US Army Corps
of Engineers ®
Portland District

Mount St. Helens Ecosystem Restoration General Reevaluation Study Reconnaissance Report

Sediment Retention Structure on the North Fork Toutle River

July 2007

Abbreviations and Acronyms

Corps	U.S. Army Corps of Engineers
cfs	cubic feet per second
cy	cubic yard(s)
DEM	Digital Elevation Model
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
fps	feet per second
FCF	fish collection facility
FCSA	Feasibility Cost Sharing Agreement
HDPE	high density polyethylene
LCFRB	Lower Columbia Fish Recovery Board
LCSCI	Lower Columbia Steelhead Conservation Initiative
NMFS	National Marine Fisheries Service
NPCC	Northwest Power Conservation Council
PCA	Project Cooperation Agreement
PE	passage efficiency (for fish)
PFC	proper functioning condition
RM	river mile(s)
SASSI	Washington State Salmon and Steelhead Stock Inventory
SRS	sediment retention structure
TE	trap efficiency (for fish)
TIN	Triangulated Irregular Network
WDF	Washington Department of Fisheries (now WDFW)
WDFW	Washington Department of Fish and Wildlife
WDW	Washington Department of Wildlife (now WDFW)

English to Metric Conversion Factors

To Convert From	To	Multiply by
feet (ft)	meters	0.3048
miles	kilometers (km)	1.6093
acres	hectares (ha)	0.4047
acres	square meters (m^2)	4047
square miles (mi^2)	square kilometers (km^2)	2.590
cubic feet (ft^3)	cubic meters (m^3)	0.02832
feet/mile	meters/kilometer (m/km)	0.1894
cubic feet/second (cfs or ft^3/s)	cubic meters/second (m^3/s)	0.02832
degrees fahrenheit (°F)	degrees celsius (°C)	(Deg F - 32) x (5/9)

Executive Summary

The purpose of the General Reevaluation Study Reconnaissance study is to determine if there is a federal interest in pursuing ecosystem restoration actions in the Toutle River watershed, while maintaining Congressionally authorized levels of flood protection for communities along the Lower Cowlitz River. The Toutle River watershed encompasses about 512 square miles primarily in Cowlitz County, Washington. The Toutle River drains the north and west sides of Mount St. Helens and flows generally westward towards the Cowlitz River. The three primary drainages in the watershed include the North Fork Toutle River, South Fork Toutle River, and Green River. Most of the North and South Forks were impacted severely by the 1980 eruption of Mount St. Helens and the resulting massive debris torrents and mudflows.

A sediment retention structure (SRS) was constructed on the North Fork Toutle River 5 years following the 1980 Mount St. Helens eruption in an attempt to prevent the continuation of severe downstream sedimentation of stream channels, which created flood conveyance, transportation, and habitat degradation concerns. The SRS totally blocked volitional upstream access to as many as 50 miles of habitat for anadromous fish. To mitigate for this effect to these fish, the U.S. Army Corps of Engineers funded habitat enhancements (development of off channel rearing areas), hatchery supplementation at Green River Hatchery, and construction of a fish collection facility (FCF) below the SRS to trap and haul salmonids to tributaries above the SRS.

The Toutle River system historically supported populations of several salmonid species that are currently listed as threatened under the Endangered Species Act including winter steelhead (*Oncorhynchus mykiss*), coho salmon *(Oncorhynchus kisutch)*, spring and fall Chinook salmon (*Oncorhynchus tshawytscha*), and chum salmon (*Oncorhynchus keta*). The North Fork Toutle historically provided productive habitat for these species. The reaches with the most restoration potential are located just downstream of the Green River confluence and further upstream on the North Fork between Hoffstadt Creek and Castle Creek.

Current conditions at the SRS were found to provide the potential for ecosystem restoration opportunities including upstream fish passage. The report addresses the existing fish passage limitations in the North Fork Toutle River as related to the trap-and-haul operations at the FCF and the inability of the SRS to volitionally pass fish. Connectivity/fish habitat restoration is specifically addressed for the sediment plain upstream of the SRS and for the Toutle River below the SRS. Also addressed is the broader issue of what ecosystem restoration efforts could be effective in the Toutle watershed independent of the federal authority or who would be the responsible party for implementation.

Determining the environmental benefits under current conditions was based on three main components:

- The percent of fish that successfully pass above the SRS with a given alternative.
- The effects of the trap-and-haul program on fish that successfully pass above the SRS (represented as percent of fish that are negatively affected by the operations).
- The effect of episodic high sediment loads on the successful return of adult fish.

Estimates for both steelhead and coho were made separately and the values were averaged for an overall percentage to come up with an environmental output improvement value. There is a large amount of uncertainty and variability around these estimates as data is limited but every effort was made to ensure that the values were treated consistently. Under existing conditions and considering the current status of the trap-and-haul operations, it was estimated that there is about 42% to 64% transport/passage for steelhead and 35% to 53% transport/passage for coho salmon. A range of potential ecosystem restoration measures and the associated costs were identified and compared to existing conditions. The following table summarizes the net increase in outputs, total estimated costs, relative cost per output, and the ranking order for each potential ecosystem restoration alternative.

Ranking of Potential Ecosystem Restoration Alternatives

Alternative	Net Increase in Outputs	Total Estimated Cost ($) (not annualized)	Relative Cost/Output ($)	Rank
BASELINE/NO ACTION (existing trap & haul after Nov 2006 high water event) = 44%	---	---	---	---
IMPROVE FALLS/SPILLWAY + FIX FCF	15.5	2,315,000	149,355	5
IMPROVE FALLS/SPILLWAY + FIX FCF + PILE DIKES	17.5	4,115,000	235,143	10
IMPROVE FALLS/SPILLWAY + REMOVE FCF BARRIER	20.5	1,700,000	82,927	3
IMPROVE FALLS/SPILLWAY + REMOVE FCF BARRIER + PILE DIKES	23.0	3,500,000	152,174	6
FISH LADDER AT SPILLWAY	not feasible	not feasible	not feasible	---
FIX EXISTING FCF	11.5	2,015,000	175,217	8
FIX FCF + NEW RELEASE SITE	18.0	2,115,000	117,500	4
FIX FCF + NEW RELEASE SITE + PILE DIKES	19.0	3,915,000	206,316	9
FIX FCF + IMPROVE TRIBUTARY SITES	14.0	2,215,000	158,214	7
FIX FCF + IMPROVE TRIBUTARY SITES + PILE DIKES	16.0	4,015,000	250,938	11
NEW FCF	30.0	12,900,000	430,000	15
NEW FCF + NEW RELEASE SITE	37.0	13,000,000	351,400	12
NEW FCF + NEW RELEASE SITE + PILE DIKES	39.0	14,800,000	379,500	13
NEW FCF + IMPROVE TRIBUTARY SITES	32.0	13,100,000	409,375	14
NEW FCF + IMPROVE TRIBUTARY SITES + PILE DIKES	34.0	14,900,000	438,235	16
NEW RELEASE SITE (can be stand alone if current FCF can function as it did pre-Nov 2006)	10.0	300,000	30,000	1
IMPROVE TRIBUTARY SITES (can be stand alone if current FCF can function as it did pre-Nov 2006)	5.0	400,000	80,000	2
PLANTINGS AT CONFLUENCES	---	2,050,000	---	---
OFF-CHANNEL BACKWATER HABITAT (Toutle River below SRS)	---	2,250,000	---	---

FCF = fish collection facility; SRS = sediment retention structure

Based on this preliminary analysis it appears there are several potential combinations of restoration measures to consider for implementation. The No Action Alternative (baseline, existing trap-and-haul operation) provides existing levels of output (about 44%) at no increased cost. Based on the cost estimates and output estimates, it appears that after the No Action Alternative, the best investment based on relative cost per output is the new release site. After that, improving tributary sites or improving the SRS spillway and removing the FCF barrier are the lowest cost per output. There is a significant breakpoint where costs per output increase when the cost of constructing a new FCF is added to the mix.

The Reconnaissance Report identified a range of possible alternatives that could provide benefits to anadromous fish species in the Toutle River watershed that are currently listed as threatened under the Endangered Species Act. Based on this preliminary assessment, a federal interest was established to pursue upstream fish passage improvements and ecosystem restoration measures in the Toutle River watershed. However, there are inherent risks and uncertainties that will need to be considered. Further study may identify reasons that preclude the implementation of fish passage improvements identified in the Reconnaissance study. Erosion and sediment movement into the North Fork Toutle River drainage continues to be significant and unpredictable. Consequently, there is a risk associated with investing in ecosystem restoration measures for the Mount St. Helens Project due to the instability of the North Fork Toutle River drainage and continuing sedimentation effects caused by the 1980 eruption of Mount St. Helens. It is anticipated that all ecosystem restoration work will focus on near-term actions to sustain and improve access to the tributary habitat above the SRS located on the North Fork Toutle River. In the future, the North Fork Toutle River system may become stable enough to consider a broader range of ecosystem restoration measures.

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1. STUDY AUTHORITY

The Energy and Water Development Appropriations Act of 2006 (Public Law 109-103, November 19, 2005) provided funding for the Chief of Engineers, ". . . to conduct a General Reevaluation Study on the Mount St. Helens project to determine if ecosystem restoration actions are prudent in the Cowlitz and Toutle watersheds for species that have been listed as being of economic importance and threatened or endangered" (119 Stat. 2249).

2. BACKGROUND

The Toutle River watershed primarily drains the northwest and southwest slopes of Mount St. Helens and has a total drainage area of about 513 square miles at its confluence with the Cowlitz River. The May 18, 1980 eruption of Mount St. Helens dramatically altered the hydraulic and hydrologic regimes of the Cowlitz and Toutle River valleys. Ashfall and the lateral blast from the eruption produced immediate and long term effects on the hydrology of the Toutle watershed by changes in the land cover and runoff characteristics. The excess of sediment produced by the eruption and its aftermath was deposited downstream in the lower Toutle, Cowlitz, and Columbia rivers. The rapid influx of sediment caused reduced the channel capacities of the rivers affected. This left the communities of Castle Rock, Lexington, Kelso, and Longview in Washington with the potential of major flooding even with normal runoff. Emergency measures were implemented by the U.S. Army Corps of Engineers (Corps) under authority of Public Law 99-88 (August 15, 1985) and interim flood control measures were implemented under authority of Public Law 98-63 (July 30, 1983). Temporary debris or check dam type structures were constructed across the North Fork Toutle River (N-1) and South Fork Toutle River (S-1) to immediately reduce the volume of sediment delivered to the Cowlitz; levees were raised along the Lower Cowlitz River to prevent flooding; and the Columbia River was dredged to eliminate the threat to navigation.

Long-term sediment control facilities were constructed under Supplemental Appropriations Act of August 15, 1985 (Public Law 99-88). The project was designed to have a life of 50 years over the period 1985 through 2035. Project performance projections and proposed modifications are made for the time period ending in the year 2035. The Corps was authorized to construct and operate a sediment retention structure (SRS) near the confluence of the Toutle and Green rivers (see cover photo). The SRS is located at river mile (RM) 13.2 on the North Fork Toutle River, 30.5 miles upstream of the mouth of the Toutle River. The Toutle River is tributary to the Cowlitz River (RM 20.0), which flows into the Columbia River near the City of Longview, Washington. The SRS was constructed to allow downstream fish passage but is currently a barrier to upstream migrating adult salmonids. The SRS totally blocks volitional access to as many as 50 miles of upstream habitat for anadromous fish. The Toutle River system historically supported populations of several salmonid species currently listed as threatened under the Endangered Species Act (ESA) including winter steelhead, coho salmon, spring and fall Chinook salmon, and chum salmon.

The SRS consists of an earthen dam that is 125-feet above the original stream bed and 1,800-feet long, with a concrete outlet works and a spillway at its north end (see cover photo). Since 1987, the SRS has prevented an enormous quantity of sediment from traveling down the North Fork and into the Toutle, Cowlitz, and Columbia rivers. An estimated 105 million cubic yards of sediment have settled out in the 4-mile long reach upstream of the SRS (Figure 1). The design of the SRS anticipated that in the future, the outlet structure through which water and fish exited to the channel below would become closed off due to sediment infill behind the structure (Corps 1985). This occurred in 1998 and the North Fork Toutle River now flows over the SRS spillway. This change in condition provides the potential to provide for volitional upstream fish passage through the SRS to valuable upstream habitat and eliminate the problems associated with collecting and trucking the fish to upstream release sites.

Figure 1. Sediment Plain Upstream of SRS (seen in the distance)

Source: Steward and Associates

The SRS spillway is a 2,200-foot long, 400-foot wide, unlined, rough-bed channel with a 7% gradient (Figure 2). High flows in 1996 damaged the spillway and caused a 6-foot vertical drop (falls) at the downstream end of the spillway. In response to the damage, the Corps constructed a weir 1,000 feet downstream of the crest to prevent down-cutting, and made minor structural repairs to the spillway. Currently, water flows through a series of high-velocity cascades and depending on flow levels, over shallow sheet-flow areas before ending in the 6-foot vertical drop at the spillway's downstream end. The water continues downstream through a combination of riffles, runs, and cascades and over a concrete velocity barrier at the fish collection facility (FCF) before merging with the Green River.

Figure 2. Middle Section of the Spillway on the North End of SRS at Late Summer Baseflow

Source: Steward and Associates

As mitigation for the SRS, a trap-and-haul FCF was funded and constructed by the Corps on the North Fork Toutle River 1.3 miles downstream from the SRS to facilitate fish passage (Figure 3). The FCF was turned over to the State of Washington to operate and maintain. Adult steelhead trout (*Oncorhynchus mykiss*) and coho salmon *(Oncorhynchus kisutch)*, both threatened species under the ESA, are collected at the FCF. Fish are collected by diverting a portion of the river above the FCF into a fish ladder. Fish are attracted by this flow into the ladder and move up into a collection pond. Fish are then moved into transport tanks on trucks and taken to two upstream release locations (Hoffstadt and Alder creeks). Transported fish are released randomly in each stream without knowledge of their stream of origin. Large sediment volumes in the North Fork Toutle River have contributed and continue to contribute to FCF operational problems.

Figure 3. Fish Collection Facility Downstream from the SRS

Source: Steward and Associates

Radio-tagging and tracking adult coho salmon and steelhead was conducted in the North Fork Toutle watershed from fall 2005 through summer 2006. The study was a collaborative effort with multiple agencies and interest groups, including the Cowlitz Tribe, U.S. Geological Survey, Washington Department of Fish and Wildlife (WDFW), Corps, Weyerhaeuser, and the U.S. Forest Service. This preliminary study and proposed additional work is an important source of information as to how and where to pursue long-term salmon recovery in the North Fork Toutle watershed in the context of Cowlitz Basin-wide salmon recovery.

Recent sediment data collection and analysis work has identified increased potential threat of flooding due to the build-up of sediment in the lower Cowlitz River. An interim dredging measure is proposed in 2007-2008 in the lower Cowlitz River to maintain authorized flood protection levels for four communities along the lower Cowlitz River (Kelso, Longview, Lexington, and Castle Rock). Additional studies are underway to determine if long-term sediment control measures are necessary to deal with the sediment load through 2035, and to maintain Congressionally authorized levels of flood protection for the communities along the lower Cowlitz River. It is important to note that the actual ability to implement potential ecosystem restoration actions would be contingent upon the decisions made in response to these ongoing flood protection studies, and what modifications to the SRS and/or FCF can be agreed upon by the Corps and the State of Washington. The original local cooperation agreement for the Corps to construct the fish collection facility, and the State of Washington to operate and maintain the facility, was signed on April 26, 1986.

3. STUDY PURPOSE AND SCOPE

The purpose of this reconnaissance report is to determine if there is a federal interest in pursuing ecosystem restoration actions in the Toutle River watershed, while maintaining the authorized levels of flood protection to communities along the Lower Cowlitz River. Current conditions at the SRS may now provide the potential for ecosystem restoration opportunities including upstream fish passage. This report addresses the existing fish passage limitations in the North Fork Toutle River as related to the trap-and-haul operations at the FCF and the inability of the SRS to volitionally pass fish. Also, connectivity/fish habitat restoration is specifically addressed for the sediment plain upstream of the SRS and for the Toutle River below the SRS.

This report also addresses the broader issue of what ecosystem restoration efforts could be effective in the Toutle watershed independent of the federal authority or who would be the responsible party for implementation. The North Fork Toutle Work Group was the impetus to initiate a study of ecosystem restoration efforts for the watershed. This informally organized group is composed of a variety of local organizations such as Friends of the Cowlitz and individuals that are interested in pursuing fish and wildlife restoration around Mount St. Helens. Information from meetings, a workshop, site visits, and other additional study information can be found in Appendix A. A database of current information relevant to restoration work in the basin is included in Appendix B. The report concludes by providing a recommendation as to what environmental restoration measures would be in the federal interest to consider for implementation.

4. LOCATION OF PROJECT/CONGRESSIONAL DISTRICT

The Toutle River watershed is located primarily in Cowlitz County, with some tributaries in Lewis and Skamania counties in Washington. The Toutle River enters the Cowlitz River about 5 miles upstream of Castle Rock, Washington. Primary tributaries to the Toutle River include the North Fork Toutle River, South Fork Toutle River, and Green River. The study area is located in the 3rd Congressional District of Washington State, and Congressman Brian Baird is the representative. The U.S. Senators from Washington State are Patty Murray and Maria Cantwell.

5. OVERVIEW OF EXISTING STUDIES, REPORTS, AND PROJECTS

Myriad efforts have been undertaken since the eruption of Mount St. Helens related to erosion and sediment management, flood protection, and fish passage/habitat issues. The major efforts completed or ongoing by the Corps and other agencies and groups that are pertinent to this ecosystem restoration study are summarized below. The *Mount St. Helens Information Database* is a more comprehensive accounting of data and information sources related to sediment, fish, and habitat restoration (see Appendix B). The database was developed by Steward and Associates for the Corps' Portland District.

5.1. Corps of Engineers Sediment Management

U.S. Army Corps of Engineers, November 1983. A Comprehensive Plan for Responding to the Long-term Threat Created by the Eruption of Mount St. Helens, Washington. This report evaluated five alternatives for sediment control and six alternative outlets for stabilizing the level of Spirit Lake.

U.S. Army Corps of Engineers, December 1984. Mount St. Helens, Washington Feasibility Report and Environmental Impact Statement, Toutle, Cowlitz and Columbia Rivers Vol. 1 and 2. This report identified the permanent sediment control plan and provided an assessment of the environmental impacts.

U.S. Army Corps of Engineers, October 1985. Mount St. Helens, Washington Decision Document, Toutle, Cowlitz and Columbia Rivers. This was the decision document used to develop a permanent solution to the sediment problem that resulted from the eruption of Mount St. Helens. Measures considered included a single SRS, dredging, and levee raises for communities in the Lower Cowlitz River valley. The recommended plan was a combination of SRS, minimal levee improvements, and dredging downstream from the SRS during construction and in later years when the SRS reservoir filled and sediment began to pass over the spillway.

U.S. Army Corps of Engineers, 1987. Mount St. Helens Sediment Control, Cowlitz, and Toutle Rivers, Washington. Design Memorandum No. 10, Sediment Retention Structure Fish Collection Facility. This design memorandum presented the description, criteria, and design of the FCF constructed by the Corps as mitigation for the SRS. It also discussed interim fish collection.

U.S. Army Corps of Engineers, April 2002. Mount St. Helens Engineering Reanalysis, Hydrologic, Hydraulics, Sedimentation, and Risk Analysis Design Documentation Report. This report reassessed the level of flood protection and determined the risk of flooding was high before the year 2035 at the lower Cowlitz River damage reaches. The study showed when the level of flood protection at the Castle Rock, Lexington, Longview, and Kelso levees would drop below the authorized levels of flood protection. In addition, basic physical and hydraulic data was developed to allow for further alternative analysis.

U.S. Army Corps of Engineers, December 2005. Cowlitz River Basin Hydrologic Summary, Water Years 2003-2004. This report summarized annual rainfall events and the largest instantaneous discharges at the Toutle River Tower Road station and at the Cowlitz River Castle Rock station. The report also showed the annual amount of sediment deposited upstream of the SRS and what is passed downstream.

U.S. Army Corps of Engineers, August 2006. Mount St. Helens Project, Cowlitz River Levee Projects—Level of Protection and Sedimentation Update. This report documented that flood protection provided by the levee projects along the lower Cowlitz River has been degraded by current sedimentation processes. The observed trend of continued loss of channel capacity was expected to continue and spread upstream, further reducing flood protection levels.

5.2. Fish and Fish Passage

Martin D.J., L.J. Wasserman, R.P. Jones and E.O. Salo, 1984. The Effects of the Mount St. Helens Eruption on Salmon Populations and Habitat of the Toutle River. Report FRI-UW-8412, University of Washington, School of Aquatic and Fisheries Sciences. Juvenile coho mortality during winter ranged from 62% to 83% in streams unaffected by the eruption and from 82% to 100% in streams affected by the eruption. Mortality increased with increases in severity of impact and was associated with channel stability, suspended sediment, and the amount of cover provided by large organic debris. Adult salmon spawned in unstable volcanic substrates with average concentrations of fine particles (<0.850 mm) ranging from 11.2% to 36.0% in 1981 and from 11.2% to 33.5% in 1982. Survival of eggs to hatching stage in volcanic substrate ranged from 50% to 95%. Successful reproduction observed in impacted streams was attributed to temporary groundwater upwelling. Adult salmon and steelhead that returned to the Toutle River were observed spawning in most tributaries formerly utilized before the eruption. The lack of instream cover provided by large organic debris was cited as the limiting factor for complete habitat recovery in the Toutle watershed.

Washington Department of Wildlife, Toutle River Fish Collection Facility Operation and Salmonid Investigations – 1989, 1990, 1991, 1992. The reports listed below provided information about the operation of the FCF including wild coho and steelhead released above the SRS. Juvenile density data (1989-1992) for steelhead, cutthroat, and coho salmon captured by electrofishing in several tributaries of the Toutle River watershed were reported. The results of creel surveys conducted in 1989-1992 on the South Fork Toutle River to assess angler use and catch rate from wild winter-run steelhead were reported. Tag returns from sport anglers were reported for 1991-1992.

- Loch, J.J. and D.R. Downing, 1990. 1989 Toutle River Fish Collection Facility Operation and Salmonid Investigations. Report 89-13.
- Loch, J.J and J.M. Pahutski, 1991. Toutle River Fish Collection Facility Operation and Salmonid Investigations, 1990. Report 91-13.
- Loch, J.J., 1992. Toutle River Fish Collection Facility Operation and Salmonid Investigations, 1991. Report 92-16.
- Loch, J.J. and J.N. Byrd, 1993. Toutle River Fish Collection Facility Operation and Salmonid Investigations, 1992. Report 93-5.

Olds, C.A., 2002. Fisheries Studies at the Sediment Retention Structure on the North Fork Toutle River 1993, 2001, 2002. Washington Department of Fish and Wildlife, prepared for the U.S. Army Corps of Engineers, Portland District. This report presented the results of fish studies conducted at the SRS. The studies used hatchery fish and likely presented a conservative estimate of SRS wild coho salmon smolt passage impact. The data indicated that 22% of wild smolts from upstream of the SRS were injured passing the SRS and FCF during emigration. Holding smolts 160 hours post treatment showed that treatments (passing spillway and FCF) did not appear to effect smolt survival in the short term. While many smolts that passed the spillway in 2001 had dorsal scrapes between the head and dorsal fin, no internal damage due to these scrapes was found. Actions that reduce spillway water velocities or suspended sediment need to be taken due to smolt passage impact and the conservation status of wild salmonids populations upstream of the SRS.

Northwest Power and Conservation Council, May 17, 2002. Draft Cowlitz River Subbasin Summary. The subbasin plan for the Cowlitz subbasin prepared through the Northwest Power and Conservation Council (NPCC) for the Bonneville Power Administration's Fish and Wildlife Program provided baseline information necessary for long-term implementation planning. The plans provided goals for fish, wildlife, and habitat; objectives to measure progress; and strategies to meet those objectives.

Lower Columbia Fish Recovery Board, December 15, 2004. Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan. Volume II – Subbasin Plan, Chapter E – Cowlitz, Coweeman and Toutle. This plan describes a vision, strategy, and actions for recovery plan for Chinook salmon, chum salmon, coho salmon, steelhead, and bull trout listed or under consideration for listing under the ESA. The plan for the Toutle River watershed describes implementation of a regional approach within the watershed, as well as assessments of local fish populations, limiting factors, and ongoing activities. The plan was developed in a partnership with the Lower Columbia Fish Recovery Board (LCFRB), NPCC, federal agencies, state agencies, tribal nations, local governments, and others. The plan also serves as the subbasin plan for the NPCC Fish and Wildlife Program to address effects of construction and operation of the FCRPS.

Bisson, P.A., C.M. Crisafulli, B. Fransen, R. Lucas, C. Hawkins, 2005. Responses of Fish to the 1980 Eruption of Mount St. Helens. In Ecological Responses to the 1980 Eruption of Mount St. Helens. V.H. Dale, F.J. Swanson, C.M. Crisafulli, eds. Springer, New York. This comprehensive report described the effects of the Mount St. Helens eruption on salmon and steelhead in the Toutle and Cowlitz River systems. It described fish passage issues at the SRS and FCF, as well as the recovery of fish habitat.

Scott, J.B. Jr., W.T. Gill (eds), July 21, 2006. Oncorhynchus mykiss: Assessment of Washington State's Anadromous Populations and Programs. Draft for Public Review and Comment. Washington Department of Fish and Wildlife, Olympia. This comprehensive report was designed to lay the foundation for the development of improved management plans that assure the productivity of Washington's native steelhead. Topics include population structure, diversity, and spatial structure; habitat, abundance, and productivity; artificial production; management; and additional challenges and opportunities. Through population viability analysis, the two steelhead populations – Coweeman winter population and the North Fork/mainstem Toutle winter population – were identified as high risk for extinction in the lower Columbia River region.

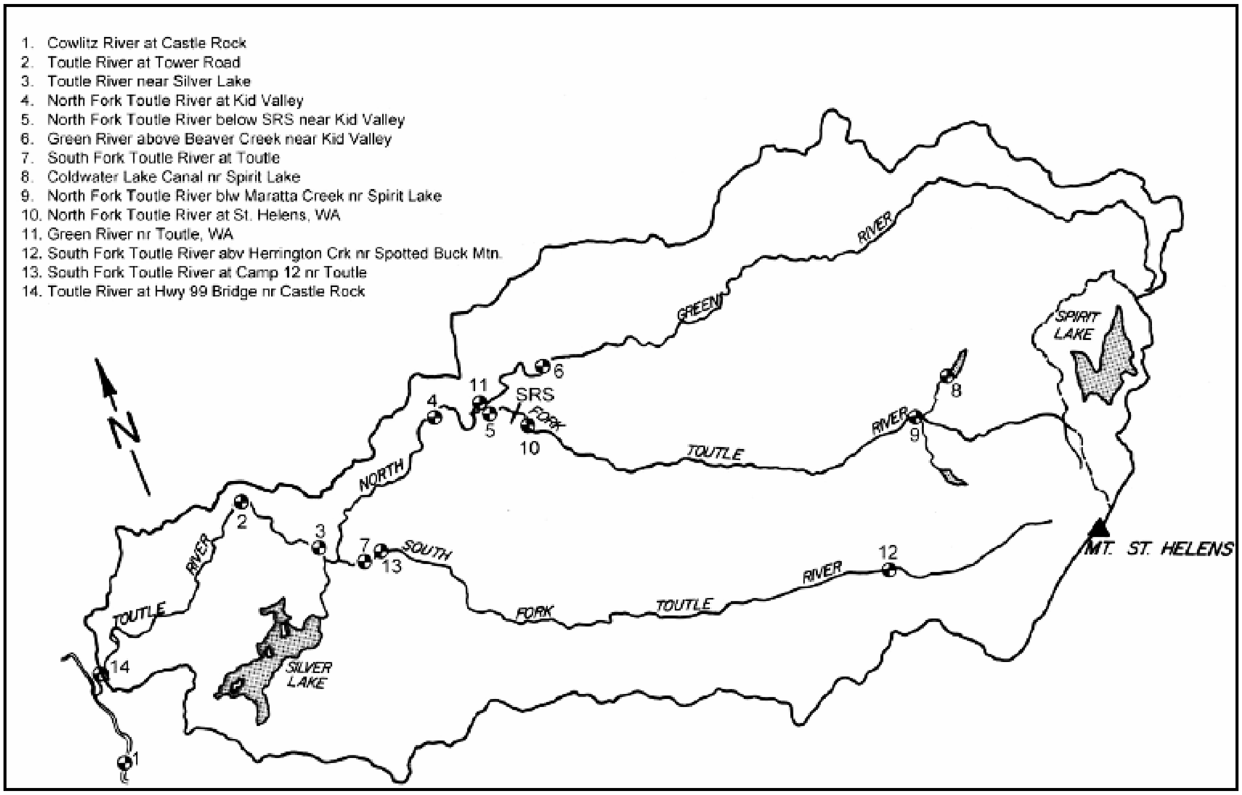
Kock, T., 2006. Migration Behavior of Radio-Tagged Adult Coho Salmon in the Upper North Fork Toutle River, Washington. Draft Report of Research. Telemetry was used to investigate movements of adult coho salmon above the FCF, the SRS, and in upstream reaches of the North Fork Toutle River and tributaries. The upstream passage of radio-tagged adult coho salmon was not observed into or through the SRS spillway. Upstream passage through the sediment plain may be flow dependent. Data suggested that the last downstream waterfall of the SRS spillway serves as an upstream barrier to passage of adult coho salmon. Tagging and monitoring efforts continue. Note that a report investigating migration behavior of adult steelhead is also being prepared.

6. TOUTLE RIVER WATERSHED EXISTING CONDITIONS

The Toutle River watershed encompasses about 512 square miles primarily in Cowlitz County, with some tributaries in Lewis and Skamania counties (Figure 4). The Toutle River enters the Cowlitz River at RM 20, just north of Castle Rock. Elevations range from near sea level at the mouth to over 8,000 feet at the summit of Mount St. Helens. The Toutle River drains the north and west sides of Mount St. Helens and flows generally westward towards the Cowlitz River. The watershed contains three primary drainages: the North Fork Toutle River, the South Fork Toutle River, and the Green River. Most of the North and South Forks were impacted severely by the 1980 eruption of Mount St. Helens and the resulting massive debris torrents and mudflows.

Forestry is the dominant land use in the Toutle River watershed. Commercial forestland makes up over 90% of the watershed. Much of the upper basin around Mount St. Helens is within the Mount St. Helens National Volcanic Monument and is managed by the U.S. Forest Service. A significant proportion of the forests to the north and west of Mount St. Helens were decimated in the 1980 eruption and are now in early seral or 'other forest' (bare soil, shrubs) vegetation conditions. Population centers in the watershed consist primarily of small rural towns.

Figure 4. Toutle River Watershed



6.1. Erosion and Sedimentation

The debris avalanche resulting from the May 18, 1980 eruption of Mount St. Helens deposited approximately 3.8 billion cubic yards of silt, sand, gravels, and trees in the upper 17 miles of the North Fork Toutle River. Lateral blast and mudflow deposits affected the South Fork Toutle River. Erosion of the debris avalanche and mudflow deposit has dramatically affected both the North and South Fork Toutle watersheds. Sediments eroded from the debris avalanche have impacts downstream on the Toutle, Cowlitz, and Columbia Rivers. The construction of the temporary N-1 debris dam and permanent SRS mitigated some of the negative effects of the increased sedimentation on the downstream reaches. As with many projects designed to control sediments, there have been some unintended morphological responses elsewhere in the watershed. These responses have ranged from increased bank erosion and channel instability to loss of connectivity of some of the smaller tributaries to the North Fork Toutle above the SRS.

6.1.1. Hydrologic Response to Mount St. Helens Eruption

The 1980 eruption of Mount St. Helens had the greatest impact on the North Fork Toutle River, which received the majority of the debris avalanche deposit (Figure 5). The Green River and South Fork Toutle River were affected by mudflow deposits. The effects of lateral blast and volcanic deposits altered the landscape characteristics of the three basins and changed the hydrologic characteristics. These effects were seen by increased peak streamflow that affected autumn and winter peaks for a period of 5 years post eruption. The immediate post-eruption changes were driven by modifications to hillslope hydrology (Major and Mark 2006). Table 1 shows the Toutle River drainage areas affected by the lateral blast and volcanic deposits.

Figure 5. Types of Deposits from the 1980 Mount St. Helens Eruption

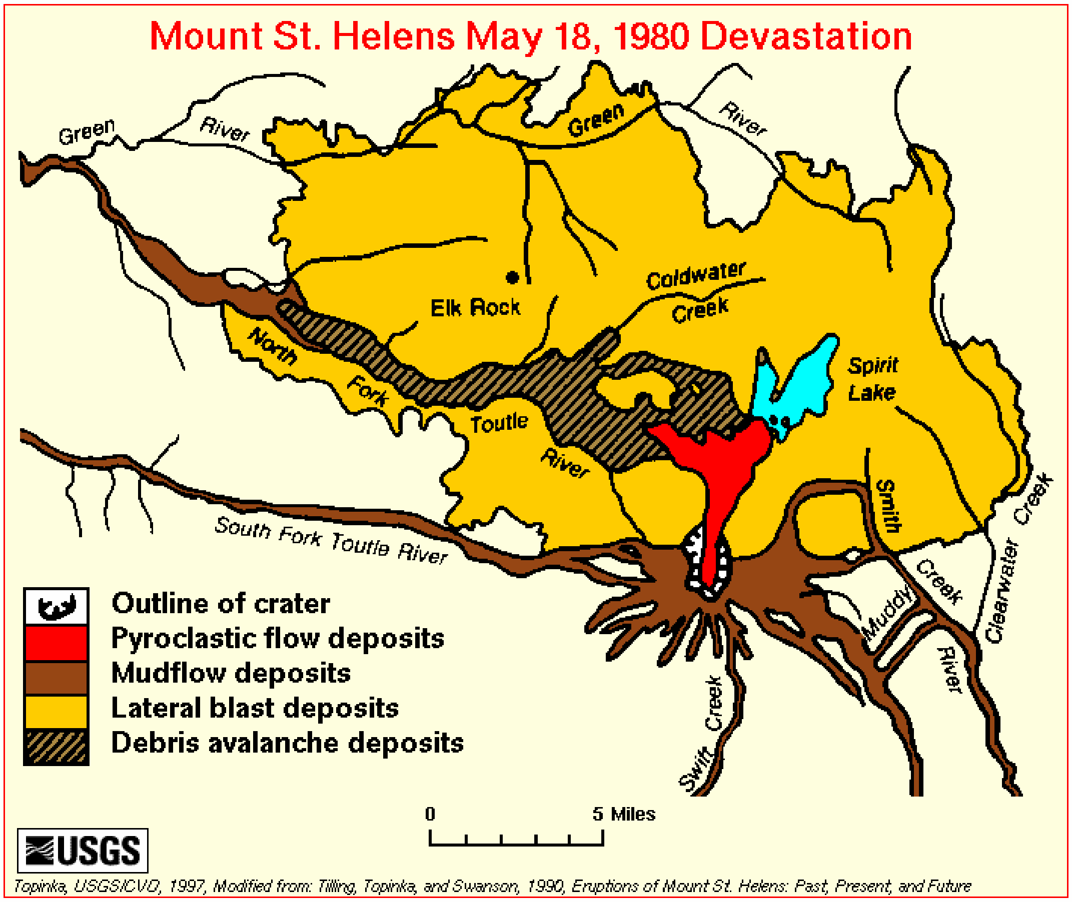


Table 1. Toutle River Basin Areas Impacted by the Mount St. Helens Eruption

Drainage	Total Drainage Area (mi^2)	Percent of Toutle River Drainage Area	Area Within Blast (mi^2)	Percent of Basin Within Blast
Green River	132	25.8	66	50.4
North Fork Toutle River above Green River	172	33.6	107	62.2
South Fork Toutle River	129	25.2	8	6.2
Spirit Lake	18	3.5	18	100.0
Lower Toutle River	61	11.9	0	0
Toutle River Basin	512	100.0	199	38.9

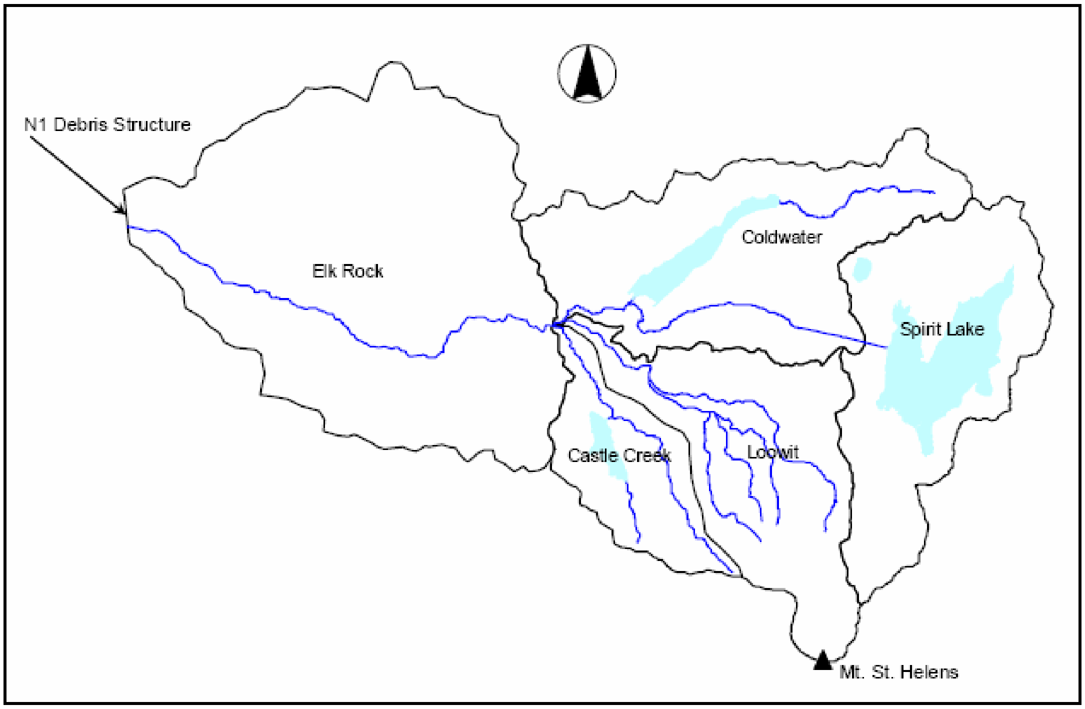
Source: Modified from Meyer and Dodge 1988.

Prior to the 1980 eruption, snow would accumulate in the Toutle River Basin at higher elevations. The frequency and magnitude of rain-caused floods became less significant as the winter season progressed. Melting of the snow pack would provide a significant contribution to the base flow during the spring months of March through June. Compared to pre-eruption conditions, the total snow pack on the mountain has been greatly reduced.

6.1.2. Erosion of Sediment from Debris Avalanche

Figure 6 shows the primary sediment sub-areas in the Toutle River watershed. Digital Elevation Models (DEMs) were developed from aerial photography for 1987 (pre-SRS) and 1999 in the form of Triangulated Irregular Networks (TINs) as part of the Corps' 2002 Mount St. Helens Engineering Reanalysis study. The DEMs were used to estimate the total erosion on the debris avalanche upstream of the SRS and the total deposition behind the SRS from 1987-1999 (Figure 7 and Table 2).

Figure 6. Primary Sediment Source Sub-areas above N-1 Debris Retention Structure

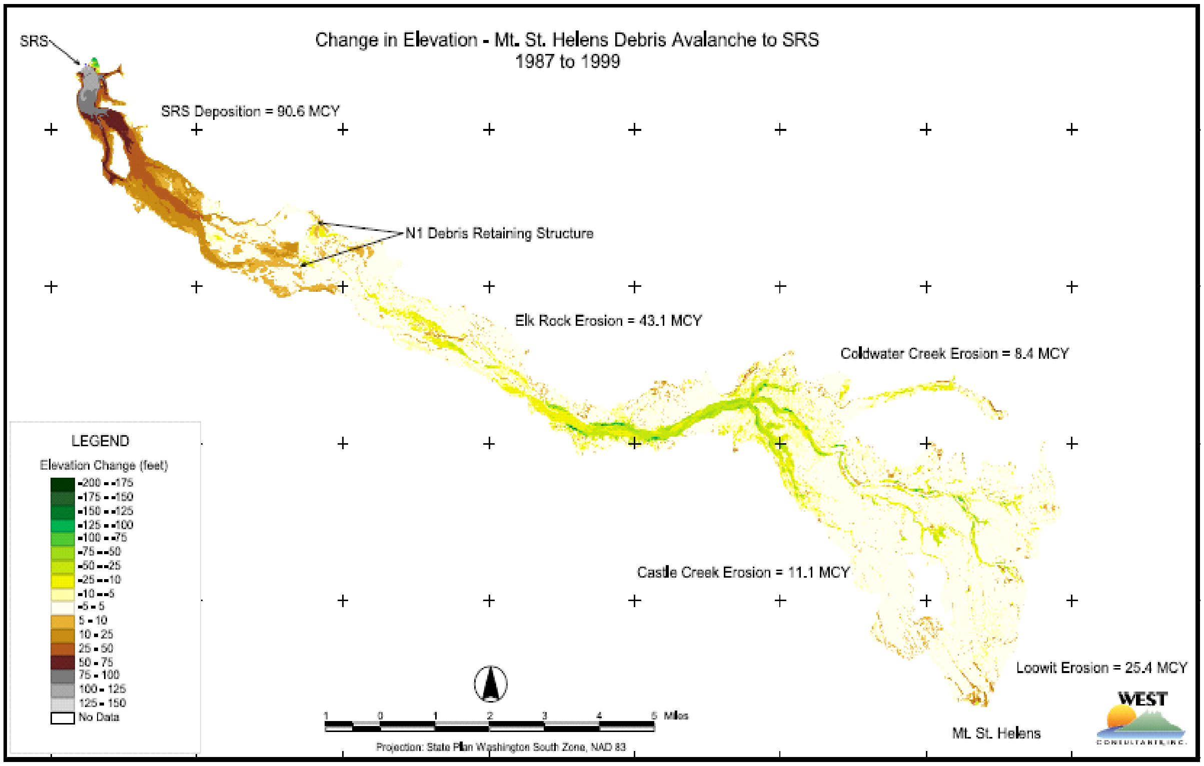


Erosion estimates were defined for each of the primary sediment sub-area on the debris avalanche. These sub-areas include Elk Rock, Coldwater, Castle, and Loowit creeks. Deposition estimates were developed for the North Fork Toutle River between the SRS and N-1 debris retention structure. The Elk Rock and Loowit sub-areas accounted for the majority of sediment yield to the SRS and North Fork Toutle below SRS; when combined, these two sub-areas account for 78% of total debris avalanche erosion from 1987 to 1999.

Table 2. Erosion Estimates Developed from 1987 and 1999 DEMs

Sediment Source Sub-area	Drainage Area (mi^2)	Measured Erosion (mcy)	Bulked Erosion (mcy)	Fraction of Total Erosion	Fraction of Drainage Area	Ratio of Total Erosion/Drainage Area
Elk Rock	42.28	43.1	50	49.0%	39.5%	1.24
Coldwater Creek + Spirit Lake	39.60	8.4	9.7	9.5%	37.0%	0.26
Castle Creek	7.92	11.1	12.9	12.6%	7.4%	1.70
Loowit	17.20	25.4	29.5	28.9%	16.1%	1.80
Total NF Toutle to N1	107	88	102.1	100%	100%	---

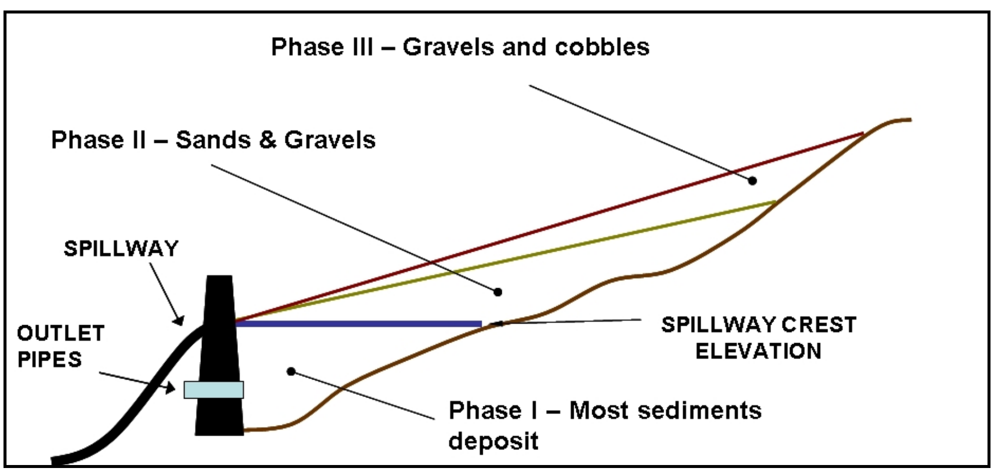
Figure 7. Erosion Estimates by Sub-area



6.1.3. Operation of the Sediment Retention Structure

The SRS was designed to operate in three general phases (Figure 8). The operational phases were based on the expected pattern of sediment deposition behind the dam and type/grain size of sediment to be trapped. Phase I was initiated when the SRS began trapping sediment behind the structure in November 1987.

Figure 8. SRS Design and Filling Pattern



For phase I operation, an impoundment was created by the dam and water was discharged through a series of outlet pipes (Figure 9). During phase I the majority of sediment moving through the system was deposited behind the SRS. Only silts, clays, and some very fine sand passed through the SRS via the outlet pipes. As sediments filled the impoundment, water was discharged through rows of outlet pipes at a higher elevation. Table 3 shows the dates when each row of outlet pipes were closed. By April 1998 the last row of outlet pipes was closed and nearly 90 million cubic yards (mcy) of sediment had filled behind the SRS. The upper row of pipes may be reopened, if necessary.

Figure 9. Phase I Operation, Photographs of Outlet Pipes and View Showing SRS

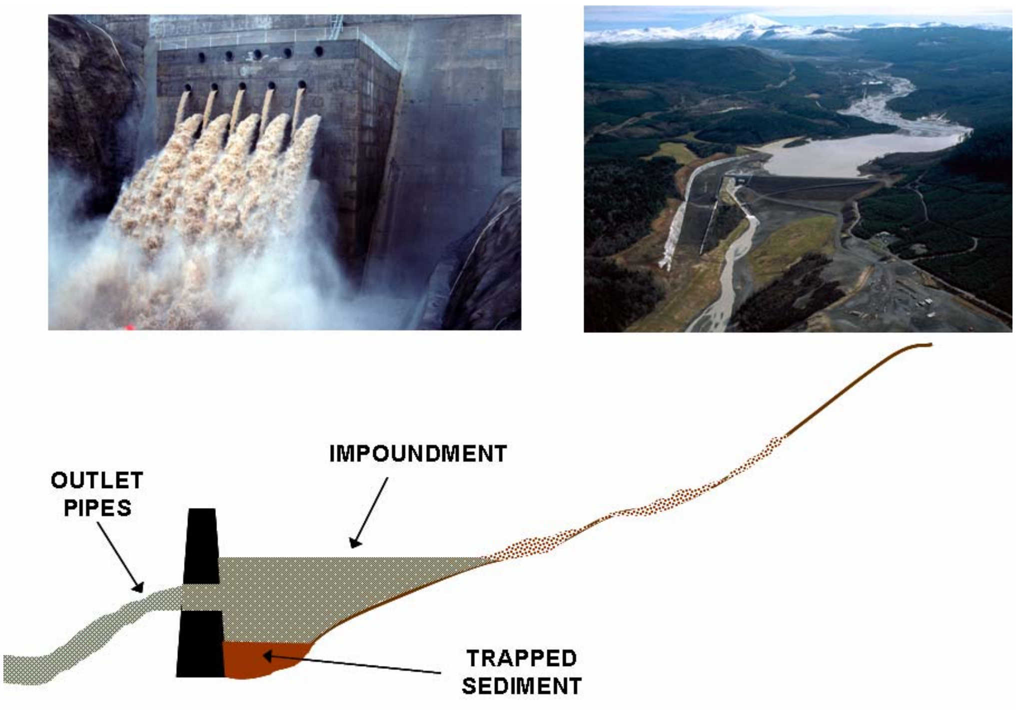


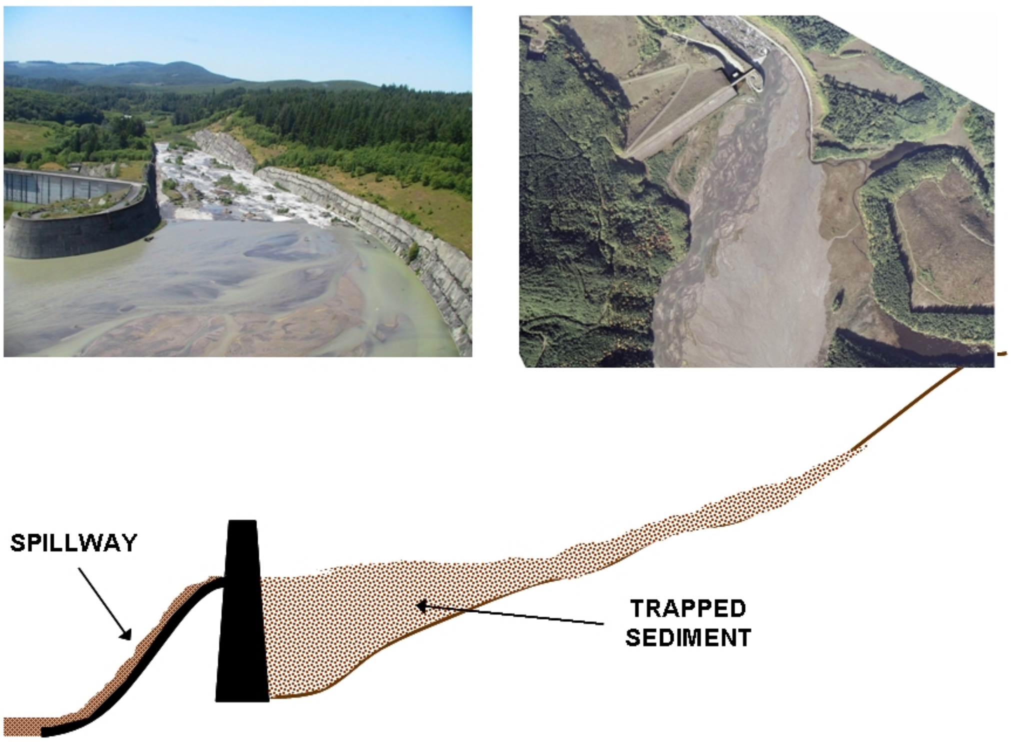
Table 3. Operational Data for SRS Outlets and Spillway

SRS Outlet	Dates of Last Operation
Bottom row	October 1991
Second from bottom	August 1993
Third from bottom	August 1995
Fourth from bottom	May 1997
Fifth from bottom	September 1997
Top row	April 1998 – available for use
Spillway	Permanently in use

The estimated sediment deposition was 90.6 mcy based on 1999 data developed by the Corps for the 2002 Mount St. Helens Engineering Reanalysis Study and was the volume used to estimate the SRS trap efficiency during phase I operation. The estimated sediment discharge passing the SRS for water years 1988 through 1998 is estimated at 10.4 mcy. Using these estimates, the total sediment managed by the project for this time period was 101 mcy (90.6 + 10.4 mcy). Thus, the SRS trap efficiency during phase I operation is estimated at 89.7% (90.6 mcy trapped/101 mcy total).

The second phase of operation began as the sediment reached the level of the spillway in 1998 (Figure 10). Since that date all North Fork Toutle River water flows through the spillway. Cumulative sediment deposition behind the SRS during phase II to date is estimated at 17.6 mcy, which brings the total deposition as of October 2006 to 105.3 mcy. The trap rate for phase II operation to date is 2.2 mcy/year (1998-2006). Data collected since the 2002 Mount St. Helens Engineering Reanalysis Study was used to update performance data on the project.

Figure 10. Phase II Operation, Photographs of Outlet Spillway and View of SRS



Trap efficiency of the SRS during the remainder of phase II and phase III operation is expected to be significantly less than phase I operation due to the lack of impounded water behind the sediment dam. The forecast estimates of annual sediment yield to the SRS over the current phase II operation (1998-2006) have ranged from 6.9 to 6.1 mcy and are based on average hydrology and average hydrology with an assumed declining rate of sediment yield based on watershed recovery from reforestation. Reforestation over the debris avalanche area would tend to reduce sediment yield. Trap efficiency during the current phase II operation is estimated to equal 33.9% based on the 2002 projections and observed deposition through 2006. Performance data for the SRS is summarized in Table 4.

Table 4. SRS Performance Data, 1987-2006

Operation Phase	Dates of Operation	Cumulative Deposition behind SRS (mcy)	Trap Rate (mcy/yr)	Trap Efficiency (%)
Phase I	Nov 1987 to Apr 1998	87.7	8.8	89.7*
Phase II	Apr 1998 to present*	105.3	2.2	33.9**

* Based on estimate of sediment discharge passing SRS from 1988-1998 made in the Corps 2002 Mount St. Helens Reanalysis Technical Report.
**Based on forecast sediment inflow used to estimate deposition behind through 2035.

6.1.4. Forecast Sediment Deposition

The Corps' Mount St. Helens Engineering Reanalysis Study that was completed in April 2002 provided a sediment deposition forecast for the SRS and performance estimates, based on sediment transport modeling of the SRS. The volume of available sediment from the debris avalanche was estimated at 3,700 mcy. The most recent estimate of the amount of this material that will erode and move through the system is 414 mcy.

The modeling for future conditions predicted that an additional 68 to 80 mcy of sediment transported through the system will deposit behind the SRS over the water years 2000 to 2035, assuming an incrementally reducing inflowing sediment load curve. If watershed recovery is not considered, then an additional 82 to 99 mcy of sediment is predicted to deposit over the same time period. Table 5 summarizes the modeling results and forecast data from the April 2002 reanalysis study.

Table 5. Summary of Modeling Results and Forecast Data, 2000 to 2035

SRS Performance	**Hydrologic Conditions**		
	Dry	**Average**	**Wet**
Forecast SRS trap efficiency 2000-2035	37%	39%	+30%
Sediment Flux Thru SRS	**Hydrologic Conditions**		
	Dry	**Average**	**Wet**
Forecast sediment yield to SRS 2000-2035 (tons)	263	283	243
Forecast sediment outflow past SRS 2000-2035 (tons)	161	197	154
Annual forecast sediment yield to SRS (tons)	7.5	8.1	6.9
Annual forecast sediment outflow past SRS (tons)	4.6	5.6	4.4
Sediment Deposition Upstream of SRS	**Hydrologic Conditions**		
	Dry	**Average**	**Wet**
Cumulative deposition 1987-2006 (mcy)	---	105.3	---
Forecast deposition 2000-2035 (mcy)	69.9	79.5	67.7
Annual rate, forecast over period 2000-2035 (mcy)	2.0/yr	2.3/yr	1.9/yr
SRS deposition 2000-2006 (mcy)	12.2	12.2	12.2
Annual rate, 2000-2006 actual (mcy)	---	2.0/yr	---
Total forecast deposition through 2035 (mcy)	164.2	173.8	162.0
Percent of design capacity (258 mcy)	64	67	63

As shown in Table 5, the greatest deposition behind the SRS occurs for average hydrologic conditions. For dry hydrologic conditions, flows are typically less than normal, resulting in a reduced sediment supply to the SRS. For wet hydrologic conditions, flows are typically greater than normal, resulting in a greater sediment supply to the SRS. However, the increased flows have a greater capacity to transport sediment past the SRS resulting in a trap efficiency of 30% as compared to 39% for average hydrologic conditions. Out-flowing sediment loads are approximately 22% greater and 5 percent smaller for wet and dry hydrologic conditions than average hydrologic conditions, respectively.

6.1.5. Impacts of Sedimentation from N-1 Structure to SRS

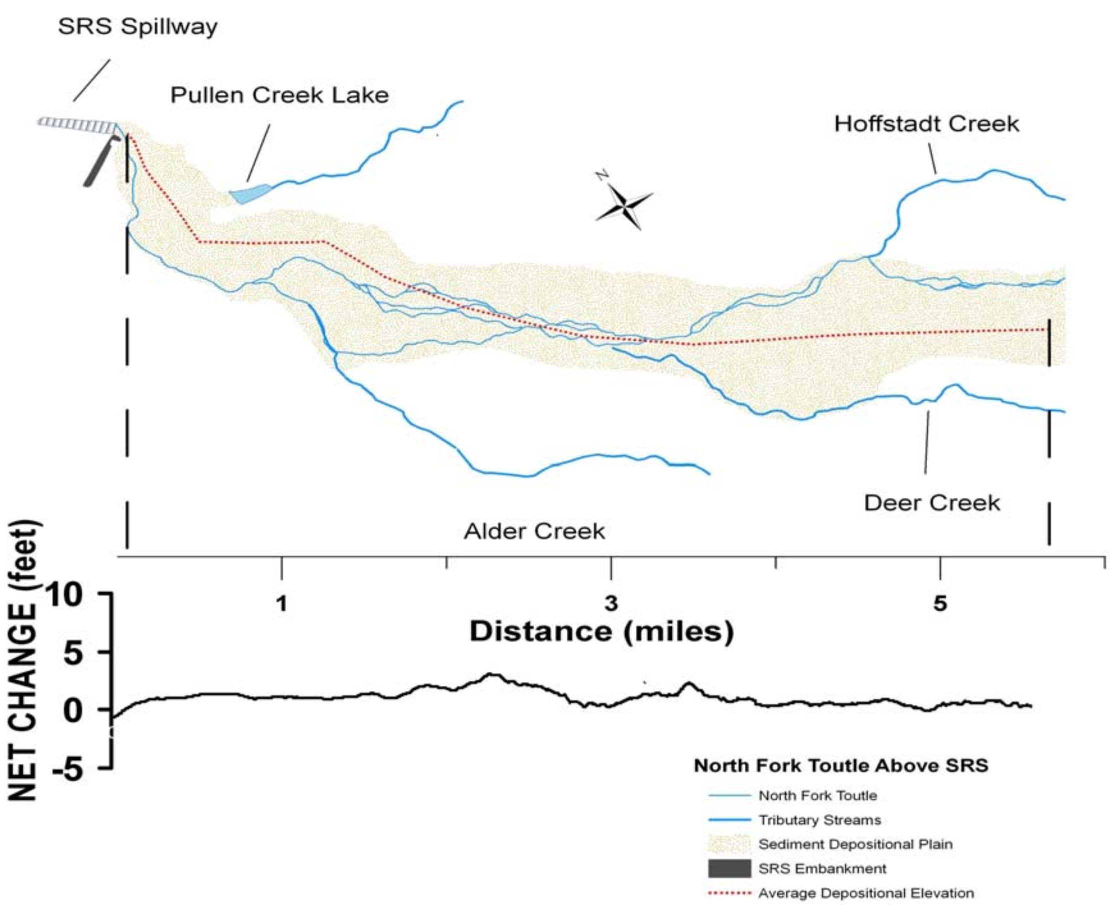
The SRS has trapped 105 mcy in the area behind the sediment dam to the base of the N-1 structure. This sediment deposition has affected the tributaries of the North Fork Toutle above the SRS. A qualitative assessment of the impacts to these tributaries is noted in Table 6.

Table 6. Sediment Deposition Impacts to Tributaries of the North Fork Toutle above SRS

Stream	Sediment Deposition Impacts	Elevation Change at Confluence (ft) 2005-2006
Pullen Creek	Deposition has caused a lake to form downstream, severing connection with North Fork Toutle.	1
Alder Creek	Sediment deposition has caused a delta to form at confluence. Connection with North Fork Toutle is transient and at times may consist of several smaller channels (braided).	1
Hoffstadt Creek	Currently maintaining stable connection to North Fork Toutle. Second confluence forms upstream at high flows from the North Fork Toutle.	0
Bear Creek	Connected to Hoffstadt Creek & affected by changes downstream at Hoffstadt-NF Toutle confluence; may serve as a high flow channel of the North Fork Toutle.	NA
Deer Creek	Within sediment deposition impacts reach; specific conditions were not identified in this study.	1

Figure 11 shows a general schematic of the tributary streams draining the North Fork Toutle through the sediment plain and a relative change in ground elevation (2005-2006) throughout this reach.

Figure 11. Tributaries to North Fork Toutle above SRS, Net Elevation Change 2005-2006



6.2. Fish Species

The Toutle River system historically supported populations of several salmon species currently listed as threatened under the ESA including winter steelhead (*Oncorhynchus mykiss*), coho salmon *(Oncorhynchus kisutch)*, spring and fall Chinook salmon (*Oncorhynchus tshawytscha*), and chum salmon (*Oncorhynchus keta*). Coastal cutthroat trout (*Oncorhynchus clarki clarki*) also was found in the Toutle River system. Much of the following information for fish species was taken from the Lower Columbia Fish Recovery Board's *Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan, Volume II – Subbasin Plan, Chapter E – Cowlitz, Coweeman and Toutle,* dated December 15, 2004 and the Northwest Power Planning Council's *Cowlitz River Subbasin Summary* (2002). Other information sources also are noted.

6.2.1. Winter Steelhead

The historical North Fork Toutle adult population of winter steelhead is estimated from 7,000-15,000 fish. Current natural spawning returns are 100 to 300 fish. It is estimated that from 1991 to 1996, none of the run was from hatchery fish (LCSCI 1998). Total escapement counts of wild winter steelhead in the North Toutle River from 1989-2001 have ranged from 18 fish in 1989 to 322 fish in 1992 (mean of 157 fish). In the Green River, spawning occurs in the mainstem, Devils, Elk, and Shultz creeks. In the North Fork Toutle River spawning occurs primarily in the mainstem, Alder, and Deer creeks. Currently, winter steelhead are managed for natural production with spawning occurring in Hoffstadt, Outlet, Alder, and Deer creeks. Spawning time is March to early June. Juvenile rearing occurs both downstream and upstream of the spawning areas. Juveniles rear for a full year or more before migrating from the Toutle basin.

Distribution

- Historically, steelhead were distributed throughout the mainstem Toutle, North Fork Toutle and Green Rivers.
- In the mainstem/NF Toutle, spawning occurs in the mainstem and Alder and Deer Creeks.
- In the Green River, spawning occurs in the mainstem and Devil, Elk, and Shultz Creeks.
- The 1980 eruption of Mount St. Helens greatly altered the habitat within the Toutle River Basin; the North Fork Toutle sustained the most significant habitat degradation.

Life History

- Adult migration timing for mainstem/North Fork Toutle and Green River winter steelhead is from December through April.
- Spawning timing on the mainstem/North Fork Toutle and Green River is generally from March to early June.
- Limited age composition data for Toutle River winter steelhead indicate that the dominant age class is 2.2 years (58.6%).
- Wild steelhead fry emerge from March through May; juveniles generally rear in fresh water for 2 years; juvenile emigration occurs from April to May, with peak migration in early May.

Diversity

- Mainstem/North Fork Toutle and Green River winter steelhead stocks designated based on distinct spawning distribution.

- Wild stock interbreeding with hatchery brood stock from the Elochoman River, Chambers Creek, and the Cowlitz River is a concern.
- Allele frequency analysis of Green River winter steelhead in 1995 was unable to determine the distinctiveness of the stock compared to other lower Columbia steelhead stocks.

Abundance

- In 1936, steelhead were observed in the Toutle River during escapement surveys.
- During period 1985-1989, an average of 2,743 winter steelhead escaped to the Toutle River annually to spawn.
- North Fork Toutle total escapement counts from 1989-2001 ranged from 18-322 fish (average 157 fish).
- Green River total escapement counts from 1985-2001 ranged from 44-775 fish (average 193 fish).
- Average escapement counts for mainstem/North Fork Toutle from 1994-1998 was 170 fish and from 1999-2004 was 257 fish.
- From 1991-1996, the winter steelhead run was believed to be completely from naturally produced fish.

Productivity & Persistence

- Live-spawning of Toutle River winter steelhead in 1982 and 1988 resulted in mean fecundity estimates of 2,251 and 3,900 eggs per female, respectively.
- Estimated potential winter steelhead smolt production for the Toutle River is 135,573.
- The NMFS Status Assessment estimated that the risk of 90% decline in 25 years was 0.71, the risk of 90% decline in 50 years was 0.93, and the risk of extinction in 50 years was 0.73 for the Green River winter steelhead.

Hatchery

- The Cowlitz Trout Hatchery, located on the mainstem Cowlitz at RM 42, is the only hatchery in the basin producing winter steelhead.
- Hatchery winter steelhead have been planted in the NF Toutle River basin from since 1953; broodstock from the Elochoman and Cowlitz Rivers and Chambers Creek have been used.
- Aside from small releases of 31,200 winter steelhead fry after the 1980 Mount St. Helens eruption, no hatchery winter steelhead have been released in the Green River.
- Hatchery fish contribute little to natural production of winter steelhead.

6.2.2. Coho Salmon

Coho are native to the South Fork Toutle River and spawn throughout the river and its tributaries. Some spawning areas were destroyed by the 1980 eruption of Mount St. Helens (WDF et al., 1993). South Fork Toutle coho natural spawners are a mixed stock of composite production. Current coho stocks are considered depressed based on chronically low production (WDF et al., 1993). Naturally spawning escapement estimates are not available. Hatchery coho production includes both “early” and “late” coho to meet harvest-management requirements. A number of tributaries in the Toutle River have good production potential. Among these are Johnson, Studebaker, Disappointment, and Herrington creeks (WDF et al., 1993).

6.2.3. Spring Chinook Salmon

Toutle River spring Chinook are not recognized by the Washington Department of Fish and Wildlife (WDFW) as a separate stock (WDF et al., 1993). In the early 1950s, annual spawning escapement was estimated to be 400 fish in the upper Toutle River (WDF 1951). The current estimated return is 164 fish (WDW 1990). The Toutle Hatchery produced spring Chinook from 1967 until 1980, when it was destroyed by the Mt. St. Helens mudflows (WDW 1990). Most Toutle spring Chinook were reared in Deer Springs Pond, which was destroyed in the winter of 1981-82 when a temporary flood-control dam was breached. Evaluation of the fish plants was not conducted, and returning adults were not captured at the hatchery. The primary management objective for the Toutle River is to produce 500 fish for the sport harvest. This would represent an estimated subbasin return of 1,697 fish and a total production of 2,976 fish (WDW 1990).

6.2.4. Fall Chinook Salmon

The historical Toutle adult population is estimated from 15,000-20,000 fish. The estimated annual escapement of fall Chinook in the Toutle and its tributaries in the early 1950s was 6,500. An average of 10,756 adults returned each year to the Toutle River basin from 1964 through 1979 (pre-eruption). The Toutle River has been stocked with fall Chinook since at least 1951 until 1980 (WDW 1990). Prior to the eruption of Mount St. Helens in 1980, significant fall Chinook natural spawning occurred in the lower 5 miles of the mainstem Toutle and in the lower North Fork Toutle. An estimated 80% of the total Toutle fall Chinook run spawned in the lower 5 miles of the mainstem Toutle (WDF 1951).

The eruption devastated much of the spawning area in the mainstem and North Fork Toutle. Current spawning primarily occurs in the lower Green below the North Toutle Hatchery and in the lower South Fork Toutle. The Toutle River Hatchery, located 0.5 miles up the Green River, began collecting brood stock again in 1990. Surplus hatchery fish were released upstream of the hatchery to spawn naturally. Brood stock has been from a mixture of sources since the 1980 eruption (WDW 1990). Current natural spawning returns range from 300 to 5,000 fish with the majority of hatchery origin fish spawning in the lower 0.5 mile of the Green River. Juvenile rearing occurs near and downstream of the spawning area. Juveniles emerge in early spring and migrate to the Columbia in spring and summer of their first year.

Green River fall Chinook are native to the Green River. About 20 miles of spawning and rearing area are available above the hatchery trap on the Green River (excluding tributaries; WDF 1973). The Green River fall Chinook natural spawners are an unknown stock. Natural spawning escapements from 1967-1979 averaged 3,025 fish with a low of 948 in 1977 and a high of 6,654 in 1972. Post eruption escapements in 1980 and 1981 were zero and 10 fish, respectively. Spawning ground counts were suspended until 1990, where the escapement was 123 fish in 1990 and 126 in 1991. Natural fall Chinook stocks were listed as depressed in SASSI (Washington State Salmon and Steelhead Stock Inventory) and show signs of a long-term negative trend (WDF et al., 1993).

Distribution

- Toutle River fall Chinook spawning distribution from 1964 to 1979 was estimated as 4.8% mainstem Toutle, 3.8% South Fork Toutle, 49.4% North Fork Toutle, and 42% Green River.
- Historical spawning areas in the mainstem Toutle, North Fork Toutle, and lower Green River were devastated by the 1980 eruption of Mount St. Helens.

- Records indicate most historical fall Chinook spawning occurred in the lower 5 miles of the mainstem Toutle River, but spawning spread as far upstream as Coldwater Creek on the North Fork Toutle River (46 mi from the river mouth).
- In the South Fork Toutle River, spawning primarily occurs from the 4700 Bridge to the confluence with the mainstem Toutle River (~2.6 mi).
- In the Green River, spawning primarily occurs from the North Toutle Hatchery to the river mouth (~0.6 mi).

Life History

- Columbia River fall Chinook migration occurs from mid August to early September, depending partly on early fall rain.
- Natural spawning occurs between late September and early-November, usually peaking in mid-October.
- Age ranges from 2-year-old jacks to 6-year-old adults, with dominant adult ages of 3 and 4.
- Fry emerge around early May, depending on time of egg deposition and water temperature; fall Chinook fry spend the summer in fresh water, and emigrate in the late summer/fall as sub-yearlings.

Diversity

- Considered a tule population within the lower Columbia River Evolutionarily Significant Unit (ESU).
- North Fork and South Fork Toutle River stocks designated based on distinct spawning distribution.

Abundance

- In 1951, the Washington Department of Fisheries (WDF, now WDFW) estimated fall Chinook escapement to the Toutle River was 6,500 fish.
- South Fork Toutle River spawning escapements from 1964-2001 ranged from 0-578 fish (average 177 fish).
- Green River spawning escapements from 1964-2001 ranged from 10-6,654 fish (average 1,900 fish).
- Hatchery production accounts for most fall Chinook returning to the Toutle River Basin; Chinook are re-establishing a population in the basin after the 1980 Mount St. Helens eruption.
- Hatchery produced adults comprise the majority of natural spawners in the Green and North Fork Toutle Rivers.

Productivity & Persistence

- Smolt density model predicted natural production potential for the Toutle River of 2,799,000 smolts.
- Juvenile production from natural spawning is presumed to be low.

Hatchery

- The North Toutle Hatchery (formerly called Green River Hatchery) is located on the lower Green River near the confluence with the North Fork Toutle River; operations began in 1956 but the hatchery was destroyed in the 1980 eruption of Mount St. Helens.
- The North Toutle Hatchery was renovated and began collecting brood stock again in 1990.

- Rearing ponds near the original hatchery site were developed after the eruption and began operation in 1985.
- Releases of fall Chinook in Toutle River Basin has occurred since 1951; current program releases 2.5 million sub-yearling fall Chinook annually; release data are displayed from 1967-2002.

6.2.5. Chum Salmon

The chum population in the Toutle watershed is considered part of the lower Cowlitz population. Chum were reported to historically utilize the lower Cowlitz River and tributaries downstream of Mayfield Dam. Lower Columbia River chum salmon run from mid-October through November; peak spawner abundance occurs in late November. Fry emerge in early spring and chum emigrate as age-0 smolts generally from March to May.

6.2.6. Coastal Cutthroat Trout

Coastal cutthroat abundance in the North Fork Toutle and Green rivers has not been quantified but the population is considered depressed. Cutthroat trout are present throughout the basin. Anadromous, fluvial, and resident forms of cutthroat trout are found in the basin. Anadromous cutthroat enter the Toutle from September to December and spawn from January through June. Most juveniles rear 2 to 4 years before migrating from their natal stream.

Little information is available for either the historic or present status of coastal cutthroat in the Toutle River. Lavier (1960) reported that 74 fish were captured at the Toutle River Hatchery in 1960. An estimated 40% of the 5,014 cutthroat harvested from the Cowlitz in 1979 were wild fish, many of which probably originated in the Toutle River (Tipping and Springer 1980). No hatchery plants of coastal cutthroat have been made in the Toutle River and none are anticipated.

All Toutle coastal cutthroat are considered one stock (WDFW 2000). Entry into the North Fork Toutle peaks between September and November, with a smaller number of fish moving throughout the winter (WDFW 2000). Spawning time occurs from January to June, and genetic data is unavailable for this stock (WDFW 2000). The status of the Toutle coastal cutthroat is depressed, based on chronically-low escapement measured at the Toutle River Fish Collection Facility and the North Toutle Hatchery, a long-term negative trend in the Columbia River catch from RM 72 to RM 48, and the habitat destruction from the 1980 eruption of Mount St. Helens (WDFW 2000). The stock is showing a slow recovery since 1980, but the escapement is chronically low. Another way to measure the status of this stock is by comparing the North Toutle Hatchery count. In 1959, 74 wild coastal cutthroat were captured during coho and Chinook collections. After 1991, annual counts have remained below six fish (WDFW 2000).

Distribution

- Anadromous forms have access to most of the watershed except upper tributary, high gradient reaches.
- Adfluvial forms are documented in Silver Lake.
- Resident and fluvial forms are observed throughout the subbasin.

Life History

- Anadromous, adfluvial, fluvial and resident forms are present.
- Anadromous river entry peaks from September through November.

- Anadromous spawning occurs from January through June.
- Fluvial and resident spawn timing is not documented but is believed to be similar to anadromous timing.

Diversity

- Distinct stock based on geographic distribution of spawning areas.
- No genetic sampling has been conducted.

Abundance

- No abundance information exists for resident and fluvial forms.
- Long term negative decline in the lower Columbia River cutthroat catch.
- North Toutle Hatchery counts have shown a steady increase since the eruption of Mount St. Helens in 1980, but escapement remains low.
- Chronically low escapement at Toutle River Fish Collection Facility (0 to 6 fish annually since 1991).

Hatchery

- North Toutle Hatchery raises Chinook and coho.
- Summer steelhead smolts from Elochoman or Kalama Hatchery are released into the South Fork and North Fork Toutle and Green Rivers annually.
- Silver Lake was stocked with rainbow trout prior to 1980.

7. PROBLEMS AND OPPORTUNITIES

7.1. Status and Condition of Fish

Salmonid species in Toutle River watershed include fall and spring Chinook, coho, and chum salmon, and winter steelhead trout. Extinction risks are significant for all species – the current health or viability ranges from very low for spring Chinook to low for fall Chinook, coho, and winter steelhead. Returns of fall Chinook, coho, and winter steelhead include both natural and hatchery produced fish.

Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan recovery goals call for restoring coho and winter steelhead to a high level of viability in the North Fork Toutle River. The 2004 Toutle Subbasin Plan used population assessments under different habitat conditions to compare fish trends and establish recovery goals. Fish population levels under current and potential habitat conditions were inferred using the Ecosystem Diagnosis and Treatment (EDT) model based on habitat characteristics of each stream reach and a synthesis of habitat effects on fish life cycle processes. Habitat-based assessments were completed in the Toutle basin for winter steelhead, fall and spring Chinook, and chum. It is important to note that spring Chinook have become functionally extinct in the Toutle subbasin. Model results indicate a decline in adult productivity for all species in the Toutle Basin. Declines in adult productivity from historical levels range from 70% for fall Chinook to greater than 90% for winter steelhead. Similarly, adult abundance levels have declined for all species. Current estimates of abundance are 44% of historical levels for fall Chinook, 13% of historical levels for winter steelhead, 11% of historical levels for coho and only 5% of historical levels for chum. Estimated diversity has also decreased significantly for all species in the Toutle Basin. Declines in species diversity range from 34% for fall Chinook, to greater than 70% for coho.

This sharp decline in diversity may be due to a dramatic loss of available habitats compared to pre-Mount St. Helens eruption conditions. The 1980 eruption may also contribute to the observed trends in productivity and abundance. Timber harvest and road building in the post-eruption years has further depressed the stocks and has limited the rate of recovery.

As with adult productivity model results in the subbasin plan, current smolt productivity is also sharply reduced as compared to historical levels. Current smolt productivity estimates are between 17% and 52% of historical productivity, depending on species. Smolt abundance numbers are similarly low, especially for chum and coho. Current smolt abundance estimates for chum and coho are at 13% and 10% of historical levels, respectively. Model results indicate that restoration of proper functioning condition (PFC) would have large benefits in all performance parameters for all species. For adult abundance, restoration of PFC would increase current returns by 107% for fall Chinook, by 255% for winter steelhead, by 496% for chum and by 600% for coho. Similarly, smolt abundance numbers would increase for all species. Coho would see the greatest increase in smolt numbers with a modeled 709% increase.

According to the Lower Columbia Fish Recovery Plan (LCFRB 2005), the abatement of fish passage and sediment problems at the SRS on the North Fork Toutle would have a tremendously positive impact on reach tiers and subwatersheds within the Toutle watershed that possess the greatest recovery potential. Actions that address passage and sediment problems at the SRS were given a high priority in the Recovery Plan.

7.2. Key Limiting Factors

7.2.1. North Fork Toutle

The North Fork Toutle historically provided productive habitat for winter steelhead, spring Chinook, and coho. Fall Chinook may also have utilized these reaches to some degree. The reaches with the most potential are located just downstream of the Green River confluence and further upstream on the North Fork between Hoffstadt Creek and Castle Creek (reach NF Toutle 13). Volitional passage is currently blocked just upstream of the Green River confluence by the SRS, created to retain eruption-related sediments following the 1980 eruption. North Fork Toutle reaches were severely impacted by mud and debris flows during the 1980 eruption, followed by intensive road building and timber harvests. The recovery emphasis is for restoration of watershed processes throughout the North Fork basin including addressing the dense road network and heavy harvests. Emphasis should also be placed on addressing the continued supply of sediment from the SRS, which has become a persistent limiting factor for fish in downstream reaches.

The SRS is also a source of fine sediment to the lower river. In addition, the ongoing erosion of material upstream of the SRS that moves through the structure has interfered with the fish collection facility just downstream of the structure. Addressing passage and sedimentation issues at the SRS will be a key component of salmon and steelhead recovery in the basin.

7.2.2. Sediment Retention Structure and Fish Collection Facility

The 1980 eruption of Mount St. Helens devastated fisheries resources in the North and South Fork Toutle River watersheds (WDW 1990; Lucas 1986; Jones and Salo 1986; Lisle et al., 1982; Collins and Dunne 1981). Tributaries in the upper North Fork Toutle watershed were completely destroyed as massive landslides and debris-flows traveled 13.5 miles down the North Fork (Jones and Salo 1986). Deposition of debris flows buried 23 square miles of terrain to an average depth of 150 feet, including more than 27 miles of anadromous stream habitat (Jones and Salo 1986). Many stream systems that were not directly affected by the debris flows were still blanketed with substantial amounts of ashfall and most of the vegetation in the watershed was blown down by the eruption (Lucas 1986).

The 1980 eruption of Mount St. Helens sent a tidal wave of melted ice and pulverized rock down the Toutle Valley into the Cowlitz River, and carried so much of this coarse sandy material and debris all the way to the Columbia River that dredging was required to clear the channel before river shipping could be resumed. Over 74 mcy of material had to be removed from the Cowlitz River within the first year after the 1980 eruption to maintain flood capacity (Cowlitz County 1983). Floodplain and wetland habitat along portions of the lower Cowlitz and Toutle Rivers was filled with the dredge spoils. Stream systems are recovering slowly from the effects of the eruption. However, elevated sediment loads, channel widening, lack of large woody debris, and riparian cover all remain problems today.

Large scale removal of this volcanic material in the Cowlitz River began at the lower end of the Toutle River by July 1980 and continued on down the Cowlitz River until engineers were reasonably confident that the cleared channel could handle expected winter flows without topping dikes and flooding Castle Rock, Longview, and Kelso. A dam to control sediment was then constructed further up the Toutle River by the Corps to prevent the re-silting of the dredged sections.

The SRS on the North Fork Toutle was constructed 5 years following the 1980 Mount St. Helens eruption in an attempt to prevent the continuation of severe downstream sedimentation of stream channels, which created flood conveyance, transportation, and habitat degradation concerns. Before the SRS was constructed a temporary sediment retention structure was built across the North Fork Toutle (N1) and dredging of sections of the streambed was initiated as an emergency measure (Figure 7). The original design capacity of the 6,100-feet-long (two sections) N1 structure was to store 6 mcy yards of sediment. The N1 structure breached several times after dredging behind the structure was terminated in 1981.

The Corps acquired a lease of the N-1 site from Weyerhaeuser, the underlying fee holder of the site. The lease term was for 5 years from July 1, 1980 to July 1, 1985, but the lease was terminated by the Corps on January 20, 1984. Currently the Corps has no property rights for use of this site. This information was obtained from Portland District real estate files; therefore, it is possible the ownership may have been transferred in the last few years. Any proposed modification of the N1 structure will require coordination and agreement with the current owner.

Once the N1 structure became ineffective in 1983, it became clear additional sediment control measures would be needed. Consequently, the Corps acquired, in fee simple, the land the SRS is constructed on, along with an easement over the impoundment area. The deed for the conveyance was filed in Cowlitz County by Washington State Department of Transportation. The SRS was constructed as part of a sediment management plan to mitigate potential flooding on the Cowlitz River from sediment migration created by the eruption and was expected to have a design life of 25 to 50 years. It also was built to have the capability for a future phased height increase.

Once in place, the SRS totally blocked volitional upstream access to as many as 50 miles of habitat for anadromous fish. To mitigate for this effect, Corps funded habitat enhancements (development of off channel rearing areas) for coho; hatchery supplementation at Green River Hatchery to raise coho, spring Chinook, and fall Chinook; and construction of a fish collection facility below the SRS to trap and haul salmon, steelhead, and coastal cutthroat to tributaries above the SRS.

Providing fish passage as part of the SRS construction was the primary mitigation recommendation of federal and state fish and wildlife agencies. Construction of a fish trap and haul facility was determined to be the most viable option. A unique agreement was reached with the State of Washington concerning federal and state participation in this project; for the fish trap, this agreement placed the responsibility for the construction of the trap on the Corps and all subsequent operation and maintenance of the trap upon the state. With this agreement, a cooperative design process was entered into which proved to be very time consuming. Consequently, it became apparent that the permanent trap could not be designed and built before SRS construction blocked fish passage and that an interim temporary trap would be needed. The temporary trap just below the SRS became inoperable its first day of operation due to sediment blockage. The location for the permanent trap site was moved downstream about a mile and a half. Final plans for the design proceeded with the understanding it would have to withstand the harsh conditions of the basin, resulting in a structure costing $6.7 million.

Until 1998, outmigrating juvenile fish could pass downstream through the SRS via the outlet works, a stacked series of 3-foot conduits, at all flows, and via the spillway during high water events. Survival of juveniles passing downstream through SRS via the outlet pipes was very low at times due to debris and high levels of suspended sediments. In 1997 modifications to the SRS spillway were made to enhance juvenile passage during high flows, including partially raising the crest of the spillway, building a plunge pool at the crest, and excavating a notch in the existing RCC fill halfway down the chute. In 1998 the outlet works was closed when the level of sediment above the SRS filled to near capacity and the spillway became the only route available for juvenile downstream passage. The spillway is a rough bed channel 2,200-feet long with a 7% slope, 400-feet across at the top and narrowing to 200-feet across at the bottom. The spillway was damaged by high water in 1996. Channel head cutting is arrested by concrete capping just below the spillway crest and construction of a notched concrete channel spanning weir 1,000 feet downstream of the crest. Much of the spillway is left as formed by instream flows, mostly high velocity cascades cut into bedrock, with some large shallow pools and three shallow sheet flow areas. During low flow periods [250 cubic feet per second (cfs)] water velocities average 5 feet per second (fps), with maximum velocities of 9 fps. At high flows of 1620 cfs (5% chance of exceedance flow) velocities can reach 19 fps. At the bottom of the spillway is a long, deep rapid ending in a 6 foot falls. The north bank of the waterfall has a cascade bypass section at 10% gradient. Below the spillway the river is a series of low gradient rapids and runs to the fish collection facility a mile downstream.

The North Fork Toutle River FCF was constructed by the Corps as mitigation for the impacts of the SRS. It was built to collect and separate fish as part of a trap and haul program for adult Chinook, steelhead, and cutthroat trout in the North Fork Toutle River above the SRS. The facility has been owned and operated by the WDFW since 1993. The intended operation was to collect fish at the FCF by diverting a portion of the river above the FCF into a fish ladder and back into the river below the barrier. Fish were to be attracted by this flow into the ladder and move up into a collection pond with an automated crowding screen. Crowded fish would be hand sorted, anesthetized in a tank, biological information is recorded, and fish are moved to transport tanks on trucks to be taken to release locations. Due to high sediment loads and stream flows, the FCF was frequently incapacitated and is in a serious state of disrepair.

In recent years, biologists from WDFW and volunteers operate the facility for 1 day per week during fall coho migration and winter/spring steelhead migration, often with fish trapped and held for up to 5 days before being transported and released. Fish are manually crowded, netted, and carried from the trap to a transport vehicle. Large amounts of sand must to be manually moved out of the trap at relatively frequent intervals and that process takes a considerable amount of time. Technical Advisory Group members with the WDFW state that the FCF is inoperable much of the time due to sediment problems and the lack of funding to remove the material. This has occurred at crucial times during adult fish migration, and they have been unable to allow any adult passage when heavy sediment loads are moving through the system.

There are also concerns that the flows through the plunge pool have altered enough to negatively affect adult attraction into the trap. The downstream lip of the plunge pool concrete, over which the river was expected to flow, has been undercut and parts of the apron have broken such that portions of the flow move laterally out of the plunge pool. This change in flow dynamics may keep fish from finding the attraction flow coming from the trap. Improvements made at the trap should increase adult fish collection efficiency and reduce stress and potential injury to fish, and could provide volitional passage.

7.2.3. Juvenile Passage Studies at SRS and Upstream Tributaries

The passage of downstream migrant juvenile salmonids in the North Fork of the Toutle River was a subject of concern since the SRS was first proposed in 1983. The NMFS proposed installing a gated lined low-flow channel cut in the spillway as an alternative to passage through the high velocity outlet works. Subsequently, a three-phase fish passage study was conducted that addressed juvenile downstream passage. The first two phases evaluated short-term survival and delayed mortality of outmigrating fish through the outlet works at the SRS. Lower than expected tag returns from these releases indicated that an unexplained mortality factor impacted these fish and that release timing and suspended sediment loads related to instream flows may have contributed to this mortality.

In 1998, after the outlet works was closed, juvenile passage occurred via the spillway. Washington Department of Fish and Game studies in 2001 and 2002 evaluated the cumulative effects of passage through the spillway and FCF on juvenile salmonids (Olds 2002). Transport, handling, and passage of hatchery raised Coho smolts released through the spillway or over the FCF dam downstream, did not appear to effect short term survival. Although around 22% of the smolts showed some signs of injuries passing through the spillway and FCF, nearly all of the injuries were superficial dorsal scrapes that healed quickly and did not effect survival for the 160 days they were held post treatment. Bioassay chamber results in 2002 again raised concerns about potential survival impacts from extended exposure to high suspended sediment loads.

Annual surveys of juvenile fish densities in Hoffstadt Creek by Weyerhaeuser indicate that despite continued releases of trap and haul coho adults into this stream, juvenile densities remain very low. Steelhead stocking in the same creek has resulted in successful spawning and production of juveniles, with juvenile steelhead densities increasing with the release of larger numbers of steelhead adults. The lack of success by coho could be a result of unsuccessful spawning or because fish leave the system after release. Another problem with this release site is its location above a natural barrier where resident cutthroat reside. Cutthroat are no longer found in the portion of the creek where the trap and haul fish are released but are still abundant upstream of the areas used by released steelhead.

Access to release sites can be problematic during high runoff conditions, good holding pools at or just below several of the release sites are limited, and the release hoses need improvements to reduce injuries and stress.

7.2.4. Adult Passage Studies at SRS

Historically as high as 11% of North Fork Toutle steelhead moved downstream after spawning to regain weight and return upstream to potentially spawn. Evaluations in 1990 indicated these fish may have difficulties in passing downstream through the conduit pipes of the outlet works where debris would often collect.

Currently, it is not clear to what extent the SRS spillway and the N1 structure are barriers to adult fish migrating upstream. Preliminary results from radio-telemetry studies found that some steelhead are capable of volitional passage up the SRS spillway, into spawning tributaries, and well above the N1 structure. Volitional upstream passage of adult coho appears to be blocked by the falls at the bottom of the SRS spillway. Adult coho and steelhead release just above the SRS into the braided sections of the North Fork Toutle River passed upstream into tributaries, with some fallback over the spillway. Most of this fallback appears related to releasing fish too close to the vicinity of top of the SRS spillway as the percentages dropped dramatically when the release site was moved upstream.

Concerns were raised about passage barriers related to high water temperatures and shallow water during low river flow periods in braided areas above the SRS. Rob Jones (NMFS) at a Toutle River/SRS Fish Passage Coordination Meeting in 1986 stated that often anadromous fish can recolonize such areas, even with periods of 70% fines in the suspended sediments and water temperatures that go above 80°F. Braiding and temperature concerns need to be considered with respect to the periods of time that adult or juvenile fish will likely be using those sections of the North Toutle above the SRS. Migration timing for adults runs from October into early June. Juvenile outmigration occurs primarily during April and May.

7.2.5. Confluence Connectivity/Fish Habitat

Although the North Fork Toutle River historically provided productive habitats for anadromous salmonids, productivity continues to remain limited due to eruption impacts. Sediment loads remain very high in the North Fork Toutle River above and below the SRS, and in the mainstem Toutle River below its confluence with the North Fork Toutle. Braided stream conditions and erosion continues to impact fish habitat in these channels under low-, medium-, and high-flow conditions.

7.3. Summary of Current Fish Status

The determination of environmental benefits under current conditions was based on three primary components:

- The percent of fish that successfully pass above the SRS with a given alternative.
- The effects of the trap-and-haul program on fish that successfully pass above the SRS (represented as percent of fish that are negatively affected by the operations).
- The effect of episodic high sediment loads on the successful return of adult fish.

Estimates for both steelhead and coho were made separately and the values were averaged for an overall percentage to come up with an environmental output improvement value. There is a large amount of uncertainty and variability around these estimates as data is limited but every effort was made to ensure that the values were treated consistently.

Overall, it has been estimated that under existing conditions, considering the current status of the trap-and-haul operations there is about 42% to 64% transport/passage for steelhead and 35% to 53% transport/passage for coho.

8. POTENTIAL MEASURES

This section describes the range of potential ecosystem restoration measures and the associated costs that have been identified. Note that the restoration measures associated with fish passage at the SRS and/or FCF would need to be completed before confluence connectivity/fish habitat actions should be implemented. In addition, maintaining authorized levels of flood protection for the communities along the Lower Cowlitz River must be fully understood and integrated into any ecosystem restoration plan.

8.1. Fish Passage Measures

8.1.1. SRS Spillway Improvements

Improve SRS Falls/Spillway. This fish passage measure requires removing the falls at the bottom of the spillway and creating lateral connections and resting pools on the spillway. The falls was formed in 1995 when high flows eroded the overburden beneath the shotcrete at the bottom of the spillway on the west side (Figures 12 and 13). This spillway improvement measure would remove the falls by excavating the rock bottom of the spillway back to a more gradual slope, and building fish passage features into the slope, such as resting pools. The estimated volume of rock excavation is about 1,000 cubic yards (cy). In addition, there may be other locations along the spillway that restrict fish passage and could be modified. Modifications may include excavation of lateral trenches for connectivity during low flows and excavation of resting pools for use during high flows. The estimated volume of rock excavation for such features is about 500 cy. The estimated total volume of rock excavation is 1,500 cy.

The rock excavation could be performed using a backhoe with hammer attachment, by drilling and blasting, or by some other method. To perform this work in the dry, it would be desirable to dewater the spillway by reviving the top row of outlet works pipes to pass flow from the North Fork Toutle River. This would involve excavating some sediment in front of the outlet pipes and using the excavated sediment to form a temporary berm to direct the river to the outlet pipes instead of the spillway. The work would be performed in the late summer when river flow is low. An alternative may be to divert the flow locally around the work areas in the spillway using temporary cofferdams. The total estimated cost for this measure is $300,000 (includes contingency, engineering and design, and construction supervision and administration).

Fish Ladder at Spillway. Another measure to improve upstream fish passage at the SRS would be to construct a fish ladder from the SRS tailwater to the headwaters above the SRS spillway. This measure was considered by the Corps at a 1987 interagency meeting. At that time, Corps engineers concluded that there were insurmountable technical difficulties. The difficulties, which remain today, include a lack of stable tailwater and headwater pools; an unreliable supply of auxiliary water or difficulties with sediment load in the water choking pipes; sediment buildup in the ladder itself; and difficult access for construction and maintenance. As a result, constructing a fish ladder at the SRS spillway was not considered a feasible method of passing fish upstream of the structure.

Figure 12. 1995 Erosion Creating the Falls

Figure 13. The Falls Today

8.1.2. Fish Collection Facility

Fix Existing FCF. According to the operators of the FCF, the primary problem affecting the facility is the sediment load and sediment accumulation in the facility. If the sediment could be kept out, the operators claim the facility would function adequately. Based on this assessment, the proposed fix involves minimizing the amount of sediment entering the facility. The fix involves three items: (1) reviving the 24-inch diameter sediment sluice; (2) removing the stoplog in the fish barrier; and (3) building a settling box at the water intake. These items are shown on Plate 1 (located at the end of this report).

Water enters the facility by passing through a trash rack with a 3-inch clear spacing and over a 15-foot-long weir at elevation 750 mean sea level at the water supply intake. Water moves through a 15-foot by 28-foot sediment settling box with a bottom sloping toward a 24-inch diameter sediment sluice pipe. Sediment is supposed to settle in the box and flush out through the sluice pipe, discharging past the fish barrier. The remaining flow passes over a weir at elevation 751 and into the FCF.

Revive Sediment Sluice Pipe. The sediment sluice pipe is not flushing sediment from the weir box, possibly because it is plugged with debris. The cause of the sediment sluice malfunction would be investigated. If the pipe is plugged with debris, one solution may be to clean out the pipe from the downstream end using a hydrojet. The total estimated cost of this work is $10,000.

Remove Stoplog. The fish barrier has a 2-foot-deep by 10-foot-wide notch adjacent to the facility and near the water intake (Plate 2). When open, water velocities through the notch are higher than over the rest of the barrier, which discourages the buildup of sediment near the notch and water intake. A stoplog is currently in place, effectively filling the notch so that water passes over the entire barrier evenly. Under this condition, sediment is more likely to build up near the water intake. It has been reported that the stoplog is jammed in place and cannot be removed easily. One solution is to mobilize a high-capacity crane to lift the stoplog out of the notch. Alternative methods of removing the stoplog also should be explored. The total estimated cost of this work is $5,000.

Settling Box. The existing sediment settling box may be too small to allow sufficient settling of sediment. The flow into the FCF ranges from 127 to 274 cfs for river flows at 170 to 5,000 cfs, respectively. The settling box needs to have a large enough detention time to allow particles of sediment to fall out as the flow passes through the box (i.e., the detention time should be greater than the fall time). Table 7 shows the results of simplified calculations of detention time and fall time in order to make an approximation of revising the size of the settling box. Plate 1 shows the revised size of the settling box, at 30 feet by 150 feet, instead of the existing 15 feet by 28 feet. The water intake, including trash rack and weir, would be moved upstream.

Table 7. Calculations of Detention Time and Fall Time for the Sediment Settling Box

Settling Box				Detention time for Q_{FCF} = 274 cfs (seconds)
Width (ft)	**Length (ft)**	**Height (ft)**	**~ Volume (ft^3)**	
30	150	7	31,500	115
Grain Size (fine sand; in mm)		**Fall Velocity**		**Fall time for height = 7 ft (seconds)**
		cm/s	**ft/s**	
0.4		5	0.16	43

274 cfs is flow through FCF when river flow is 5,000 cfs.
Fall velocity is for stagnant water. Hindered settling in moving water may reduce fall velocity.
ft = feet; ft^3 = cubic feet; mm = millimeters; cm/s = centimeters/second; ft/s = feet/second

The FCF currently collects roughly 10,000 cy of sediment per year (estimated from the amount of sediment the facility operators remove each year). The goal is to collect this sediment load in the resized settling box to prevent it from entering the facility. Sediment would be removed from the box by two mechanisms: flushing out through the sediment sluice and removal by use of vacuum pumping. The vacuum pumping system could involve an agitator to stir up the sediment from the bottom of the box and a pump designed to handle sediment with its suction line in the box and the discharge point at a nearby location with truck access. The total estimated cost of the resized settling box is $250,000. In addition to this initial cost, the estimated cost of removing and disposing of the sediment from the box is $50,000 annually.

New Trap-and-Haul FCF. A new trap-and-haul FCF could be constructed to more effectively move fish upstream of the SRS. One option would be a facility consisting of a fish ladder with auxiliary water leading to an elevated holding pool and a hands-off sorting structure that would load fish into trucks below. This type of facility is currently being designed for the Corps' Cougar Dam and Lake project in the McKenzie River watershed in Oregon. Based on the cost estimate for the Cougar Dam project, the total estimated cost of a new trap-and-haul facility just downstream of the SRS ranges from $10 to $15 million.

Remove FCF Fish/Velocity Barrier. If the SRS spillway improvements lead to desirable volitional fish passage, the next step could be to modify the FCF itself to allow for volitional passage. Volitional passage at the FCF is prevented by a concrete fish/velocity barrier (Figure 14). The barrier forms a two-tiered falls about 25 to 30 feet in height. To allow for volitional fish passage, the concrete structure would be removed and the upstream river channel would be graded to produce a navigable slope and channel for fish. The total estimated cost for this measure is $1 million.

Figure 14. FCF Fish/Velocity Barrier

Source: Steward and Associates

8.1.3. Release Sites

New Release Site above SRS (volitional movements). A new release site would be constructed just above the SRS on the south side. The existing road from the crest to the pool at the left abutment would be improved and extended to the new release site at the North Fork Toutle River. Work at the release site would involve building a corrugated metal pipe chute for delivering fish from a truck into the river, a gravel turnaround area, and possibly measures to stabilize the release site area. The estimated cost for this measure is $100,000.

Improve Tributary Sites. This work would be similar in scope to the new release site above the SRS but without the road work. The estimated cost to improve the four existing release sites is $200,000.

8.2. Confluence Connectivity/Fish Habitat

8.2.1. Sediment Plain Structures

Pile Dikes. Pile dikes may potentially be effective for concentrating a braided river with high sediment load into a single channel. Pile dikes may be constructed in various ways. For cost estimating purposes, the proposed pile dike is considered to be constructed using timber piles spaced 2.5 feet apart and connected with a horizontal spreader timber. Further assessment of pile dikes and the true potential of effectively using them in this dynamic environment will be required during the feasibility phase.

The proposed location for a pile dike structure is in the vicinity of Alder Creek (Figure 15). The North Fork Toutle River currently passes between the two "islands" in the sediment plain. In the past the North Fork has passed on the east side of the larger, more northerly island. The pile dike would span roughly 0.5 mile from the northeast side of the sediment plain to the southern tip of the larger island, guiding the North Fork to stay in its current location west of the larger island. It is expected that sediment would accumulate around the pile dike during high flow events; after high flow events the river would recede into the single channel.

Because the sediment plain is still filling, it is anticipated that a second pile dike may be needed at a later date, possibly in 15 years. Figure 16 shows the sediment plain's profile upstream of the SRS from 1988 to 2004. The original estimate of the approximate final slope was one-half the original stream slope. This slope is shown on Figure 16 as S/2. If the sediment plain continues to fill to S/2, the range of future deposition is from 0 to approximately 40 feet in height. Figure 17 shows deposition from 3 to 7 feet in the vicinity of Alder Creek from 2001 to 2004. Note the slope of the plain from east to west. The proposed pile dike would maintain this slope. However, after sediment has filled to near the top of the pile dike on the east side of the plain, further deposition may tend to migrate west, decreasing the slope from east to west and increasing the chance of an avulsion causing the river to shift east of the island. To reduce the likelihood of this occurring, a second pile dike would be constructed above the first when/if the ground on the west side builds to an elevation near the top of the first dike (Figure 17). This series of two successive dikes would maintain a significant elevation gradient across the plain (high to low from east to west) and maintain a barrier to an avulsion as the sediment plain fills. The estimated cost of the pile dike measure is $900,000 (includes contingency, engineering and design, and construction supervision/administration). A similar cost would be required if a second pile dike is needed, possibly in 15 years.

In addition to pile dikes, other types of sediment plain structures were considered but ultimately removed from the list of potential measures. Several types of low-height sluicing structures were considered including gabions, logs, large stones, jersey barriers, sheet piling, and a modified high density polyethylene (HDPE) net pen structure envisioned by a local resident and engineer, Lou Reebs. A low-height sluicing structure would act similarly to a pile dike, trapping sediment during high flow events and guiding low flows to a desirable established channel, but would be lower in height than a pile dike. Because of the lesser height of the sluicing structures, more of them would be needed to keep up with the rise in the sediment plain and as a result, the low-height sluicing structure options turned out more expensive than the pile dikes option.

A large embankment-type structure with spillway also was considered. The structure would be located upstream of the N1 structure and would be $^1/_8$ to ½ of the size of the N1 structure. The purpose of this structure would be to retain sediment continuing to erode from the debris avalanche. Because of the high cost of such a structure and the high probability of it breaching, as N1 breached, this type of structure was not considered further.

8.2.2. Tributary Plantings/Stabilization

Treatments include planting riparian vegetation, introducing woody debris, and stabilizing creek banks, if necessary. The purpose of this work would be to maintain and enhance habitat. The Alder, Deer, Hoffstadt, and Bear tributaries may benefit from planting/stabilization work. The total estimated initial cost to treat all four tributaries is $800,000 including contingency, engineering and design, and construction supervision and administration. The construction cost is based on treating 500 ft of tributary, for four tributaries, at a cost of $300 per linear foot. The cost to maintain plantings and stability under changing conditions is $250,000 every 5 years.

Figure 15. Proposed Location of Pile Dike

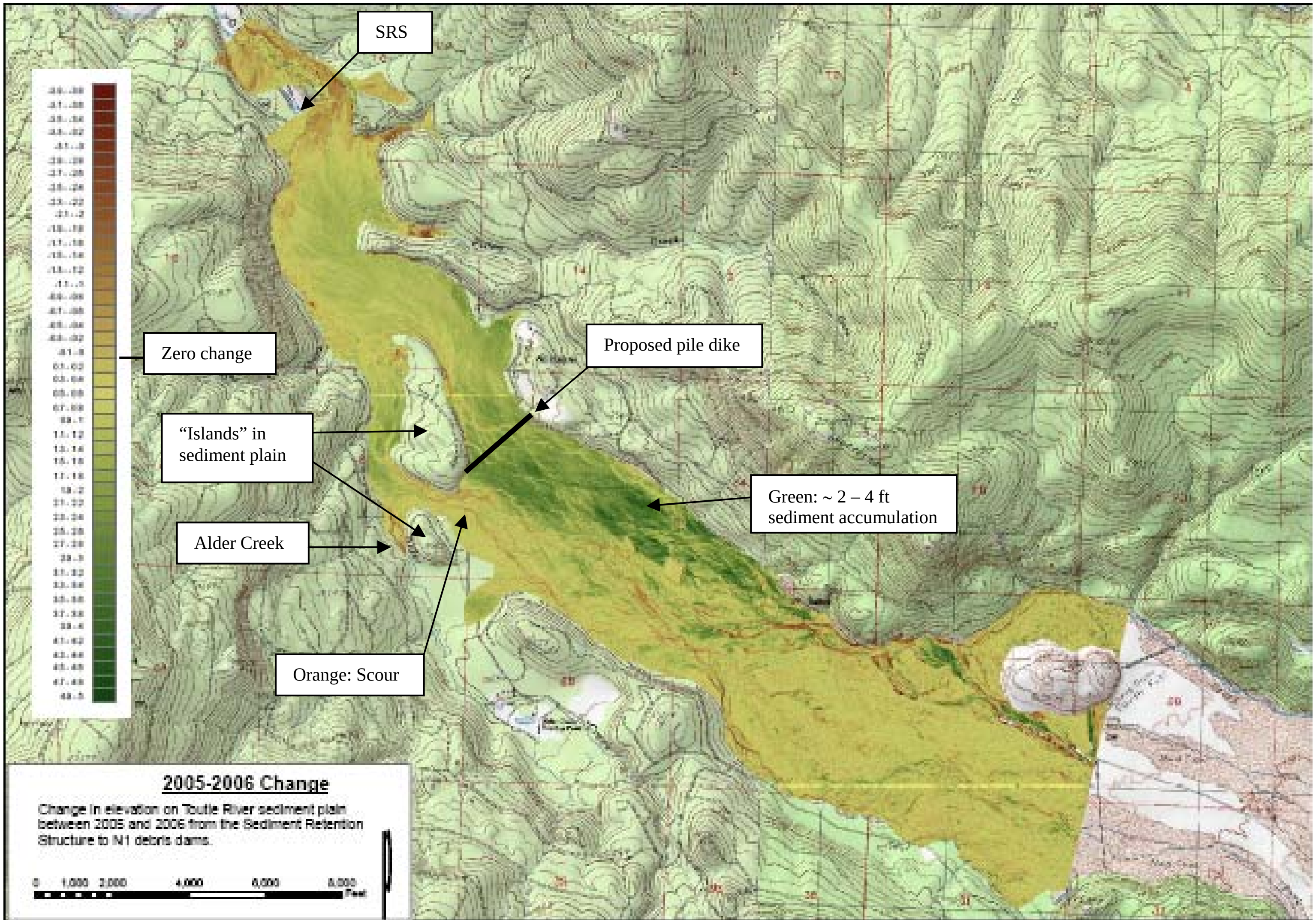


Figure 16. Sediment Profile Upstream of the SRS

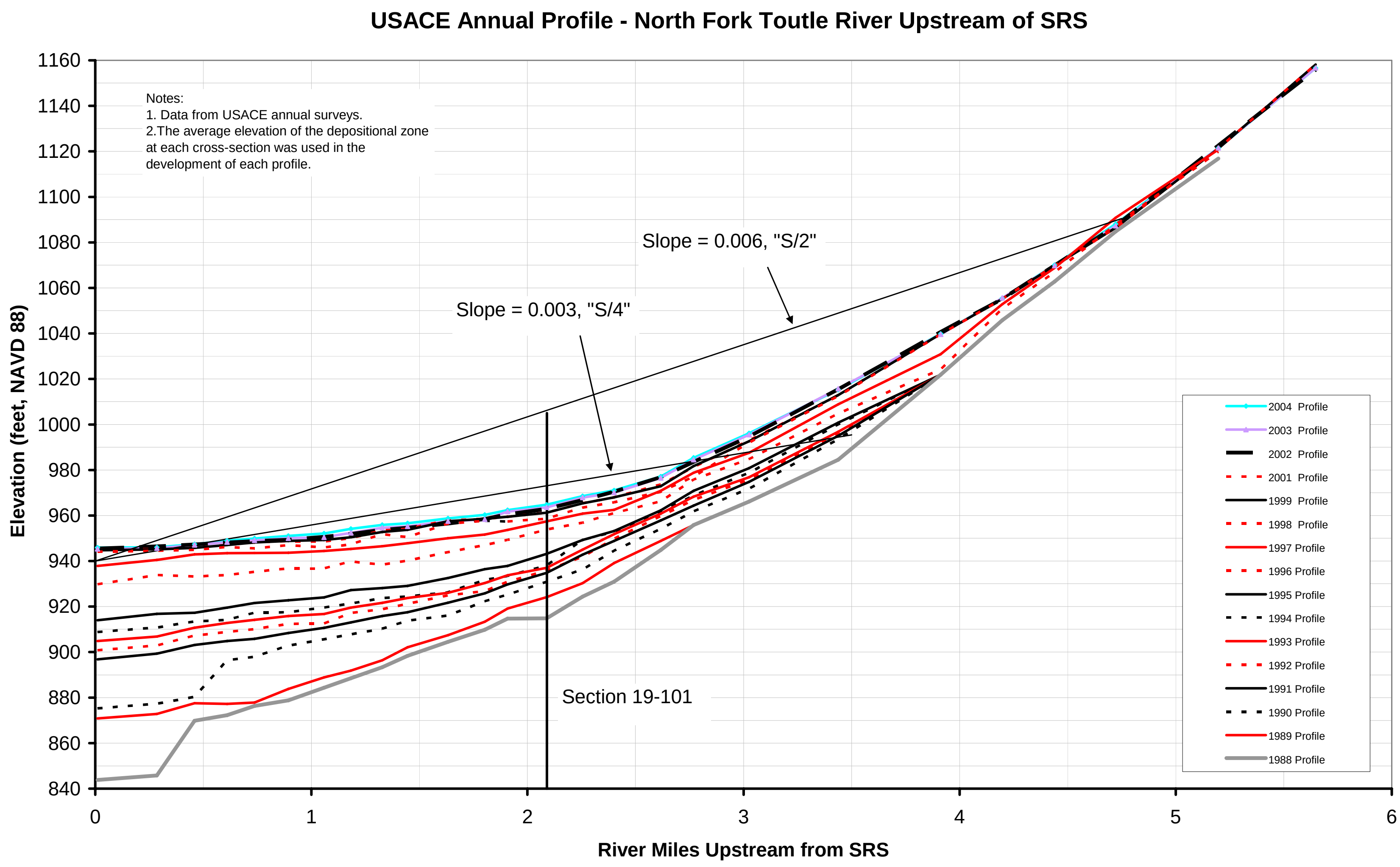
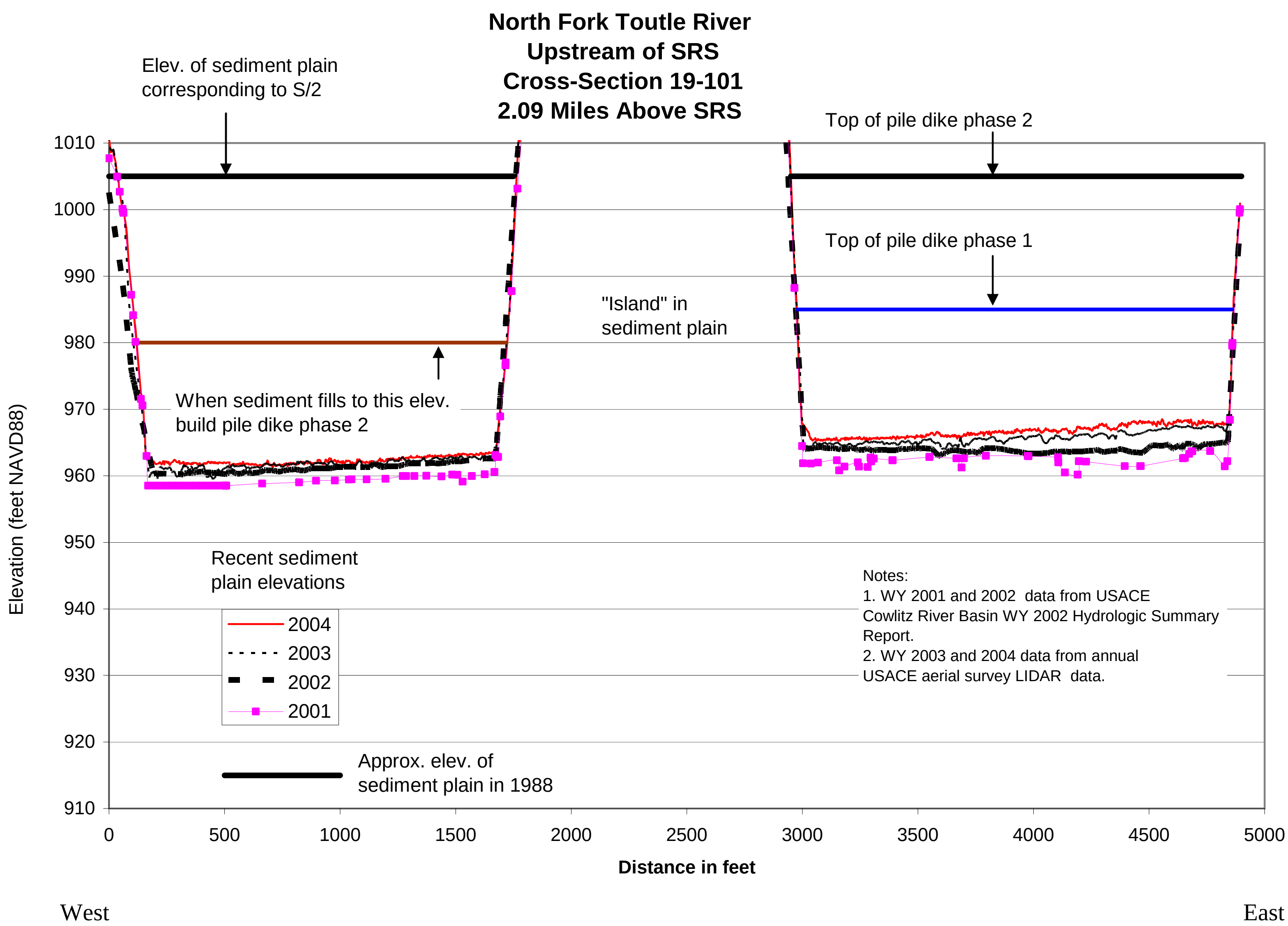


Figure 17. Sediment Plain Cross Section Two Miles above the SRS near Alder Creek



8.2.3. Toutle River Off-channel Habitat Restoration Downstream of SRS

Preliminary work to identify potential opportunities to create off-channel habitat was initiated by Tetra Tech (2006). In the preliminary work, 14 projects along the lower Cowlitz River involving restoration of side or off-channel areas to create fish habitat for a variety of fish species were identified. Activities include reconnecting side and off-channels to the Cowlitz by excavation, placement of large woody debris and log jams, riparian plantings, and bioengineered bank stabilization. The proposed projects range in size from 8 to 70 acres. The number of off-channel restoration projects proposed along the Toutle River between the SRS and the Cowlitz River in this report depends on the magnitude of benefit for fish per project. The total estimated cost of each project is $2 to $2.5 million.

9. ENVIRONMENTAL BENEFITS OF POTENTIAL MEASURES

The determination of environmental benefits of the alternative measures was based on three primary components:

- The percent of fish that successfully pass above the SRS with a given alternative.
- The effects of the trap-and-haul program on fish that successfully pass above the SRS (represented as percent of fish that are negatively affected by the operations).
- The effect of episodic high sediment loads on the successful return of adult fish.

Estimates for both steelhead and coho were made separately and the values were averaged for an overall percentage and compared against the baseline estimate of the current situation to come up with an environmental output improvement for a given alternative. There is a large amount of uncertainty and variability around these estimates as data is limited but every effort was made to ensure that the values were treated consistently.

For alternatives that involve the use of the FCF, the first component of the environmental outputs is an estimate of the trap efficiency for fish (TE). This is an estimate of the number of fish that reach the trap on their way to streams above the SRS that are successfully captured by the trap. Many factors affect this estimate, primary of which is the ability of migrating fish to find the entrance to and remain in the trap. Level of flow, in-river sediment load, the operational condition of the trap, and how well fish are collected from the trap will affect the TE. Few data of trapping efficiency are available, so a range of estimates for year-to-year TE was based on discussions with biologist operating the facility and by comparing the design and operation of the North Fork Toutle FCF with other traps in the region. Relatively speaking, high flow and sediment load event years, such as occurred in the fall of 2006 will greatly reduce the TE, especially with the long-term operational, maintenance, and effects from potential design problems that have been ongoing.

For alternatives that do not include the FCF, estimates for the first component of the environmental outputs are based on the percentage of fish that successfully pass up the spillway channel (PE = passage efficiency). Preliminary data from a small sample of radio-tagged steelhead and coho show that about 20% of steelhead and no coho ascend the existing SRS spillway. Coho do not appear able to navigate the existing falls at the bottom of the spillway. Estimates of PE with modifications made at the spillway are based on the expected flow velocity changes, the increase in connectivity, and the distribution of resting pools that would be engineered into those modifications; the swimming capabilities of steelhead and coho; and how well these species pass streams with similar conditions to those expected at the modified spillway. The PE estimates (60% to 80% for steelhead and 50% to

70% for coho, depending on environmental conditions) would need to be verified by evaluations of radio-tagged fish to ensure expected levels of passage are being achieved.

The second component of the environmental outputs consists of an estimate of the change from the existing to an alternative trap-and-haul program on those fish that are trucked above the SRS. This estimate is based on changes to the quality of the trapping and handling operations, improvements to the release sites, and expected changes to the historic data on the level of successful production of juveniles in streams where trap-and-haul fish are released. Some alternatives do not include trap-and-haul operations and thus, do not include a value for this component.

The third component is an estimate of the potential effects of modifications made above the SRS to direct flows and stabilize channels with the idea of improving sediment loads, water temperatures, and connectivity over the passage season. The estimate is in terms of how these modifications alter the percentage of fish successfully returning above the SRS. Naturally occurring revegetation along the North Fork Toutle tributaries (above the periodic high flow events that occur along the mainstem) have greatly improved spawning by reducing temperatures and stabilizing streambeds. However, there is considerable uncertainty as to whether the proposed alternative addressing this third component (pile diking and vegetation planting within the periodic high flow event zone) would actually reduce sediment loads or maintain connectivity if implemented, especially after observing the effects of the major flow event in November 2006. In addition, the effects to spawning beds and backwater connectivity in areas downstream from the SRS and FCF from deposition of high sediment loads may impact fish outside of the focus of this report.

The majority of the negative effects associated with high sediment loads and temperatures are expected to impact outmigrating juveniles. Studies in 2001 and 2002 evaluated the cumulative effects of passage through the spillway and FCF on juvenile salmonids. Transport, handling, and passage of hatchery coho smolts released through the spillway or over the FCF dam downstream did not appear to affect short-term survival. Although around 22% of the smolts showed some signs of injuries passing through the spillway and FCF, nearly all of the injuries were superficial dorsal scrapes that healed quickly and did not effect survival for the 160 days they were held post-treatment (personal communication, Craig Olds, 2002).

The baseline value of the existing trap-and-haul program was determined by using the same rationale as discussed above. Trap efficiency varies greatly at the current trap and it was essential to address that variability in determining a baseline output over the year for the two fish species. High flow and sediment condition years, maintenance and operational problems, and design limits can greatly reduce the number of fish entering the trap. Estimates for these values were based on discussions with biologists operating the trap, and comparing the operation and maintenance of this facility to other documented facilities. The estimates ranged from 45% to 68% TE for steelhead and 38% to 56% TE for coho depending on environmental and facility conditions. The high debris- and sediment-filled flows that occurred in November 2006 and the lasting effects from this event further limited the capabilities of the existing trap; this was considered to have reduced the existing baseline toward the lower third of the above TE ranges. The estimate of TE for fixing the current FCF was 60% to 80% and 90% for a new state-of-the-art FCF for both species based on trapping success at new facilities in the region.

Additional trap-and-haul program factors also entered in to determining the baseline value when considering the second component listed above. Several practices used at the FCF are less than optimal for a trap-and-haul program. Fish are hand-netted from a non-functioning crowder pool where they can reside for up to 5 days before capture, lifted over a fence, and carried in nets to an examination table before being placed in the transport truck. Several of the release sites have difficulties being reached when conditions are wet; many of the release pipes have limited water, variable slopes, rough joints between pipe sections, and do not drop fish into pools. The Hoffstadt Creek release site for steelhead is located above a natural barrier in a stretch of stream where native spawning cutthroat have been displaced. Adult fish counts and juvenile production estimates for steelhead and coho in Hoffstadt Creek made by Weyerhaeuser from 1991 (when juvenile stocking of coho ceased) to 2004 found a steady positive correlation between steelhead spawners and juveniles although coho production remained very, very low even with increased releases of coho over the years. This seems to indicate that either coho are spawning unsuccessfully or they are leaving Hoffstadt Creek, perhaps in search of their natal streams. The negative effects from these factors related to the existing trap-and-haul program were estimated at (-15%) for steelhead and (-30%) for coho. The negative value of the trap-and-haul effects would drop if the FCF was repaired, if a new FCF was built, if a new release site was built, or if an existing tributary release site were improved.

One factor not included in the environmental outputs is the risk related to a major volcanic or seismic event occurring on Mount St. Helens. It is impossible to predict the probability of such an event within the 30-year time frame of this study. However, any sizeable debris flow event would likely devastate any measures constructed within the sediment plain.

Lastly, not all actions that make up an alternative are additive and some actions cannot stand alone. For instance, making spillway repairs to allow good volitional passage must also include either improvements to the FCF or removal of the FCF. Also, when a range of values for the two fish species was derived, an average of these values was used for the net increase.

Table 8 summarizes the estimated environmental outputs for the range of potential ecosystem restoration alternatives considered. Without improvements, it is estimated that the existing trap-and-haul operations provide about 42% to 64% transport/passage for steelhead and 35% to 53% transport/passage for coho. All other improvements are compared to this without-project condition to determine what kind of increase in outputs various options can provide.

Table 8. Environmental Outputs by Potential Ecosystem Restoration Alternative

Alternatives	Fish Species	Output Assumptions *	Output	Midpoint % Output	Increase Above Baseline	Average % Increase (Units)
BASELINE (existing trap & haul)	Steelhead	Currently in low range of TE and 15% T&H effect with 3% sed. effect	42% - 64%	0.48	---	---
	Coho	Currently in low range of TE and 30% T&H effect with 3% sed. effect	35% - 53%	0.40 [0.44 mean for both fish]	---	
IMPROVE FALLS/SPILLWAY and FIX FCF	Steelhead	60% - 80% TE/PE, 5% T&H effect, 3% sed. effect	54% - 73%	0.635	0.155	15.5
	Coho	50% - 80% TE/PE, 10% T&H effect, 3% sed. effect	42% - 69%	0.555	0.155	
IMPROVE FALLS/SPILLWAY and FIX FCF + PILE DIKES	Steelhead	60% - 80% TE/PE, 5% T&H effect, 1% sed. effect	56% - 75%	0.655	0.175	17.5
	Coho	50% - 80% TE/PE, 10% T&H effect, 1% sed. effect	44% - 71%	0.575	0.175	
IMPROVE FALLS/SPILLWAY + REMOVE FCF BARRIER	Steelhead	60% - 80% PE, 3% sed. effect	57% - 77%	0.67	0.19	20.5
	Coho	50% - 80% PE, 3% sed. effect	47% - 77%	0.62	0.22	
IMPROVE FALLS/SPILLWAY + REMOVE FCF BARRIER + PILE DIKES	Steelhead	60% - 80% PE, 1% sed. effect	59% - 79%	0.69	0.21	23.0
	Coho	50% - 80% PE, 1% sed. effect	49% - 79%	0.64	0.24	
FISH LADDER AT SPILLWAY	not feasible	---	---	---	---	---
FIX EXISTING FCF	Steelhead	60% - 80% TE, 10% T&H effect, 3% sed. effect	51% - 70%	0.605	0.125	11.5
	Coho	60% - 80% TE, 25% T&H effect, 3% sed. effect	43% - 58%	0.505	0.105	
FIX FCF + NEW RELEASE SITE	Steelhead	60% - 80% TE, 5% T&H effect, 3% sed. effect	54% - 73%	0.635	0.155	18.0
	Coho	60% - 80% TE, 10% T&H effect, 3% sed. effect	51% - 70%	0.605	0.205	
FIX FCF + NEW RELEASE SITE + PILE DIKES	Steelhead	60% - 80% TE, 5% T&H effect, 1% sed. effect	56% - 75%	0.645	0.165	19.0
	Coho	60% - 80% TE, 10% T&H effect, 1% sed. effect	53% - 71%	0.62	0.22	
FIX FCF + IMPROVE TRIBUTARY SITES	Steelhead	60% - 80% TE, 10% T&H effect, 3% sed. effect	51% - 70%	0.595	0.115	14.0
	Coho	60% - 80% TE, 15% T&H effect, 3% sed. effect	48% - 65%	0.565	0.165	

* Notes:
TE = trap efficiency for fish
T&H = trap-and-haul
PE = passage efficiency
sed. effect = sedimentation effect

Table 8 (continued). Environmental Outputs by Potential Ecosystem Restoration Alternative

Alternatives	Fish Species	Output Assumptions *	Output	Midpoint % Output	Increase Above Baseline	Average % Increase (Units)
FIX FCF + IMPROVE TRIBUTARY SITES + PILE DIKES	Steelhead	60% - 80% TE, 10% T&H effect, 1% sed. effect	53% - 71%	0.61	0.13	16.0
	Coho	60% - 80% TE, 15% T&H effect, 1% sed. effect	50% - 67%	0.585	0.185	
NEW FCF (state-of-the-art)	Steelhead	90% TE, 10% T&H effect, 3% sed. effect	78%	0.78	0.30	30.0
	Coho	90% TE, 20% T&H effect, 3% sed. effect	70%	0.70	0.30	
NEW FCF + NEW RELEASE SITE	Steelhead	90% TE, 5% T&H effect, 3% sed. effect	83%	0.83	0.35	37.0
	Coho	90% TE, 10% T&H effect, 3% sed. effect	78%	0.78	0.38	
NEW FCF + NEW RELEASE SITE + PILE DIKES	Steelhead	90% TE, 5% T&H effect, 1% sed. effect	85%	0.85	0.37	39.0
	Coho	90% TE, 10% T&H effect, 1% sed. effect	80%	0.80	0.40	
NEW FCF + IMPROVE TRIBUTARY SITES	Steelhead	90% TE, 10% T&H effect, 3% sed. effect	78%	0.78	0.30	32.0
	Coho	90% TE, 15% T&H effect, 3% sed. effect	74%	0.74	0.34	
NEW FCF + IMPROVE TRIBUTARY SITES + PILE DIKES	Steelhead	90% TE, 10% T&H effect, 1% sed. effect	80%	0.80	0.32	34.0
	Coho	90% TE, 15% T&H effect, 1% sed. effect	76%	0.76	0.36	
NEW RELEASE SITE	---	Results same as baseline but with 10% improvement to T&H effects so benefits = 10%		---	---	10.0
IMPROVE TRIBUTARY SITES	---	Results same as baseline but with 5% improvement to T&H effects so benefits = 5%		---	---	5.0
PLANTINGS @CONFLUENCES & OFF-CHANNEL BACKWATER HABITAT (Toutle River below SRS)	---	Outputs not quantified	---	---	---	---

* Notes:

TE = trap efficiency for fish
T&H = trap-and-haul
PE = passage efficiency
sed. effect = sedimentation effect

10. CONCLUSIONS

Table 9 summarizes the net increase in outputs, total estimated costs, relative cost per output, and the ranking order for each potential ecosystem restoration alternative. Based on this preliminary analysis it appears there are several potential combinations of restoration measures to consider for implementation. The No Action alternative (baseline, existing trap-and-haul operation) provides existing levels of output (about 44%) at no increased cost. Based on the cost estimates and output estimates, it appears that after the No Action alternative, the best investment based on relative cost per output is the new release site. After that, improving tributary sites or improving the SRS spillway and removing the FCF barrier are the lowest cost per output. There is a significant breakpoint where costs per output increase when the cost of constructing a new FCF is added to the mix.

Table 9. Ranking of Potential Ecosystem Restoration Alternatives

Alternative	Net Increase in Outputs	Total Estimated Cost ($) (not annualized)	Relative Cost/Output ($)	Rank
BASELINE/NO ACTION (existing trap & haul after Nov 2006 high water event) = 44%	---	---	---	---
IMPROVE FALLS/SPILLWAY + FIX FCF	15.5	2,315,000	149,355	5
IMPROVE FALLS/SPILLWAY + FIX FCF + PILE DIKES	17.5	4,115,000	235,143	10
IMPROVE FALLS/SPILLWAY + REMOVE FCF BARRIER	20.5	1,700,000	82,927	3
IMPROVE FALLS/SPILLWAY + REMOVE FCF BARRIER + PILE DIKES	23.0	3,500,000	152,174	6
FISH LADDER AT SPILLWAY	not feasible	not feasible	not feasible	---
FIX EXISTING FCF	11.5	2,015,000	175,217	8
FIX FCF + NEW RELEASE SITE	18.0	2,115,000	117,500	4
FIX FCF + NEW RELEASE SITE + PILE DIKES	19.0	3,915,000	206,316	9
FIX FCF + IMPROVE TRIBUTARY SITES	14.0	2,215,000	158,214	7
FIX FCF + IMPROVE TRIBUTARY SITES + PILE DIKES	16.0	4,015,000	250,938	11
NEW FCF	30.0	12,900,000	430,000	15
NEW FCF + NEW RELEASE SITE	37.0	13,000,000	351,400	12
NEW FCF + NEW RELEASE SITE + PILE DIKES	39.0	14,800,000	379,500	13
NEW FCF + IMPROVE TRIBUTARY SITES	32.0	13,100,000	409,375	14
NEW FCF + IMPROVE TRIBUTARY SITES + PILE DIKES	34.0	14,900,000	438,235	16
NEW RELEASE SITE (can be stand alone if current FCF can function as it did pre-Nov 2006)	10.0	300,000	30,000	1
IMPROVE TRIBUTARY SITES (can be stand alone if current FCF can function as it did pre-Nov 2006)	5.0	400,000	80,000	2
PLANTINGS AT CONFLUENCES	---	2,050,000	---	---
OFF-CHANNEL BACKWATER HABITAT (Toutle River below SRS)	---	2,250,000	---	---

11. POTENTIAL ISSUES

11.1. Authority to Make Changes to Existing Corps Facilities for Restoration Purpose

Components of the proposed ecosystem restoration actions identified in the reconnaissance-level study would require changes to existing Corps facilities. Specifically, the SRS was constructed by the Corps to provide flood protection to the communities in the lower Cowlitz River. Proposed ecosystem restoration measures includes modifying the SRS spillway to allow upstream fish passage. This raises the question as to whether ecosystem restoration work at the SRS is possible under the original authorizing language. There is no explicit authorization language that mentions ecosystem restoration work other than mitigation for the SRS. However, historical documents and correspondence indicate modifications for fish passage were under consideration.

Based on a review of historical documents the following findings were made:

- Modifications at the SRS to benefit fish are appropriate under the original authority. Consideration of fish passage was incorporated in the design of the SRS spillway. Downstream passage through the spillway was intended once sediment filled behind the structure. The Corps anticipated fish passage would be possible upstream at some point in the future; and necessary modifications to allow that are warranted.
- The original spillway was designed to provide for downstream and upstream fish passage. Therefore, the original authority could be used to modify facilities to provide fish passage.
- The reviewed documents do not explicitly mention potential future modifications to fish and wildlife measures under the original project authority. The Local Cooperative Agreement explicitly indicates the State of Washington is responsible for operating and maintaining the FCF that was constructed by the Corps – there was no mention of additional measures or modifications that could/would be considered at a later date. However, a 1998 Corps' planning letter report explicitly mentions upstream fish passage improvements at the SRS may be warranted to "complete the project."
- Internal Corps' correspondence indicates upstream fish passage modifications should be evaluated once sediment fills to the spillway elevation.

Based on a review and assessment of historical records, it may be possible for the Corps to evaluate and implement modifications at the SRS for fish passage under current authority. However, policy and legal issues remain and the Corps will need to resolve these issues before proceeding with any fish passage modification assessments at the spillway. Even if it is determined that the Corps can address fish passage issues at the SRS under existing authority, agreement from the WDFW on modifying/removing the FCF barrier must first occur.

11.2. Non-federal Sponsor

This reconnaissance study constitutes the first phase of study to define problems and opportunities, identify potential solutions, determine if there is federal interest, and determine if there is a non-federal sponsor willing to cost-share the feasibility study and implementation of a project. The reconnaissance phase is completed upon signing a Feasibility Cost-Sharing Agreement by the Corps and the non-federal sponsor. The second phase is completion of a feasibility study to optimize the plan to be built and it can take up to 3 to 5 years to complete. The feasibility study is cost shared equally between the Corps and the non-federal sponsor. The non-federal sponsor's share of construction costs is 35% and there is no limit to the federal share.

Feasibility level General Investigation studies for environmental restoration are authorized under Section 306 of the Water Resources Development Act of 1990, as amended. They involve jointly conducting a study with a non-federal sponsor and, if shown by the study to be feasible, the construction of the project.

11.3. Impact of Historical Agreements and Responsibilities

Provided below is a summary of pertinent information from the review of historical agreements/documents that may impact the viability of some of the proposed restoration actions.

Local Cooperation Agreement between the Department of Army and State of Washington and Diking Improvement Districts (April 26th, 1986).

The Corps will perform the construction of the SRS, the fish mitigation measures at the SRS, the downstream dredging, and improvements to downstream levees. In addition, the Corps will operate and maintain the SRS itself. The State will operate and maintain all project mitigation measures, as well as the dredged material disposal sites. The State will operate and maintain the accumulated sediment behind the SRS and responsible to operate and maintain the fish facility.

Letter from State of Washington, Department of Community Development to Corps of Engineers (May 3rd, 1993).

This letter indicates the ownership of the fish collection facility was turned over and accepted by the State of Washington. Specifically, the Department of (Fish &) Wildlife will be responsible for operating and maintaining the facility.

Letter from Corps to Washington Department of Community Development (September 13th, 1989).

This letter indicates that with the transfer of the fish facility, the Corps does not intend to "experiment" with the design of this facility, and the Corps does not have authorization or funding for future work and, therefore, can make no further commitment.

Sediment Retention Structure, Fish Collection Facility Design Memorandum No. 10, Mount St. Helens Sediment Control Cowlitz, and Toutle Rivers, Washington (September 1987).

Discussion refers to downstream migrants at SRS and some concerns about the design. Discussion is included indicating that NMFS had concerns with design of downstream fish passage through the SRS. An attached letter emphasizes that the Corps will design and construct facilities and it will be responsibility of State of Washington to operate and manage facilities. Reference is made to the Local Cooperative Agreement. The FCF is described as permanent feature.

Mount St. Helens, Washington Decision Document (October 1985).

Specific reference to mitigation measures for SRS, levees and dredging. Mitigation for SRS is fish bypass facility to trap adults to be hauled upstream of SRS. Juveniles would pass downstream through outlet works (until closed) and then the spillway. The mitigation and monitoring requirements discussed.

<u>1998 Corps Planning Letter Report (June 1998).</u>

The Planning Letter indicates there was some thought and consideration of upstream fish passage through the SRS spillway. It is stated that an evaluation needs to be completed to determine the extent of design and construction required….for modifications to the spillway so that upstream migrating adults could safely pass the SRS. Adult passage using the spillway would require less human handling and provide a more natural condition with less stress to the fish than that which occurs through operation of currently existing FCF with its trap and haul operations.

The report conclusions mention that on-going coordination will be required to evaluate the justification within the existing legislation for upstream fish passage at specific locations. These studies should be viewed as actions to complete the previously uncompleted portions of the originally authorized project. Therefore, it is appropriate to fund these actions through the existing Construction General authority.

<u>Internal E-mail (Christensen) to other internal Corps staff (January10, 1996).</u>

The e-mail stated that an analysis of eventual upstream fish passage through the spillway and the natural erosion gullies should be considered, unless more sediment is being transported than we predicted or the decision is made to increase the available storage behind the structure, both of which were to be evaluated as the pool began to reach full capacity.

The previously established agreements with multiple responsible parties in the Mount St. Helens project area makes it necessary to clarify roles and responsibilities for the proposed restoration actions. For instance, the WDFW is responsible for the operation and maintenance of the FCF located downstream of the SRS. Any successful plan to improve upstream fish passage will be contingent upon the participation of the State of Washington in either modifying or removing the existing FCF.

11.4. Interrelationship of the Previous Work and Proposed Restoration Activities

The implementation of any restoration plan must be fully integrated and coordinated with the need to maintain flood protection levels for communities along the Lower Cowlitz River. Specifically, the Corps is responsible for the ongoing sediment monitoring and analyses work in the basin to maintain long-term flood protection in levels the Lower Cowlitz River through 2035.

11.5. Land Ownership

The location of potential ecosystem restoration actions will likely encompass multiple ownerships and will require a collaborative effort in order to successfully implement ecosystem restoration. For instance, the Corps has ownership of the SRS structure itself but the sediment pool behind the dam is under ownership of the State of Washington. The FCF is owned and operated by the State of Washington. The tributaries above the SRS are primarily located on Weyerhaeuser property. In addition, the U.S. Forest Service manages significant amounts of land in the upper Toutle watershed.

12. NEXT STEPS

Following are specific steps that will need to be completed in order to move forward with the feasibility phase:

1. Determine non-federal sponsorship.
2. Develop Feasibility Cost Sharing Agreement (FCSA) between the Corps and non-federal sponsor for a feasibility-level study.
3. Before proceeding with feasibility study obtain necessary interagency agreements. This would include:
    a. An agreement from the State of Washington that modifications to, or removal of, the existing FCF are acceptable.
    b. A determination that volitional passage of wild and hatchery fish is acceptable to the fish agencies.
    c. A determination of whether or not it is within the existing Corps' authority to modify the SRS spillway for upstream volitional fish passage.
4. Determine what actions can be implemented under the existing Corps authority and before feasibility study is complete. Potential actions to consider include modifications to the SRS and the FCF.
5. Conduct the feasibility-level study and determine a recommended ecosystem restoration plan for implementation.
6. Develop a Project Cooperation Agreement (PCA) with the non-federal sponsor.
7. The recommended ecosystem restoration plan will be shared with the Office of Management and Budget and submitted to Congress for approval.
8. Complete plans and specifications for the recommended ecosystem restoration plan.
9. Construct the ecosystem restoration plan.

13. RECOMMENDATION

The General Reevaluation Study Reconnaissance Report for the Mount St. Helens Project identified a range of possible alternatives that could provide benefits to anadromous fish species in the Toutle River watershed that are currently listed as threatened under the Endangered Species Act. Based on this preliminary assessment, a federal interest was established to pursue upstream fish passage improvements and ecosystem restoration measures in the Toutle River watershed.

However, there are inherent risks and uncertainties that will need to be considered. Further study may identify reasons that preclude the implementation of fish passage improvements identified in the General Reevaluation Study Reconnaissance Report. Erosion and sediment movement into the North Fork Toutle River drainage continues to be significant and unpredictable. Consequently, there is a risk associated with investing in ecosystem restoration measures for the Mount St. Helens Project due to the instability of the North Fork Toutle River drainage and continuing sedimentation effects caused by the 1980 eruption of Mount St. Helens. It is anticipated that all ecosystem restoration work will focus on near-term actions to sustain and improve access to the tributary habitat above the sediment retention structure located at river mile 13.2 of the North Fork Toutle River. In the future, the North Fork Toutle River system may become stable enough to consider a broader range of ecosystem restoration measures.

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