysville employees or residents who have opted into their public opt-in alerts).
k. Marysville Emergency Management staff shall receive initial admin training from County DEM to ensure they are aware of all agreed upon naming conventions already in place.
    - Marysville shall ensure that its Marysville EM Admins are the lead for all other Marysville employees who shall have admin rights into the system and shall ensure that all Marysville admins follow the agreed upon naming convention for user profiles, lists, and alerts.
l. On a regular basis (at least quarterly) County DEM shall audit Marysville user profiles, lists, and alert templates to ensure the standards are being followed (this falls in line with the regular checks County DEM conducts for all other agencies in the system).
m. Due to limitations of the system, Marysville EM Admins shall have access to see/review all reports of any alert sent by any admin in the system. If Rave is able to change the system limitations in the future, Marysville will then only be able to view reports of alerts sent by Marysville employees.
n. Marysville EM Admins agree that they shall only view reports of alerts sent by Marysville employees or alerts sent within Marysville.
o. Currently, Rave does not limit the number of profiles, lists, alert templates, or admins that the system can have. If that changes, Marysville's costs shall be adjusted once updated costs are determined.
p. County DEM may send alerts to Marysville public opt-in alert recipients or Marysville internal users only at the request of Marysville EM.

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 5/21/2025

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
Seattle - Alliant Insurance Services, Inc.
401 Union Street, 31st Floor
Seattle WA 98101

CONTACT NAME: Jamie Arnoldi
PHONE (A/C, No, Ext): 949-627-7000
FAX (A/C, No):
E-MAIL ADDRESS: Jamie.Arnoldi@alliant.com

INSURED
City of Marysville
501 Delta Ave
Marysville WA 98270-4234

INSURER(S) AFFORDING COVERAGE	NAIC #
INSURER A : National Fire & Marine Insuran	20079
INSURER B : Safety National Casualty Corpo	15105
INSURER C :	
INSURER D :	
INSURER E :	
INSURER F :	

COVERAGES **CERTIFICATE NUMBER:** 73297483 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
B	X COMMERCIAL GENERAL LIABILITY	Y		XPR4067991	1/1/2025	1/1/2026	EACH OCCURRENCE	$ 1,000,000
	CLAIMS-MADE / X OCCUR						DAMAGE TO RENTED PREMISES (Ea occurrence)	$ 500,000
							MED EXP (Any one person)	$
							PERSONAL & ADV INJURY	$ 1,000,000
	GEN'L AGGREGATE LIMIT APPLIES PER:						GENERAL AGGREGATE	$ 2,000,000
	POLICY / PRO-JECT / LOC						PRODUCTS - COMP/OP AGG	$ 2,000,000
	OTHER:						SIR	$ 400,000
	AUTOMOBILE LIABILITY						COMBINED SINGLE LIMIT (Ea accident)	$
	ANY AUTO						BODILY INJURY (Per person)	$
	OWNED AUTOS ONLY / SCHEDULED AUTOS						BODILY INJURY (Per accident)	$
	HIRED AUTOS ONLY / NON-OWNED AUTOS ONLY						PROPERTY DAMAGE (Per accident)	$
								$
B	UMBRELLA LIAB / X OCCUR			XPR4067991	1/1/2025	1/1/2026	EACH OCCURRENCE	$ 5,000,000
	X EXCESS LIAB / CLAIMS-MADE						AGGREGATE	$ 5,000,000
	DED / RETENTION $							$
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY Y / N						PER STATUTE / OTH-ER	
	ANYPROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH)	N / A					E.L. EACH ACCIDENT	$
	If yes, describe under DESCRIPTION OF OPERATIONS below						E.L. DISEASE - EA EMPLOYEE	$
							E.L. DISEASE - POLICY LIMIT	$
A B	Cyber Liability Stop Gap - Employers Liability*	Y		APIP2425 XPR4067991	7/1/2024 1/1/2025	7/1/2025 1/1/2026	Insured/Member Agg. See Below*	$2,000,000 See Below*

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

*Stop Gap - Employers Liability:
Each Accident: $1,000,000
Aggregate: $1,000,000
Each Employee: $1,000,000
SIR: $400,000

RE: Interlocal Agreement with Snohomish County for IT services relating to Network, Internet, and GIS support services.
Snohomish County, its officers, officials, employees and agents are included as Additional Insured. Coverage is primary and non-contributory.

CERTIFICATE HOLDER

Snohomish County
Department of Information Technology
3000 Rockefeller Ave.
Everett WA 98201

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE
Brian A. White

THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

ADDITIONAL INSURED - SCHEDULED CONTRACTS

This endorsement may be used to modify insurance provided under the following:

GENERAL LIABILITY COVERAGE PART
AUTOMOBILE LIABILITY COVERAGE PART
LAW ENFORCEMENT LIABILITY COVERAGE PART

This endorsement does NOT extend insurance for any above Coverage Part if Item 3 of the Declarations for this Policy indicates "Not Covered" for such Coverage Part.

SCHEDULE

Coverage Part(s) Modified By This Endorsement		
GENERAL LIABILITY COVERAGE PART AUTOMOBILE LIABILITY COVERAGE PART		
Additional Insured	**Description Of Contract**	**Contract Date**
Person(s) or organization(s) to whom you are obligated by virtue of a written contract to provide insurance and when such written contract is executed prior to a loss to which this insurance applies.	As per written contract on file with Insured	As per written contract on file with Insured

G. The following is added to Section **B. WHO IS AN INSURED** of each applicable Coverage Part listed in the **SCHEDULE** above:

Any person(s) or organization(s) listed in the **SCHEDULE** to whom you are obligated by virtue of a written contract to provide insurance solely with respect to **bodily injury** or **property damage** is an Insured.

However, insurance for such additional Insured applies only to **bodily injury** and **property damage** required within the terms of the contract and only to the extent that such additional Insured is liable for **bodily injury** or **property damage** caused by your acts or omissions in the performance of your operations.

H. The following is added to Section D. LIMITS OF INDEMNITY of each applicable Coverage Part listed in the SCHEDULE above:

The Limits of Indemnity afforded to the additional Insured shown in the SCHEDULE will be limited to the Limits of Indemnity required within the terms of the contract or the Limits of Indemnity of this Policy, whichever is less. The Limits of Indemnity afforded to such additional Insured will apply in excess of the retained limit shown in the Item 3. of the Declarations.

Any insurance provided in this endorsement is part of and not in addition to the Limits of Indemnity shown in Item 4. of the Declarations for each applicable Coverage Part.

THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

PRIMARY AND NONCONTRIBUTORY – OTHER INSURANCE CONDITION

This endorsement may be used to modify insurance provided under the following:

GENERAL LIABILITY COVERAGE PART
AUTOMOBILE LIABILITY COVERAGE PART

This endorsement does NOT extend insurance for any above Coverage Part if Item 3 of the Declarations for this Policy indicates "Not Covered" for such Coverage Part.

SCHEDULE

Coverage Part(s) Modified By This Endorsement
GENERAL LIABILITY COVERAGE PART AUTOMOBILE LIABILITY COVERAGE PART
Description of person(s) or organization(s):
Person(s) or Organization(s) as required by written contract when such written contract is executed prior to an occurrence, offense or loss to which this endorsement applies.

Solely with respect to those Coverage Part(s) listed in the **SCHEDULE**, Section **A. COMMON POLICY CONDITIONS**, Paragraph **12.** in the Common Policy Conditions, Exclusions and Definitions section of this policy is amended to include the following, and supersedes any provision to the contrary:

This insurance is primary to and will not seek contribution from any other insurance available to the additional insured shown in the **SCHEDULE** provided that:

a. The additional insured is a Named Insured under such other insurance; and

b. You have agreed in writing in a contract or agreement that this insurance would be primary and would not seek contribution from any other insurance available to the additional insured.