Scenario of Small Flood Damage Reduction Projects

November 2014

Prepared by HDR, Inc. and
Watershed Science and Engineering, Inc.

Prepared for Chehalis Basin Work Group

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AC	acres
basin	Chehalis Basin
Chehalis Basin Strategy	Chehalis Basin Strategy: Reducing Flood Damage and Enhancing Aquatic Species Project
CMP	corrugated metal pipe
CWT	hundred weight
CY	cubic yards
EA	each
Ecology	Washington State Department of Ecology
Flood Authority	Chehalis River Basin Flood Authority
GIS	geographic information systems
H&H	hydrology and hydraulics
HEC-RAS	Hydrologic Engineering Center River Analysis System
I-5	Interstate 5 Highway
LF	linear feet
LS	lump sum
LWM	large woody material
MI	miles
MP	milepost
OFM	Office of Financial Management
RM	road mile
SF	square feet
SR6	Washington State Route 6 Highway
SY	square yards
TM	Technical Memorandum
TN	tons
US12	U.S. Highway 12
USACE	U.S. Army Corps of Engineers
WDFW	Washington Department of Fish & Wildlife
WDNR	Washington Department of Natural Resources
Work Group	Chehalis Basin Work Group
WSDOT	Washington State Department of Transportation
WSE	Watershed Science and Engineering
WWTP	wastewater treatment plant

Executive Summary

1 Executive Summary

This Technical Memorandum (TM) presents the results of the Scenario of Small Flood Damage Reduction Projects task of the Chehalis Basin Strategy: Reducing Flood Damage and Enhancing Aquatic Species (Chehalis Basin Strategy).

The intention of this TM is to address the potential benefits and potential adverse impacts of a combination of smaller projects across the basin, focused on protecting key infrastructure, reducing shoreline erosion, and improving flow conveyance and drainage at key points in the basin. Potential projects were evaluated in both with-dam and without-dam scenarios and in conjunction with the alternatives for Interstate 5 (I-5) that are being developed by the Washington State Department of Transportation (WSDOT). A program of smaller projects aimed at protecting key infrastructure and priority areas throughout the basin might provide a measureable reduction in damages from major floods. Further analysis of such a program will determine how much flood damage reduction is possible, and at what cost, and will provide additional context for considering large-scale projects. The Small Projects Team worked with the Chehalis River Basin Flood Authority (Flood Authority), local governments, the Chehalis Tribe, conservation districts, and other interested parties to identify flood damage reduction projects and assess the potential benefits and potential adverse impacts of a suite of small projects with and without a water-retention structure and with and without alternatives to protect I-5.

The evaluation and prioritization process was initiated through meetings with members of the Flood Authority and other stakeholders within the Chehalis Basin during October and November 2013 to identify potential small projects. A list of small projects was developed which included previous small projects identified by the Flood Authority and the State Team (the Washington Department of Ecology and the Washington Department of Fish and Wildlife). Evaluation criteria for prioritization of projects was developed, and projects were ranked based on the evaluation criteria.

This task also included developing conceptual-level designs for up to 10 potential small flood damage reduction projects and a discussion of the potential benefits and adverse impacts of these projects, both with and without a large water-retention structure and with and without alternatives to protect I-5. The criteria for evaluating the designs are listed below and were used to select the 10 projects for conceptual designs:

- Ability to affect a broad area of the Chehalis River Floodplain
- Value and size of the area and infrastructure protected
- Amount of the population protected
- Ability to permit and implement
- Cost to maintain after completion
- Environmental benefits
- Adaptability

The following 10 projects, listed in no particular order, were evaluated and ranked based on these criteria:

- Kirkland Road Study – City of Napavine
- SR6 Flow Bypass and Road Raise – Lewis County
- Dillenbaugh Creek Realignment – City of Chehalis
- Main Street – City of Chehalis
- Salzer Creek Backwater Control – Lewis County
- Main Street Reconstruction – Town of Bucoda
- Moon Road – Chehalis Tribe
- Black River Bridge – Chehalis Tribe
- Roundtree Creek Study – Chehalis Tribe
- Wynoochee Valley Road Raise – Grays Harbor County

The conceptual designs and the opinions of probable costs for the 10 projects were based on existing available information. The hydraulic model developed for the Chehalis Basin Strategy was used for assessing the potential benefits and adverse impacts of these 10 potential small flood damage reduction projects.

The Small Projects Team recommends considering providing funding for the Kirkland Road Study, the Roundtree Creek Study, the Wynoochee Valley Raise and the Dillenbaugh Creek small projects. Funding will be necessary to collect additional data, perform further studies, hydraulic modeling and progress design.

The Small Projects Team also recommends funding the City of Cosmopolis Mill Creek project. The Mill Creek project was previously funded in the 2013–2015 biennium; however, the City returned a portion of its allocated funding with the expectation that the funds that were returned and additional funding would be provided through the Flood Authority for completing this project. The Flood Authority made the decision to reallocate funds to projects in Montesano that were more of an emergency nature, from funds previously allocated to Mill Creek, Satsop River restoration, and a Wishkah Road project.

Introduction

2 Introduction

This section provides a project background, summarizes the previous related work, and describes the project purpose and objectives.

2.1 PROJECT BACKGROUND

The Chehalis Basin has historically been prone to flooding. The economic damages of the 2007 flood alone were estimated at more than $900 million, with one-third of that damage coming from disruption and damage to the transportation system, including Interstate 5 (I-5), other highways, and rail lines. Many different flood hazard mitigation projects and approaches have been proposed and studied in response to the major floods. After the 2007 flood, the Chehalis River Basin Flood Authority (Flood Authority) was created to focus on developing flood hazard mitigation measures throughout the basin and to identify and implement flood damage reduction projects in the basin. The Flood Authority has been studying water retention in the upper Chehalis River Basin along with smaller flood hazard mitigation projects lower in the basin.

In 2011, the Washington State Legislature required the Office of Financial Management (OFM) to prepare a report on alternative flood damage reduction projects and—in coordination with tribal governments, local governments, and state and federal agencies—to recommend priority flood hazard mitigation projects for continued feasibility assessment and design work. In response to the legislative direction, the Ruckelshaus Center published a report in December 2012 titled *Chehalis Basin Flood Hazard Mitigation Alternatives Report*. That report compiled existing information on the potential flood hazard mitigation projects that were of most interest to basin leaders and decision makers at the time. In this report, potential flood hazard mitigation benefits, adverse impacts, costs, and implementation issues are summarized for each project to the degree that such information was available. Along with that effort, the Chehalis Basin Work Group (Work Group), comprising Chehalis Basin leaders, recommended to then-Governor Gregoire a series of actions that, taken together, would represent a significant investment to reduce flood damages in the short term, enhance natural floodplain functions and fisheries, and put basin leaders on a firm footing to make critical decisions about large-scale projects. The Work Group recognized that habitat loss in the basin has contributed to a reduction in native fish populations. A basin-wide approach to integrate flood damage reduction and environmental enhancement is needed. Fish populations must be increased while flood damage is reduced.

The Chehalis Basin Strategy: Reducing Flood Damage and Enhancing Aquatic Species Project (Chehalis Basin Strategy) is evaluating the feasibility of mitigating flood hazards within the basin and opportunities to enhance ecological conditions, aquatic habitat, and abundance of fish in the basin. The scope of the project includes studying a water-retention structure (dam), options for protecting I-5 with or without a dam, and other small flood damage reduction projects throughout the Chehalis Basin (basin) with or without a dam. The project will provide information needed by the Work Group and stakeholders in the region in support of their decision about whether to advance the project to the next phase of feasibility studies and project permitting.

As part of the evaluation of projects to reduce flood damages, the Small Projects Team explored the potential benefits and potential adverse impacts of a combination of smaller projects across the basin, focusing on protecting key infrastructure, reducing shoreline erosion, and improving flow conveyance and drainage at key points in the basin. Potential projects were evaluated in both with-dam" and "without a dam" scenarios and in conjunction with an alternative for I-5 that is being developed by the Washington State Department of Transportation (WSDOT). A program of smaller projects aimed at protecting key infrastructure and priority areas throughout the basin might provide a measureable reduction in damages from major floods. Further analysis of such a program will determine how much flood damage reduction is possible, and at what cost, and will provide additional context for considering large-scale projects. The Small Projects Team worked with the Flood Authority, local governments, the Chehalis Tribe, conservation districts, and other interested parties to identify flood damage reduction projects and assess the potential benefits and potential adverse impacts of a suite of small projects with and without a water-retention structure and with and without alternatives to protect I-5.

2.2 PREVIOUS REPORTS

There are many ideas regarding how best to achieve flood damage reduction within the basin, and numerous alternatives to water retention, large levees, and I-5 projects have been discussed. These ideas include additional capital/construction projects, such as building floodwater bypasses at Mellen Street and near Scheuber Road; numerous programmatic alternatives such as land use regulation, home elevation, flood-proofing and buyout programs; and projects to increase the "natural capital" of the area through improvements to riparian buffers and new floodplain function and storage. These projects are described in the *Chehalis Basin Flood Hazard Mitigation Alternatives Report* prepared by the Ruckelshaus Center in 2012. That report uses information compiled from numerous studies and work including the following:

- Anchor QEA Chehalis River Flood Storage Dam Fish Population Impact Study
- Chehalis River Basin Comprehensive Flood Hazard Management Plan
- Chehalis River Basin Watershed Management Plan
- Chehalis River Flood Water Retention Project Phase IIB Feasibility Study
- Comprehensive Flood Hazard Management Plan for Confederated Tribes of the Chehalis Reservation
- DNR [Washington Department of Natural Resources] Draft Chehalis River Basin Forestland Section
- Flood Protection and Ecosystem Services in the Chehalis River Basin
- Pacific International Engineering Chehalis River Basin Flood Reduction Report
- U.S. Army Corps of Engineers (USACE) Centralia Flood Risk Management Project Draft Closeout Report
- Chehalis – Centralia Airport Levee Improvement Project – Preliminary Construction Estimates
- Preliminary project details and cost estimates from the Washington State Conservation Commission on riparian improvement, bank erosion, and "critter pad" projects
- Summary information from local jurisdictions in the Chehalis Basin on floodproofing, buyout, and elevation programs
- Assessment interviews conducted by the Ruckelshaus Center with technical and policy experts throughout the Chehalis Basin
- Meetings with stakeholders in the lower Chehalis Basin on potential flood hazard mitigation projects in June 2012
- Technical and policy workshops held in the basin in May and June 2012

This memorandum focuses on the identification of smaller-scale alternatives to water retention, large levees, and I-5 projects.

As a starting point, the Small Projects Team reviewed projects compiled by the Chehalis River Basin Flood Authority (Flood Authority). In March 2012, the Project Committee of the Flood Authority generated a memorandum which listed potential projects extracted from flood planning documents throughout the basin. Fifteen sources were used in that work, and it was conducted over 6 months. The list of projects generated from that work was used in discussions with jurisdictions and stakeholders within the basin to verify the status of the projects and to determine whether a project should move forward as part of this current work. In most cases, for the projects from the Flood Authority that are not being included on the list compiled for this report, either the project has been completed or the sponsoring jurisdiction did not want to pursue the project.

In addition to the large upstream retention structure that is being evaluated under a separate task for this project, the state agencies have suggested that additional floodplain storage be evaluated. This option of constructing multiple smaller structures to increase floodplain storage has been previously investigated in numerous studies by USACE (USACE 2003). Projects evaluated by USACE included small headwater dams, flow restrictors, and flood storage dikes within the floodplain. The results of these evaluations by USACE all showed that there would be minimal to no reduction in the downstream flood levels for the 100-year flood.

In November 2012, the Washington Department of Ecology (Ecology) and the Washington Department of Fish and Wildlife (WDFW) generated a list of multi-purpose projects, which were perceived to have both flood damage reduction benefits and ecological benefits. The projects were prioritized by WDFW and Ecology as low, medium, or high priority. That list has been reviewed again by Ecology and WDFW, and the projects that are ranked as medium or high priority to provide significant flood reduction benefits (and have not already been completed or are currently funded) are included in the list of projects in this memorandum.

Programmatic or basin-wide approaches to flood damage reduction were obtained from the Ruckelshaus report. The most significant approach is floodproofing or buyout of flood-prone structures in the basin.

2.3 PURPOSE AND OBJECTIVES

The potential benefits and adverse impacts of a suite of smaller local projects were evaluated with the use of a hydraulic model of the Chehalis River. Benefits and impacts were determined by comparing simulated water surface elevations between existing conditions and a scenario with the suite of small projects. Flood damage reduction was assumed to correlate to a decrease in flood water surface elevations while an increase in flood hazard damages was assumed to correlate with an increase in flood water surface elevations. These projects focus on protecting key infrastructure, controlling bank erosion, and improving flow conveyance and drainage at key locations in the basin.

A suite of small-scale projects might provide measureable reductions in flood damages from major floods with less adverse impacts than the large-scale projects. Conceptual designs and cost estimates were prepared for each of the small projects at a reconnaissance level based on available data for comparison purposes only. A suite of projects were analyzed to determine how much damage reduction is possible, and at what cost, to provide additional context for comparison with large-scale projects.

3 Prioritization of Small Projects

3.1 POTENTIAL SMALL PROJECTS

The following list of potential projects (Table 3-1) is not a prioritized list; it was generated based on meetings with members of the Flood Authority and other stakeholders within the Chehalis Basin during October and November 2013. The goal of the potential projects is to decrease flood hazard damages associated with flood events in the Chehalis Basin. The list also includes a subset of the environmental multi-objective projects from a November 2, 2012, listing of projects by the State Team (Ecology and WDFW) and programmatic/basin-wide projects identified by stakeholders. The list generated by Ecology and WDFW was reviewed, and some projects in the medium-priority category were not included because the Small Projects Team determined that they did not provide any significant flood damage reduction. The low-priority projects as designated by Ecology and WDFW are all downstream of the mouth of the Chehalis River (in Grays Harbor) and are not included because they lie outside the project limits for this work. The multi-purpose projects that are included in the list of potential projects below will be further evaluated for their flood damage reduction benefits to determine whether they will be included as small projects for flood damage reduction. The multi-purpose projects identified by Ecology and WDFW will also be included in the Aquatic Species Enhancement Plan portion of the overall project. This is the total list of projects proposed at that time. Some of these projects either are no longer being considered by the local sponsor or have already been implemented, so these projects will no longer be included with the remaining projects for prioritization purposes. The programmatic /basin-wide projects are being evaluated under separate tasks of the Project.

Table 3-1
Summary of Potential Projects

POTENTIAL PROJECTS LOCATION	PROJECT NAME	DESCRIPTION
Programmatic/Basin-wide Projects		
Basin-wide	Buyout/Floodproofing	• Evaluation of large-scale buyout of properties or raising homes and/or businesses subject to flooding. • Throughout the basin.
Basin-wide	Critter Pads	• Construct critter pads in various locations in Grays Harbor and Lewis and Thurston Counties.
Basin-wide	Culvert Improvements or Replacement	• Evaluation of upgrade of culverts for flood damage reduction and fish passage. • Throughout the basin, over 2,600 culverts have been identified.
Projects Identified through Interviews with Stakeholders between October and November 2013		
City of Aberdeen	Fry Creek	• High tides and flooding on the Chehalis River cause neighborhood and highway flooding. • Potential project: Install new tide gate and pump station to reduce flooding. • No work has been done to date.
Boistfort Water District	Wildwood Sediment Pond Addition	• Add a second sedimentation pond to the current facility. • Some preliminary engineering has been completed.
Town of Bucoda	Main Street Reconstruction	• Skookumchuck River overflows and closes intersection of 11th Street and Main Street, blocking access from the adjacent neighborhood to the highway. • Potential project: Install culvert/bridge at the intersection and raise Main Street to allow access during high flows.

POTENTIAL PROJECTS LOCATION	PROJECT NAME	DESCRIPTION
Town of Bucoda	Restoration of Relic Channel	• Evaluate excavating the relic channel as a high-flow bypass on the Skookumchuck River on the southeast side of the town. • Could alleviate flooding in the town.
City of Centralia	China Creek	• China Creek floods downtown during high flows on China Creek. • Project: Create storage in upper basin to reduce flooding of downtown. • Some work has been done to date to look at alternatives. • City intends to construct a project in the vicinity of the Agnew Mill Ponds for flood damage reduction and habitat enhancement.
City of Centralia	Skookumchuck River Mitigation	• The highway work completed by WSDOT near the Skookumchuck River might not sufficiently protect the floodplain of the river. • Look for opportunities to mitigate impacts to the floodplain from the transportation project.
City of Centralia/Lewis County	Salzer Creek	• Flooding occurs east of I-5 due to backwatering during high flows on the Chehalis River. • Potential project: Install backwater control.
City of Chehalis	Airport Levee Phase 2	• Phase 1 is currently underway. • Phase 1 is widening the base of the existing levee and restoring the top of the levee to existing design level. • Project: Construct the levee to 3 feet above the 100-year flood elevation.

POTENTIAL PROJECTS LOCATION	PROJECT NAME	DESCRIPTION
City of Chehalis	Dillenbaugh Creek Realignment	• Current alignment of the creek goes under I-5 multiple times. • Flooding occurs in Chehalis and along I-5. • Project: Construct new channel from undercrossing at Rice Road through Stan Hedwall Park and closing openings under I-5 between SR6 and 13th Street interchange • Creek would then discharge to Newaukum River. • Rerouting reduces flooding and provides habitat enhancement. • Some work has been done to date.
City of Chehalis	Main Street	• Main Street floods and closes access from downtown Chehalis to I-5. • Potential project: Temporary structure along Main Street to keep access open between downtown and I-5. • Construction of a dam in the upper basin could alleviate flooding along Main Street.
City of Chehalis	Potential Storage	• Brainstormed areas of open land that could have potential to increase storage. • Potential storage areas: – Between railroad and N. National Avenue – By old WWTP – Salzer Creek – area of large wetland and floodplain
Confederated Tribes of the Chehalis Reservation	Moon Road	• Roadway floods in two places south of U.S. Highway 12. • Potential project: Raise roadway elevation and install culverts to keep Moon Road open during moderate flooding events similar to completed project on Anderson Road.
Confederated Tribes of the Chehalis Reservation	Black River Bridge	• Existing bridge constricts flow during higher flows. • WSDOT has studied replacing the bridge. • Potential project: Replace existing bridge with a wider, longer bridge.

POTENTIAL PROJECTS LOCATION	PROJECT NAME	DESCRIPTION
Confederated Tribes of the Chehalis Reservation	Roundtree Creek	• Roundtree Creek flows into Harris Creek, which floods the city of Oakville. • The channel is no longer in its original alignment. • Potential project: Restore Roundtree Creek to its original alignment, thereby reducing flooding downstream and potential habitat improvement.
City of Cosmopolis	Mill Creek	• Flooding of neighborhoods from Mill Creek and backwater of Mill Creek from Chehalis River flooding. • Replacement of failed dam at Mill Creek Park. • Assessment and possible modification to tide gate with installation of pump station. • Assessment of culverts along Mill Creek for needed improvements. • Some work has been done to date, and City received partial funding for dam replacement.
City of Elma	Wastewater Treatment Plant	• The streambank at the outfall is eroding. • The outfall is exposed. • The outfall is on Grays Harbor County property. • Potential project: Relocate outfall and provide streambank protection.
Grays Harbor County	Wynoochee Valley Road Raise	• Flooding on the Wynoochee River causes flooding and closure of road. • The road is used as an alternate route when Highway 12 is closed due to flooding. • Potential project: Elevate a portion of the roadway near Milepost 1.

POTENTIAL PROJECTS LOCATION	PROJECT NAME	DESCRIPTION
Grays Harbor County	Wishkah Road Regrade – at Ellison Dip	• Flooding causes road closures and cuts off hundreds of properties in Wishkah Valley. • County has identified four areas that should be raised to eliminate road closures. • Project: Raise the grade of the areas by paving the low areas with up to 1 foot of blacktop.
Grays Harbor County	Sheet-pile Flood Levee	• Construction of sheetpile along Wishkah Road between mileposts 2.2 and 2.7, based on design that was previously funded.
Grays Harbor County	South Bank Road	• Flooding on the Chehalis River causes the road to wash out near milepost 8.2. • Potential project: Design and construct bridge to allow floodwaters to flow under the bridge and eliminate flooding and washout of roadway.
Grays Harbor County	South Bank Road (Wakefield Road)	• Construction of overflow bridge at milepost 16.9, based on design that was previously funded.
Grays Harbor County/City of Montesano	SR 107 Relic Channel Restoration	• Erosion issues in area. • Potential project: Restore relic channel of the Chehalis River and cutting off oxbow. • Act as an overflow channel.
Lewis County	SR6 Flow Bypass and Road Raise	• Floodwaters pond behind SR6 and overtop the road. • culverts or bridges under SR6 east of Scheuber Road and elevate roadway.
City of Montesano	WWTP Lagoon/ Wynoochee River Erosion	• Migrating river bend on the Wynoochee River is exposing the embankment of the treatment plant sludge lagoon. • In 2007, City installed emergency bank protection. • Potential project: Install a long-term measure to protect WWTP facilities/lagoon. Sheetpile constructed in 2014

POTENTIAL PROJECTS LOCATION	PROJECT NAME	DESCRIPTION
City of Napavine	Kirkland Road Flooding	• Flooding of Rush Road underpass and shallow flooding upstream along Kirkland Road during floods on the Newaukum River. • Project: Planning study to look at causes and potential solutions. • City is also interested in WSDOT's plan for the Rush Road overpass alternative.
City of Napavine	Newaukum River Bridges	• Suspect backwaters on Newaukum River due to I-5 and City's bridge downstream of I-5. • Potential project: Study to look at causes and potential solutions.
City of Oakville	Subdivision Flooding	• Flooding occurs in southeast Oakville likely due to Harris Creek, Black River, and another unnamed stream. • Potential project: Study to determine flooding causes and potential solutions.
Thurston County/ City of Centralia/ Town of Bucoda	Skookumchuck Dam Operations	• Dam currently is not operated for flood storage. • If the dam becomes available for other uses and/or ownership, potential project is to study the operation of the dam for multiple uses including flood storage.
Multi-purpose Projects Identified by Ecology and WDFW in 2012		
City of Centralia	RM 68 Oxbow Reconnection	• Reconnect oxbow with mainstem Chehalis River. • Enhance low-elevation areas, side channels, and floodplain habitat with vegetated benches and LWM.
City of Chehalis	Stan Hedwall Park Floodplain Reconnection	• Includes reconnecting existing side channels, four engineered log jams, and riparian revegetation over 40 acres.

POTENTIAL PROJECTS LOCATION	PROJECT NAME	DESCRIPTION
Grays Harbor County	Gaddis Creek Fish Barrier Culvert Project	• South Bank Road in East Grays Harbor County near the Sharon Grange. • Replace a 6-foot-diameter culvert with a 14-foot-wide by 8-foot-high pipe arch culvert. • Barrier corrections have been completed by WDNR and Grays Harbor County in the upper watershed, which is about 5 miles long, and this is the last remaining barrier culvert in this watershed. • Reduces backwater from existing culverts and reopens stream corridor. • Scoping and design have been completed for this project.
Grays Harbor County	RM 36 Oxbow Reconnection	• Reconnect oxbow with mainstem Chehalis River. • Enhance low-elevation areas, side channels, and floodplain habitat with vegetated benches and LWM.
Grays Harbor County	RM 43 Oxbow Reconnection	• Reconnect oxbow with mainstem Chehalis River. • Enhance low-elevation areas, side channels, and floodplain habitat with vegetated benches and LWM.
Lewis County	WDFW Pheasant Farm	• 200 acres (combined WDFW and private landowner just downstream). WDFW owns a pheasant farm and might be open to conservation • Good floodplain area with potential excavation and enhancement. The area closest to the river already has a number of higher-flow side channels and good riparian cover; existing good quality. • A few hayed fields could be excavated for wetlands and side channels and also revegetated.
Lewis County	RM 78 Oxbow	• Reconnect oxbow with mainstem Chehalis River. • Enhance low-elevation areas, side channels, and floodplain habitat with vegetated benches and LWM.

POTENTIAL PROJECTS LOCATION	PROJECT NAME	DESCRIPTION
Lewis County	Salzer Creek at Centralia Alpha Road Floodplain Storage and Riparian Restoration	• Create approximately 2,000 feet of sinuous stream and install LWM log clusters. • Revegetate with native trees and shrubs. • Excavate emergent wetland and revegetate with wetland plants.
Lewis County	Salzer Creek Lower Mile Oxbow Reconnection and Riparian Restoration	• Connect Salzer Creek to old Chehalis River oxbow. • Includes revegetating and regrading banks of Salzer Creek to 2H:1V slopes with a bench or 3H:1V slopes and removing invasive species and planting a native understory. • Also includes wetland creation, enhancement, and installation of LWD.
Lewis County	Oxbow Lake Reconnection	• Approximately 75 acres. • Two landowners. • Improve connection to main channel of Chehalis River. Not currently a connection, but, when floodwaters exceed the bank elevation (above a 2-year flow or possibly a 5-year flow), it might briefly connect. • Will require about 12 feet of excavation to create a channel connection to Chehalis River for winter rearing (that is, November to May).

POTENTIAL PROJECTS LOCATION	PROJECT NAME	DESCRIPTION
Thurston County	Allen Creek Restoration	• Along Case Road just south of 113th Avenue SW between Littlerock and Maytown • Reconstruct and restore 2,100 feet of Allen Creek, a tributary to Beaver Creek and part of the Scatter Creek watershed. Abandon 1,600 feet of ditch adjacent to Case Road and move the stream back into its historical, meandering path. • This would be a channel reconnection and connectivity and riparian restoration project. • Scoping has been completed, but further design work is needed.

Notes: _I-5 = Interstate 5
LWM = large woody material
WDFW = Washington State Department of Fish & Wildlife
WDNR = Washington State Department of Natural Resources
WSDOT = Washington State Department of Transportation
WWTP = wastewater treatment plant

3.2 SMALL PROJECT EVALUATION CRITERIA

Evaluation criteria were developed by the Small Projects Team and distributed to the Flood Authority's Project Committee and the state resource agencies for their review. The following is a listing of the resulting evaluation criteria.

3.2.1 CRITERION #1: ABILITY TO AFFECT A BROAD AREA OF THE CHEHALIS RIVER FLOODPLAIN

Does a small project have the ability to affect a broader area of the mainstem of the Chehalis River (not just a local area)? Does the project provide flood reduction upstream or downstream of the project's immediate benefits?

- 1a Positively affect other properties by reducing flood damages (decrease in floodwater elevation).
- 1b Negatively affect other properties by increasing flood damages (increase in floodwater elevation).

3.2.2 CRITERION #2: VALUE AND SIZE OF THE AREA AND INFRASTRUCTURE PROTECTED

From a qualitative view, how much value and area does a small project have the ability to protect.

3.2.3 CRITERION #3: AMOUNT OF THE POPULATION PROTECTED

From a qualitative view, how large of a population can a small project protect.

3.2.4 CRITERION #4: ABILITY TO PERMIT AND IMPLEMENT

A key factor for a project is that it can be permitted and implemented. Some key factors are:

- Complexity of permit issues – Assessment of how many permits and resource agencies will be needed to permit the project, and are there permitting issues that make this project unpermittable.
- Schedule to obtain permits to determine construction schedule – Assessment of long lead time to obtain permits and how they affect the construction schedule.
- Real estate issues – Assessment of how many separate property owners own the land to complete the project, and has the land already been acquired or is land acquisition still needed.
- Stakeholder involvement – Assessment of how many stakeholders will be involved to complete the project and will the project take significant stakeholder involvement to implement the project.
- Constructability complexity – Assessment of construction access, construction phasing, critical area impacts, geotechnical issues (if known), traffic disruptions, etc.
- Timing for completion of project – Assessment of how long it will take the project to be implemented. Faster implementation is more desirable.

3.2.5 CRITERION #5: MAINTENANCE, ETC., COSTS AFTER COMPLETION

An important consideration in designing and constructing any project is the need and complexity the project will have for “beyond construction” costs (for example, operations, maintenance, repair, inspections, etc.) that need to be taken into consideration.

3.2.6 CRITERION #6: ENVIRONMENTAL BENEFITS

In addition to flood damage reduction benefits, can a small project also provide the following environmental benefits?

- Habitat
- Water quality
- Affecting natural processes that create or maintain habitat
- Effect on non-native species

3.2.7 CRITERION #7: ADAPTABILITY

Because future conditions change, it is important for a project to not become out of date or no longer be viable, by being adaptable to provide benefits under various scenarios (that is, climate change, with or without other projects, etc.).

3.3 SMALL PROJECT REVIEW AND RANKING PROCESS

In consultation with the Flood Authority's Project Committee and the state resource agencies, the Small Projects Team developed the following scoring system for ranking projects using the seven criteria listed in the previous section.

A total composite score was determined for each project based on the degree to which the Small Projects Team believes that the project meets, or does not meet, each of the small projects evaluation criteria.

Criteria 1 to 3 were used to rank the projects because they are the primary drivers for reducing flood damages. Criteria 4 to 7 were used as secondary drivers to help distinguish the ranked projects if needed.

3.3.1 SCORING

- Provide a score of 4 if the project strongly meets the criteria.
- Provide a score of 3 if the project meets the criteria.
- Provide a score of 2 if the project neither meets nor does not meet the criteria.
- Provide a score of 1 if the project does not meet the criteria.
- Provide a score of 0 if the project strongly does not meet the criteria.

3.3.2 SCORING FOR 1B

- Provide a score of 0 if the project is not likely to cause negative impacts by increasing flood damages.
- Provide a score of –1 if the project is likely to cause minor negative impacts (but unquantified) by increasing flood damages.
- Provide a score of –2 if the project is likely to cause moderate negative impacts by increasing flood damages.
- Provide a score of –3 if the project is likely to cause significant negative impacts by increasing flood damages.

3.3.3 RESULTS

This process was completed in April 2014, and projects were ranked by the Small Projects Team in consultation with the Flood Authority's Project Committee.

Table 4-1 shows the results of the ranking process for the 28 specific projects and the 11 multi-purpose projects shown in Table 3-1 using the scoring process described above.

From all of the projects shown in Table 4-1, the Small Projects Team selected 10 projects for conceptual designs. These 10 projects, along with their scores from the ranking process, are listed in Table 4-2.

Table 4-1
Summary of Project Ranking

POTENTIAL PROJECT LOCATION	PROJECT NAME	SCORING									
** = LIKELY TO BE AFFECTED BY WSDOT I-5 ALTERNATIVES; REQUIRES MORE COORDINATION.		PRIMARY WEIGHTING					SECONDARY WEIGHTING				
		CRITERION 1A	CRITERION 1B	CRITERION 2	CRITERION 3	SUM	CRITERION 4	CRITERION 5	CRITERION 6	CRITERION 7	SUM
Projects Identified through Interviews with Stakeholders between October and November 2013											
Lewis County	SR6 Flow Bypass and Road Raise**	3	–1	4	4	**10**	1	2	2	0	**5**
City of Chehalis	Airport Levee Phase 2**	3	–1	4	4	**10**	1	2	0	1	**4**
City of Chehalis	Dillenbaugh Creek Realignment**	2	–1	3	3	**7**	1	0	2	1	**4**
City of Centralia	China Creek	0	0	3	3	**6**	1	1	1	1	**4**
City of Chehalis	Main Street**	0	0	2	3	**5**	3	3	1	1	**8**
Confederated Tribes of the Chehalis Reservation	Black River Bridge	1	–1	3	2	**5**	2	3	2	1	**8**
Grays Harbor County/City of Montesano	SR 107 Relic Channel Restoration	2	–1	3	1	**5**	1	1	2	1	**5**
City of Cosmopolis	Mill Creek	0	0	2	2	**4**	2	1	2	1	**6**
Confederated Tribes of the Chehalis Reservation	Roundtree Creek	0	0	2	2	**4**	2	1	3	1	**7**
City of Oakville	Subdivision Flooding	0	0	2	2	**4**	2	1	3	1	**7**
Grays Harbor County	Sheet-pile Flood Levee	0	0	2	2	**4**	3	1	1	1	**6**
Grays Harbor County	Wishkah Road (MP 3.7 to MP 4.1) Flood Study	0	0	2	2	**4**	2	1	1	1	**5**
City of Centralia/ Lewis County	Salzer Creek	1	–1	2	2	**4**	1	1	1	2	**5**
Town of Bucoda	Main Street Reconstruction	0	0	1	2	**3**	3	3	0	1	**7**

POTENTIAL PROJECT LOCATION	PROJECT NAME	SCORING									
** = LIKELY TO BE AFFECTED BY WSDOT I-5 ALTERNATIVES; REQUIRES MORE COORDINATION.		PRIMARY WEIGHTING					SECONDARY WEIGHTING				
		CRITERION 1A	CRITERION 1B	CRITERION 2	CRITERION 3	SUM	CRITERION 4	CRITERION 5	CRITERION 6	CRITERION 7	SUM
Projects Identified through Interviews with Stakeholders between October and November 2013											
City of Aberdeen	Fry Creek	0	0	2	1	**3**	2	2	1	2	**7**
City of Elma	WWTP	0	0	3	0	**3**	3	2	2	1	**8**
City of Montesano	WWTP Lagoon/ Wynoochee River Erosion	0	0	3	0	**3**	1	2	2	1	**6**
Confederated Tribes of the Chehalis Reservation	Moon Road	0	-1	2	2	**3**	2	3	1	1	**7**
Grays Harbor County	South Bank Road (MP 8.2)	0	0	2	1	**3**	2	3	2	1	**8**
Grays Harbor County	Wynoochee Valley Road Raise	0	0	2	1	**3**	3	3	0	1	**7**
City of Napavine	Kirkland Road Flooding	0	–1	2	1	**2**	1	1	1	1	**4**
Grays Harbor County	South Bank Road (MP 16.9)	0	0	2	1	**3**	2	1	1	1	**5**
City of Napavine	Newaukum River Bridges	0	0	0	2	**2**	1	2	1	1	**5**
Town of Bucoda	Restoration of Relic Channel	0	0	0	1	**1**	1	1	2	2	**6**
City of Chehalis	Potential Storage	0	0	0	0	**0**	2	4	4	1	**11**
City of Centralia	Skookumchuck River Mitigation	0	0	0	0	**0**	2	2	3	1	**8**
Boistfort Water District	Wildwood Sediment Pond Addition	0	0	0	0	**0**	3	1	1	2	**7**
Thurston County/ City of Centralia/ Town of Bucoda	Skookumchuck Dam Operations	This project will not be ranked due to its previous studies, complexity and ownership issues outside the scope of work of this project.									

		PRIMARY WEIGHTING					SECONDARY WEIGHTING				
		CRITERION 1A	CRITERION 1B	CRITERION 2	CRITERION 3	SUM	CRITERION 4	CRITERION 5	CRITERION 6	CRITERION 7	SUM
Multi-purpose Projects Identified by Ecology and WDFW in 2012											
City of Centralia	RM 68 Oxbow Reconnection	0	0	0	0	**0**	1	2	4	1	**8**
City of Chehalis	Stan Hedwall Park Floodplain Reconnection	0	0	0	0	**0**	2	2	4	1	**9**
Grays Harbor County	Gaddis Creek Fish Barrier Culvert Project	0	0	0	0	**0**	2	2	4	1	**9**
Grays Harbor County	RM 36 Oxbow Reconnection	0	0	0	0	**0**	1	2	4	1	**8**
Grays Harbor County	RM 43 Oxbow Reconnection	0	0	0	0	**0**	1	2	4	1	**8**
Lewis County	WDFW Pheasant Farm		0	0	0	**0**	2	2	4	1	**9**
Lewis County	RM 78 Oxbow	0	0	0	0	**0**	1	2	4	1	**8**
Lewis County	Salzer Creek at Centralia Alpha Road Floodplain Storage and Riparian Restoration	0	0	0	0	**0**	1	2	4	1	**8**
Lewis County	Salzer Creek Lower Mile Oxbow Reconnection and Riparian Restoration	0	0	0	0	**0**	2	2	4	1	**9**
Lewis County	Oxbow Lake Reconnection	0	0	0	0	**0**	1	2	4	1	**8**
Thurston County	Allen Creek Restoration	0	0	0	0	**0**	1	2	4	1	**8**

Notes:
Ecology = Washington State Department of Ecology
MP = milepost
RM = road mile
SR6 = State Route 6
WDFW = Washington State Department of Fish & Wildlife

Table 4-2
Summary of 10 Projects Selected for Conceptual Design

POTENTIAL PROJECT LOCATION	PROJECT NAME	SCORING									
** = LIKELY TO BE AFFECTED BY WSDOT I-5 ALTERNATIVES; REQUIRES MORE COORDINATION.		PRIMARY WEIGHTING					SECONDARY WEIGHTING				
		CRITERION 1A	CRITERION 1B	CRITERION 2	CRITERION 3	SUM	CRITERION 4	CRITERION 5	CRITERION 6	CRITERION 7	SUM
Projects Identified through Interviews with Stakeholders between October and November 2013											
Lewis County	SR6 Flow Bypass and Road Raise**	3	–1	4	4	**10**	1	2	2	0	**5**
City of Chehalis	Dillenbaugh Creek Realignment**	2	–1	3	3	**7**	1	0	2	1	**4**
City of Chehalis	Main Street**	0	0	2	3	**5**	3	3	1	1	**8**
Confederated Tribes of the Chehalis Reservation	Black River Bridge	1	–1	3	2	**5**	2	3	2	1	**8**
Confederated Tribes of the Chehalis Reservation	Roundtree Creek	0	0	2	2	**4**	2	1	3	1	**7**
City of Centralia/ Lewis County	Salzer Creek	1	–1	2	2	**4**	1	1	1	2	**5**
Town of Bucoda	Main Street Reconstruction	0	0	1	2	**3**	3	3	0	1	**7**
Confederated Tribes of the Chehalis Reservation	Moon Road	0	–1	2	2	**3**	2	3	1	1	**7**
Grays Harbor County	Wynoochee Valley Road Raise	0	0	2	1	**3**	3	3	0	1	**7**
City of Napavine	Kirkland Road Flooding	0	–1	2	1	**2**	1	1	1	1	**4**

Small Project Conceptual Design

4 Small Project Conceptual Design

The scope of services for the Scenario of Small Flood Damage Reduction Projects task included developing conceptual-level designs for 10 potential small flood damage reduction projects and evaluating the potential benefits and adverse impacts of these projects, both with and without a large water-retention structure and with and without alternatives to protect I-5. The Small Projects Team used the evaluation criteria described in Section 3.2 used to select the 10 projects described in the following sections. Projects were evaluated and ranked based on these criteria.

The conceptual designs were designed at a reconnaissance level and are based on existing available information and are sufficient for assessing potential benefits and adverse impacts for comparison purposes only. Available existing information was typically limited to the following for each small project:

- General description of proposed project from a local stakeholder
- Anecdotal information regarding the existing flooding problem
- Simulated existing water surface elevations associated with a 100-year event on the Chehalis River estimated from the Chehalis River hydraulic model developed by Watershed Science and Engineering (WSE)
- Topographic data derived from Light Detection and Ranging (LiDAR) data used in the hydraulic model

No existing geotechnical data were available, and the Small Projects Team did not perform geotechnical investigations for this task. Detailed structural calculations were not performed due to the lack of geotechnical information. Topographic information was extracted from the LiDAR surface used in the Chehalis River hydraulic model. Aerial photographs were used to lay out conceptual design extents and assess existing site conditions; these tasks included but were not limited to estimating existing road dimensions, estimating approximate right-of-way limits, and identifying existing infrastructure. Impacts to private property and right-of-way were not quantified at this time.

Each of the following sections describes the assumptions that the Small Projects Team made at this level of work and the additional information needed for further levels of design. In general, the projects were designed to provide 1 foot of freeboard from the existing 100-year flood level.

4.1 KIRKLAND ROAD STUDY – CITY OF NAPAVINE

4.1.1 EXISTING FLOODING PROBLEMS

Kirkland Road is located just east of the Rush Road interchange at Exit 72 on I-5 (Figure 4-1). During high-flow events on the Newaukum River, overland flooding occurs, resulting in shallow sheetflow flooding of

Kirkland Road and deeper flooding near the I-5 underpass at the interchange. According to the City, flooding has occurred in 7 of the last 25 years.

4.1.2 PROPOSED PROJECT

The proposed project is a study to analyze potential solutions to the current flooding problem. Potential solutions include raising Kirkland Road above flood elevations and installing a new culvert on the north side of the Kirkland Road to convey flow into the Newaukum River via an existing slough. Other solutions would likely be identified during the study.

4.1.3 ASSUMPTIONS

The proposed study is assumed to include developing a hydraulic model to help analyze potential solutions.

4.2 SR6 FLOW BYPASS AND ROAD RAISE – LEWIS COUNTY

4.2.1 EXISTING FLOODING PROBLEMS

State Route 6 (SR 6) presently ponds Chehalis River floodwater on the south side of the road during high-flow events on the Chehalis River until the water eventually overtops the road, resulting in closure of SR6. During previous events, SR 6 was closed for approximately 1.2 miles east of Scheuber Road due to overtopping by floodwater.

4.2.2 PROPOSED PROJECT

The intent of the proposed project is to keep SR6 open during the 100-year flood event on the Chehalis River while not altering current flood levels or the distribution of flood flows. The proposed project includes raising the profile of SR6 to provide 1 foot of freeboard above the existing 100-year water surface elevation that was simulated with the Chehalis River hydraulic model being developed by WSE. The project would involve raising approximately 1.5 miles of SR6 up to 4 feet in elevation. Additionally, two new bridges are proposed along the newly raised portion of SR6 to convey flow under the road to prevent an increase of water surface elevations on the south side of the highway associated with raising the road (Figure 4-2). The bridges would be approximately 350 feet wide and 1,800 feet long. The existing SR6 embankment beneath the bridges would remain intact to maintain the current distribution of flood flows on the north and south sides of SR6. As a result of raising the road, it would be necessary to raise multiple intersections, accesses, and private driveways. Two driveways and a gravel access would need relocation.

4.2.3 ASSUMPTIONS

The following assumptions were made during the layout of this conceptual design:

- The proposed road geometry will match existing SR6 geometry. From aerial photographs, existing geometry was estimated to be two 12-foot drive lanes with 8-foot shoulders. An additional turn lane is present at Scheuber Road.
- The proposed bridge geometry was assumed to have a deck thickness of 2 feet. The low chord of the bridge geometry was placed above the simulated 100-year water surface elevation. The bridge deck was assumed to be supported by 3-foot-diameter piles every 50 feet. The underlying subsurface conditions were assumed to be suitable to support a bridge, but the bridge will require geotechnical information to design.

- Impacts to right-of-way were not identified. The team assumed that the fill associated with the raised road embankment could be graded or contained by retaining walls.

4.3 DILLENBAUGH CREEK REALIGNMENT – CITY OF CHEHALIS

4.3.1 EXISTING FLOODING PROBLEMS

Flooding occurs along I-5 and within the city of Chehalis during high-flow events due to overbank flooding of Dillenbaugh Creek and backwater flooding of the Chehalis and Newaukum Rivers. Backwater enters the city of Chehalis through multiple openings under I-5, two rail lines, and one private road associated with Dillenbaugh Creek.

4.3.2 PROPOSED PROJECT

The proposed project includes realigning Dillenbaugh Creek from the undercrossing at Rice Road through Stan Hedwall Park. Currently, Dillenbaugh Creek crosses I-5 at three locations before discharging to the Chehalis River. A new channel would be constructed that would ultimately reroute Dillenbaugh Creek through Stan Hedwall Park to the right bank of the Newaukum River over a length of approximately 3,600 feet (Figure 4-3). Based on aerial photographs, the top width of Dillenbaugh Creek is estimated at about 14 feet. For the purpose of estimating quantities, the channel was assumed to be trapezoidal, with 2H:1V side slopes for a depth of 2.5 feet, with a bottom width of 4.5 feet. The team assumed that restoration including plantings of shrubs and trees and supplemental compost-amended soil would extend 30 feet from the top of each bank. Two new culvert crossings would need to be installed in Stan Hedwall Park. The existing culvert under Rice Road might also need to be replaced. The team assumed that the culverts would be required to meet fish passage criteria. The channel downstream of the realigned portion of Dillenbaugh Creek would remain in place, since it appears to provide local drainage between Rice Road and the BNSF Railway rail crossing.

In addition to realigning Dillenbaugh Creek, the openings under I-5 would need to be closed to prevent backwater from flowing under I-5 to the east toward Chehalis. The openings that would need to be closed, listed from north to south, are:

- Dillenbaugh Creek crossing at the southbound I-5 on-ramp at the SR6/Main Street interchange
- Tacoma Rail crossing
- Dillenbaugh Creek and BNSF crossing
- Existing culvert crossing under I-5, just north of the 13th Street exit

4.3.2.1 Southbound I-5 Ramp Opening Closure

The existing opening under the I-5 southbound ramp is proposed to be closed with the use of 20 feet of sheetpile wall, 15 feet of a temporary stoplog structure, and a 110-foot sheetpile closure structure (Figure 4-4). The temporary stoplog structure would be located across a small private road/pathway. Under normal conditions, the stoplog structure would not be installed, and access to the path would not be disrupted. During expected flood conditions, temporary posts, stoplogs, and braces would be installed in a concrete sill until flood levels have receded. The sheetpile wall would remain in place permanently.

The sheetpile closure structure would be a permanent structure with three box culverts installed at varying elevations. Tide gates would be located at the outlet (Chehalis River side) and sluice gates at the inlet of the box culverts. The tide gates would close as backwater levels from Chehalis River flooding rise, thus closing and preventing flow into the city of Chehalis. Under normal conditions, the tide gates

would remain open and allow flow out from Dillenbaugh Creek. The contributing flow out of the Dillenbaugh Creek opening would consist mostly of interior drainage from the city of Chehalis because Dillenbaugh Creek has been realigned upstream of this crossing.

4.3.2.2 Tacoma Rail Opening Closure

The existing opening under I-5 associated with the Tacoma Rail line crossing under I-5 is proposed to be closed with 75 feet of sheetpile wall and a 40-foot temporary stoplog closure structure (Figure 4-5). The sheetpile walls would be permanently installed outside the active portion of the rail yard. The existing rail yard would be closed with a temporary stoplog structure that would be installed on a concrete sill with stoplogs, braces, and support posts during expected flooding conditions. The rail line would not be able to operate while the stoplog structure is in place, but this rail line is normally not open during major flooding events.

BNSF Rail Opening Closure

The existing opening under I-5 associated with the BNSF line crossing under I-5 is proposed to be closed with 140 feet of sheetpile wall, 100 feet of temporary stoplog structure, and a 195-foot sheetpile closure structure (Figure 4-6). The sheetpile walls would be permanently installed outside the active portion of the rail yard. The existing rail yard would be closed with a temporary stoplog structure that would be installed on a concrete sill with stoplogs, braces, and support posts during expected flooding conditions. The rail line would not be able to operate while the stoplog structure is in place, but this rail line is normally not open during major flooding events.

The sheetpile closure structure would be a permanent structure with multiple box culverts installed at varying elevations. Tide gates would be located at the outlet (Chehalis River side) and sluice gates at the inlet of the box culverts. The tide gates would close as backwater levels from the Chehalis River flooding rise, thus closing and preventing flow into the city of Chehalis. Under normal conditions, the tide gates would remain open and allow flow under I-5. The contributing flow from Dillenbaugh Creek would be less than existing conditions because the proposed Dillenbaugh Creek Realignment is located upstream of this crossing. Culverts have been included in the sheetpile closure structure to account for local drainage inflow downstream of the channel realignment and allow flow exchange between a wetland east of I-5.

4.3.2.3 Culvert Crossing near 13th Street Exit

An existing culvert is located under I-5 just north of the 13th Street exit (Figure 4-3). As-built information was not located for the culvert. In order to close this structure, the team proposes to retrofit the existing structure with a backflow-control device. This likely would be a tide gate or flap gate.

4.3.3 ASSUMPTIONS

The following assumptions were made during the conceptual design of the Dillenbaugh Creek project:

- Detailed structural calculations were not performed due to the lack of geotechnical information.
- Size, quantity, and invert of box culverts in the sheetpile closure structures were placed to approximate the existing channel configuration. A more detailed hydrology and hydraulics (H&H) study and considerations for fish passage will be required to fully determine the final culvert configuration.
- The proposed channel size of Dillenbaugh Creek was assumed from inspection of aerial photographs and LiDAR data. Determining the final size of the creek channel will require a field

survey and additional H&H analysis. The team assumes that the new channel and associated culverts will be required to provide fish passage, so coordination with WDFW will be necessary.
- The team assumes that the rail companies would agree to have a temporary stoplog closure installed during high water levels. Further coordination with the rail companies will be required to progress this concept.
- Lewis County would be responsible for storing and erecting the temporary stoplog structure.

4.4 MAIN STREET – CITY OF CHEHALIS

4.4.1 EXISTING FLOODING PROBLEMS

Flooding occurs over West Main Street in the city of Chehalis during high-flow events on Dillenbaugh Creek and the Chehalis River. This flooding prevents access to I-5 at Exit 77.

4.4.2 PROPOSED PROJECT

The proposed project is to install approximately 660 feet of temporary stoplog structure along the south side of Main Street above the 100-year flood level (approximate elevation 185.4 feet) to maintain access between the city of Chehalis and I-5 during high-flow events (Figure 4-7). Originally, the team assumed that the existing road could be raised, but the team determined that a temporary stoplog structure would be a better option due to the presence of an at-grade rail crossing.

The proposed stoplog structure would be installed in line with the existing sidewalk. During flood events, the floodwall would be assembled of posts, stoplogs, and braces. Once flood levels have receded, the structure would be taken down and stored. The existing rail line would not be able to operate while the stoplogs are installed. Accesses to local businesses from Main Street would also be closed while the stoplogs are in place.

An existing 36-inch corrugated metal pipe (CMP) culvert crosses under Main Street. The team proposes to retrofit this structure with a backflow device, such as a flap gate, to prevent the flow of water to the north side of Main Street during flood events.

4.4.3 ASSUMPTIONS

The following assumptions were made during the conceptual design:

- The rail companies would agree to have a temporary stoplog closure installed during high water levels. Further coordination with the rail companies will be required to progress this concept.
- The City of Chehalis would be responsible for storing and erecting the temporary floodwall.

4.5 SALZER CREEK BACKWATER CONTROL – LEWIS COUNTY

4.5.1 EXISTING FLOODING PROBLEMS

The east side of I-5 is flooded by overbank flooding of Salzer Creek and backwater flooding from the Chehalis River. The current opening under I-5 is submerged during the simulated 100-year flood event. An existing private road is located within the opening under I-5.

4.5.2 PROPOSED PROJECT

The proposed project is to install a backwater control structure in Salzer Creek to prevent backwater flooding under I-5. The control structure would be installed immediately downstream of the Salzer Creek

and I-5 crossing and would tie into WSDOT's Alternative 1. The existing opening under I-5 is proposed to be closed with an unknown length of sheetpile wall, 50 feet of a temporary stoplog structure, and a 100-foot sheetpile closure structure (Figure 4-8). The temporary stoplog structure would be located across a small private road/pathway. Under normal conditions, the stoplog structure would not be installed, and access to this road would not be disrupted. During expected flood conditions, temporary posts, stoplogs, and braces would be installed in a concrete sill until flood levels have receded. The sheetpile wall would remain in place permanently and would extend to tie into WSDOT's Alternative 1.

The sheetpile closure structure would be a permanent structure with multiple box culverts installed at varying elevations. Tide gates would be located at the outlet (Chehalis River side) and sluice gates at the inlet of the box culverts. The tide gates would close as backwater levels from the Chehalis River flooding rise, thus closing and preventing flow under I-5. Under normal conditions, the tide gates would remain open and allow flow out from Salzer Creek.

4.5.3 ASSUMPTIONS

The following assumptions were made during the conceptual design of the Salzer Creek closure:

- WSDOT's Alternative 1 is assumed to be compatible with the conceptual design of the closure structure. This project will not close the I-5 opening it if is not connected to WSDOT Alternative 1.
- Detailed structural calculations were not performed due to the lack of geotechnical information.
- Size, quantity, and invert of box culverts in the sheetpile closure structures were placed to approximate the existing channel configuration. A more detailed H&H study and considerations for fish passage will be required to fully determine the final culvert configuration.
- The team assumes that the owner of the private road would agree to have a temporary stoplog closure installed during high water levels. Further coordination with the private owner will be required to progress this concept.
- Lewis County will be responsible for storing and erecting the temporary stoplog structure.

4.6 MAIN STREET RECONSTRUCTION – TOWN OF BUCODA

4.6.1 EXISTING FLOODING PROBLEMS

Overbank flooding on the Skookumchuck River results in the closure of Main Street near the intersection with 11th Street in the town of Bucoda. Approximately 50 residences on the south side of 11th Street are isolated from emergency services during high-flow events. In January 2009, the homes and citizens were cut off from the rest of the town for 2 days.

4.6.2 PROPOSED PROJECT

The proposed project involves elevating approximately 1,200 feet of Main Street and 300 feet of 11th Street by 1 to 2 feet to a minimum elevation of 246 feet. Additionally, two 75-foot-long bridges are proposed to provide an overflow path for Skookumchuck River floodwaters (Figure 4-9). The two bridges are proposed along the estimated overflow path on Main Street and 11th Street. The existing road beneath the proposed bridges would be removed to match surrounding grade and provide an overflow path.

Multiple intersections, alleys, sidewalks, and driveways would need to be raised to accommodate the road raise. The existing right-of-way would be occupied by fill material associated with the road raise. Currently, the right-of-way appears to provide street parking for private residences. This parking would

likely be eliminated if the road is raised. Retaining walls would need to be installed near the bridges and intersection of Main and 11th to contain the fill associated with raising the road and to limit impacts to private property.

Utilities were not considered during the conceptual design; however, it is likely that the project would trigger stormwater requirements.

Private property would need to be acquired as part of the proposed design.

4.6.3 ASSUMPTIONS

The following assumptions were made during the conceptual design for the proposed Main Street Reconstruction in Bucoda:

- The proposed road geometry will match existing road geometry on Main Street and 11th Street. From aerial photographs, existing geometry was estimated to be two 10-foot drive lanes with 10-foot gravel shoulders on Main Street.
- The proposed bridge geometry was assumed to have a deck thickness of 2 feet. The low chord of the bridge geometry was at elevation 246 feet. The bridge deck was assumed to be supported by 3-foot-diameter piles every 50 feet. The underlying subsurface conditions were assumed to be suitable to support a bridge, but the bridge will require geotechnical information to design.
- Private property will need to be acquired to accommodate conceptual design.
- Retaining walls will be needed to limit impacts associated with the road raise near the bridges.

4.7 MOON ROAD – CHEHALIS TRIBE

4.7.1 EXISTING FLOODING PROBLEMS

At its current grade, the portion of Moon Road south of U.S. Highway 12 (US12) is overtopped in multiple locations during moderate flood events on the Chehalis River, thus preventing access to Reservation properties. During moderate flood events, US12 remains open.

4.7.2 PROPOSED PROJECT

The intent of this project is to keep of Moon Road open while US12 is not being overtopped. Once US12 is overtopped, it is not necessary to keep Moon Road open. This project includes elevating the low portions of Moon Road to the same elevation as US12 (111.7 feet), a distance of approximately 1,500 feet (Figure 4-10). The proposed project extends from the intersection of US12 to 188th Avenue SW. Four private driveways would need to be raised as a result of raising Moon Road. This project is similar to the Anderson Road project, which was located approximately 1 mile west of Moon Road and which was completed by the Chehalis Tribe several years ago.

4.7.3 ASSUMPTIONS

- The proposed road geometry will match the existing road geometry on Moon Road. Based on the team's inspection of aerial photographs, the existing roadway width is composed of two 11-foot travel lanes with 2-foot gravel shoulders.
- This conceptual design did not analyze water surface elevations along 188th Avenue SW. This road might also need to be raised to prevent overtopping and provide access to Reservation properties.

4.8 BLACK RIVER BRIDGE – CHEHALIS TRIBE

4.8.1 EXISTING FLOODING PROBLEMS

During high flows on the Black and Chehalis Rivers, the Black River bridge on US12 causes a flow constriction, resulting in bank scour, bed erosion, and loss of riparian habitat. In 2001, repairs were made to the bridge to protect the bridge piers and abutments. Failure of the bridge piers and abutments could result in loss of the bridge during a high-flow event. Existing flooding problems at the bridge are documented in the Chehalis Tribe's 2009 Comprehensive Flood Hazard Management Plan.

4.8.2 PROPOSED PROJECT

In 2005, WSDOT authored a Black River Bridge Feasibility Study to examine replacing the existing Black River crossing on US12 at the request of the Chehalis Tribe. The study recommended replacing the existing bridge with a wider, longer bridge. The proposed bridge would be 40 feet wide with a length of 125 feet and a low chord elevation of 97 feet (Figure 4-11).

4.8.3 ASSUMPTIONS

The proposed geometry described in the feasibility study was used for the conceptual design and for incorporation in the hydraulic modeling effort.

4.9 ROUNDTREE CREEK STUDY – CHEHALIS TRIBE

4.9.1 EXISTING FLOODING PROBLEMS

Roundtree Creek has been rerouted to flow along US12 into Harris Creek, which flows through the city of Oakville (Figure 4-12). During major flooding on the Chehalis and Black Rivers, Harris Creek leaves its banks and floods portions of Oakville.

4.9.2 PROPOSED PROJECT

The proposed project is a study to analyze potential solutions to the current flooding problem on Roundtree Creek and Harris Creek near the eastern city limits of Oakville. Potential solutions include restoring Roundtree Creek to its historical flowpath from its current alignment, which is adjacent to US12. Other sources of flooding and solutions would likely be identified during the study.

4.9.3 ASSUMPTIONS

The proposed study is assumed to include developing a hydraulic model to help analyze potential solutions.

4.10 WYNOOCHEE VALLEY ROAD RAISE – GRAY'S HARBOR COUNTY

4.10.1 EXISTING FLOODING PROBLEMS

Wynoochee Valley Road is flooded by floodwater from the Wynoochee River and Chehalis River backwater and is closed during 20-year or larger flood event. Flooding occurs at a low section of road in the vicinity of road mile 1.0. When this road is closed, access to the entire Wynoochee Valley is cut off. About 800 people use the road daily.

The existing hydraulic model does not predict overtopping in the vicinity of road mile 1.0; however, the Grays Harbor County Engineer has observed flooding of the roadway on multiple occasions at this location.

4.10.2 PROPOSED PROJECT

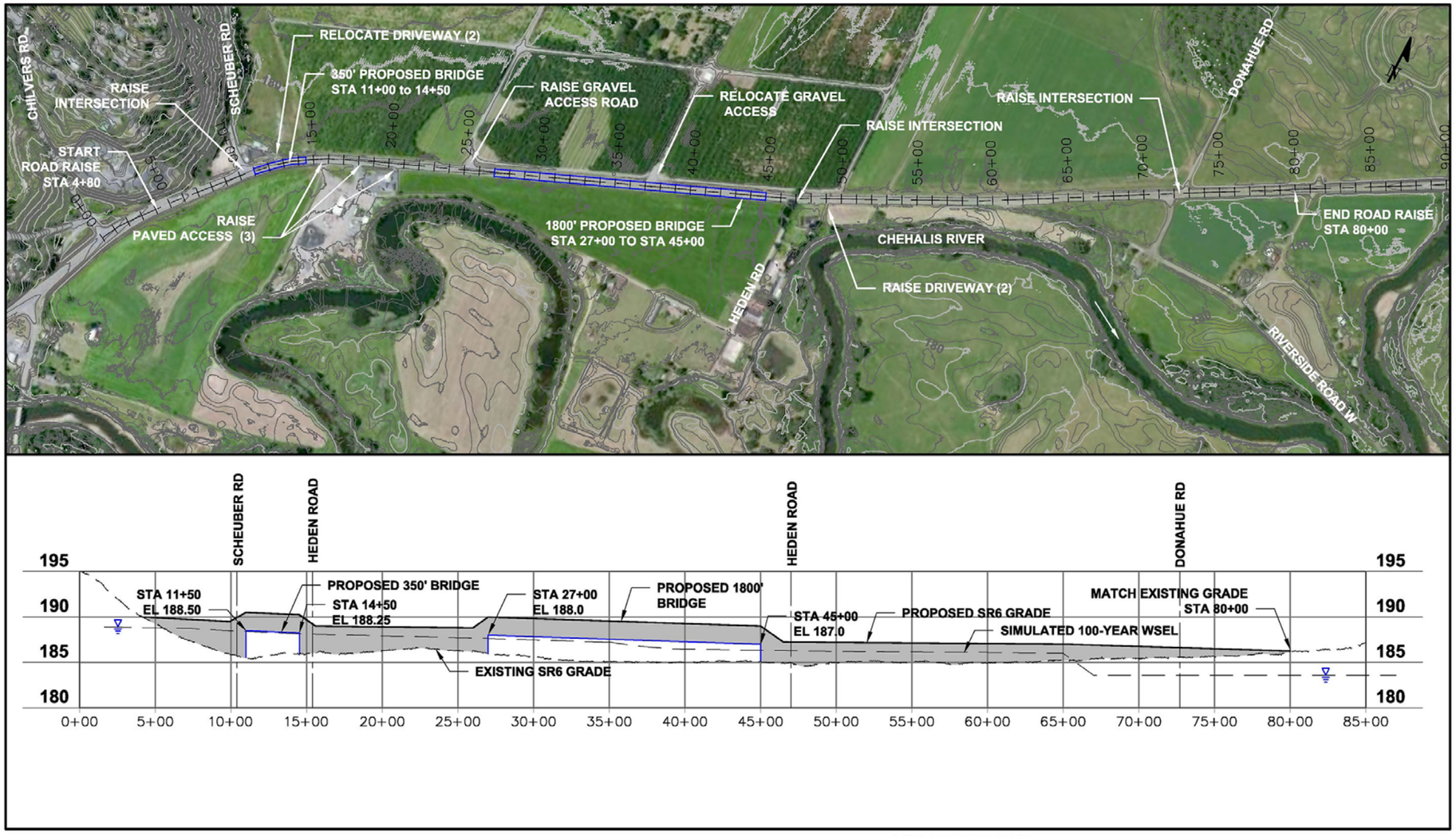
The proposed project includes elevating approximately 350 feet of Wynoochee Valley Road by approximately 1 to 2 feet near the intersection with Valentine Gardens Lane (Figure 4-13). The intent of the project is to keep Wynoochee Valley Road passable during at least the 50-year flood event.

4.10.3 ASSUMPTIONS

The proposed road geometry will match the existing Wynoochee Valley road geometry. Based on aerial photographs, the existing geometry is estimated to be two 10-foot drive lanes with 5-foot gravel shoulders. The team assumes that the road could be raised within the existing right-of-way and without the use of retaining walls.

Figure 4-1
Kirkland Road Conceptual Study City of Napavine

Figure 4-2
SR6 Flow Bypass and Road Raise Conceptual Design Lewis County



NOTE:
1. CONCEPTUAL DESIGN FOR DISCUSSION PURPOSE ONLY. NOT FOR CONSTRUCTION.

SR6 REGRADE
CONCEPTUAL DESIGN
LEWIS COUNTY

Chehalis Basin Flood Study Small Projects

DATE
AUGUST 2014

FIGURE
4-2

Figure 4-3
Dillenbaugh Creek Realignment Conceptual Design Lewis County

NOTE:
1. CONCEPTUAL DESIGN FOR DISCUSSION ONLY. NOT FOR CONSTRUCTION.

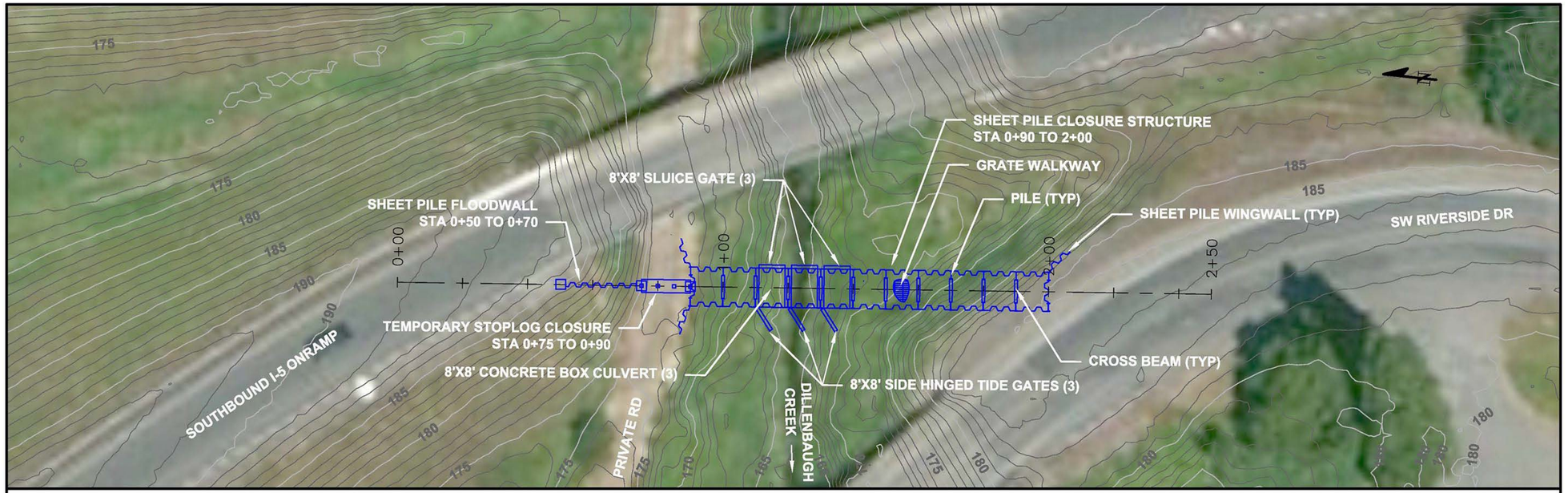
DILLENBAUGH CREEK REALIGNMENT CONCEPTUAL DESIGN LEWIS COUNTY

Chehalis Basin Flood Study Small Projects

DATE
AUGUST 2014

FIGURE
4-3

Figure 4-4
Dillenbaugh Creek Realignment I-5 Southbound Ramp Closure Concept Lewis County



NOTE:
1. CONCEPTUAL DESIGN FOR DISCUSSION ONLY. NOT FOR CONSTRUCTION.
2. ELEVATIONS OF STRUCTURAL ELEMENTS FOR ILLUSTRATION ONLY. DESIGN OF STRUCTURE WILL REQUIRE GEOTECHNICAL INFORMATION.
3. SIZE AND INVERT OF CULVERTS FOR ILLUSTRATION ONLY. SIZE AND INVERT OF CULVERTS TO BE DESIGNED WITH MORE DETAILED H&H INFORMATION AND CONSIDERATIONS FOR FISH PASSAGE.

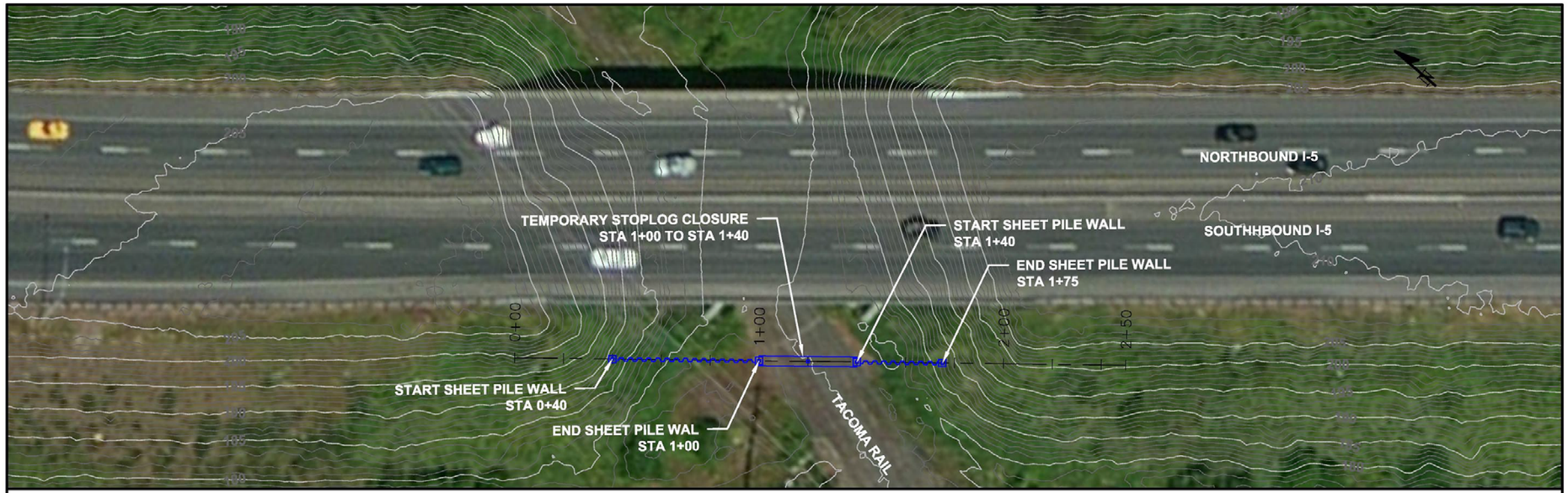
DILLENGBAUGH CREEK REALIGNMENT
I-5 SOUTHBOUND RAMP CLOSURE CONCEPT
LEWIS COUNTY

Chehalis Basin Flood Study Small Projects

DATE
AUGUST 2014

FIGURE
4-4

Figure 4-5
Dillenbaugh Creek Realignment Tacoma Rail Crossing Concept Lewis County



NOTE:
1. CONCEPTUAL DESIGN FOR DISCUSSION ONLY. NOT FOR CONSTRUCTION.
2. ELEVATIONS OF STRUCTURAL ELEMENTS FOR ILLUSTRATION ONLY. DESIGN OF STRUCTURE WILL REQUIRE GEOTECHNICAL INFORMATION.

HDR

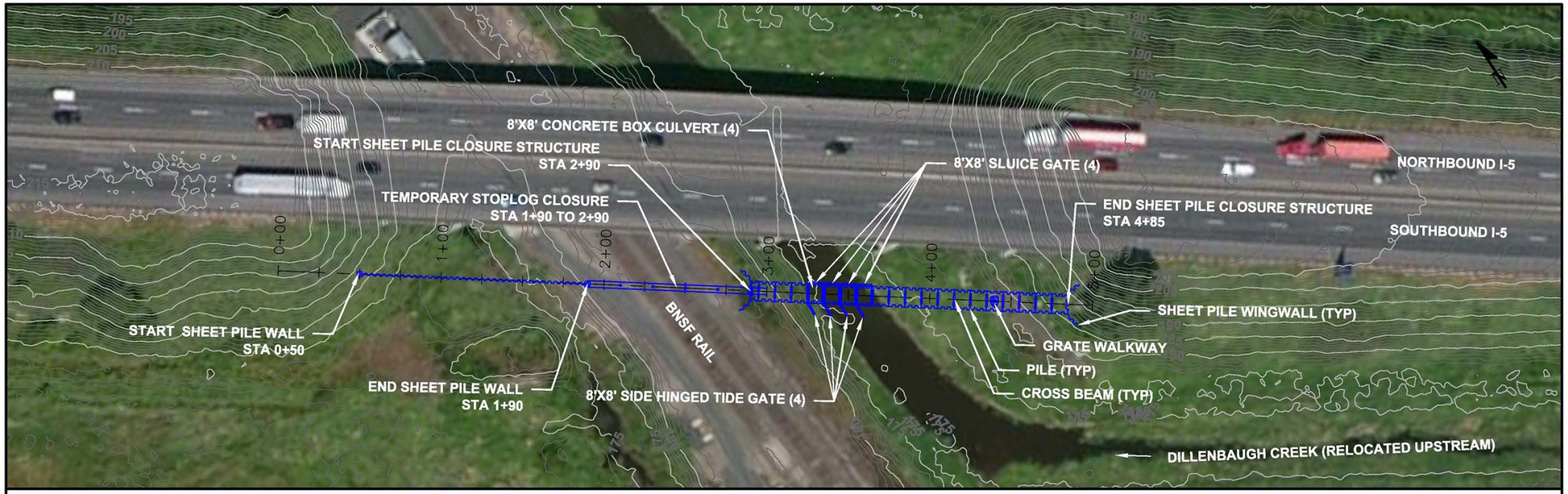
DILLENBAUGH CREEK REALIGNMENT
TACOMA RAIL CROSSING CONCEPT
LEWIS COUNTY

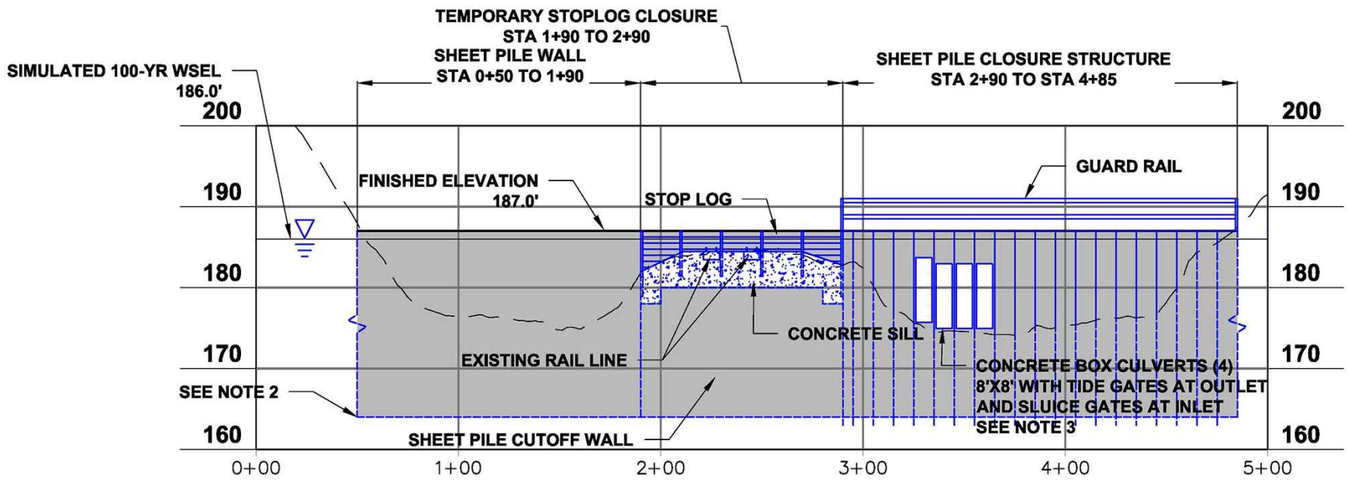
Chehalis Basin Flood Study Small Projects

DATE
August 2014

FIGURE
4-5

Figure 4-6
Dillenbaugh Creek Realignment BNSF Rail Crossing Concept Lewis County





NOTE:

1. CONCEPTUAL DESIGN FOR DISCUSSION ONLY. NOT FOR CONSTRUCTION.
2. ELEVATIONS OF STRUCTURAL ELEMENTS FOR ILLUSTRATION ONLY. DESIGN OF STRUCTURE WILL REQUIRE GEOTECHNICAL INFORMATION.
3. SIZE AND INVERT OF CULVERTS FOR ILLUSTRATION ONLY. SIZE AND INVERT OF CULVERTS TO BE DESIGNED WITH MORE DETAILED H&H INFORMATION AND CONSIDERATIONS FOR FISH PASSAGE.

HDR

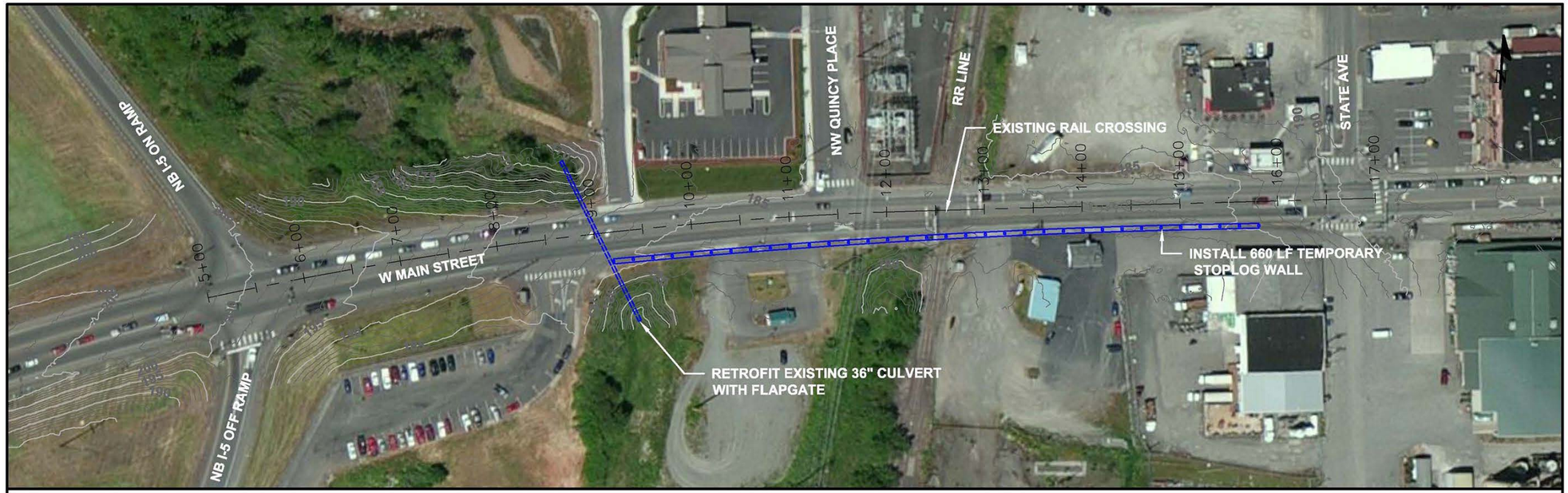
DILLENBAUGH CREEK REALIGNMENT
BNSF RAIL CROSSING CONCEPT
LEWIS COUNTY

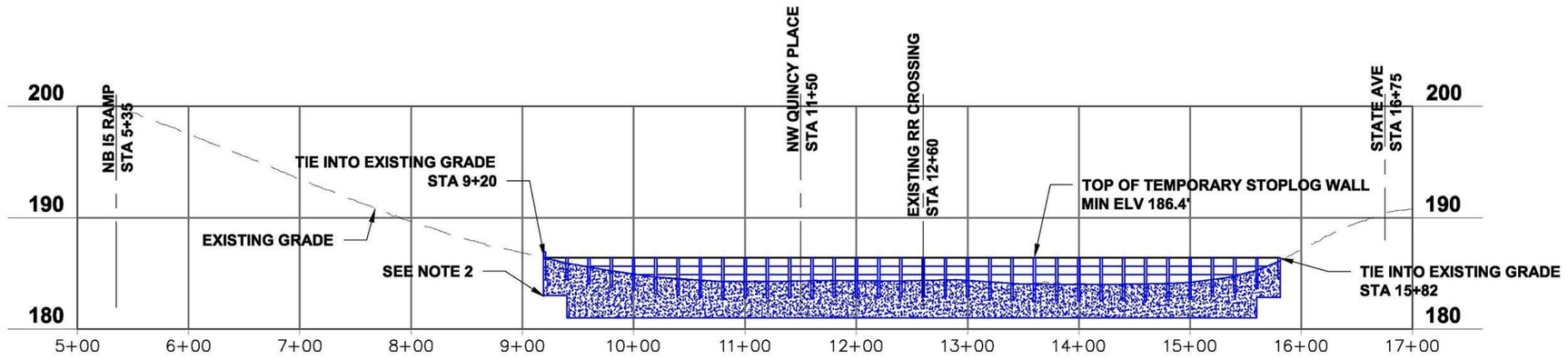
Chehalis Basin Flood Study Small Projects

DATE
AUGUST 2014

FIGURE
4-6

Figure 4-7
Main Street Conceptual Design City of Chehalis





NOTE:
1. CONCEPTUAL DESIGN FOR DISCUSSION ONLY. NOT FOR CONSTRUCTION.
2. ELEVATIONS OF STRUCTURAL ELEMENTS FOR ILLUSTRATION ONLY. DESIGN OF STRUCTURE WILL REQUIRE GEOTECHNICAL INFORMATION. SHEETPILE CUTOFF WALL MAY BE NEEDED DEPENDING ON SUBSURFACE CONDITIONS.

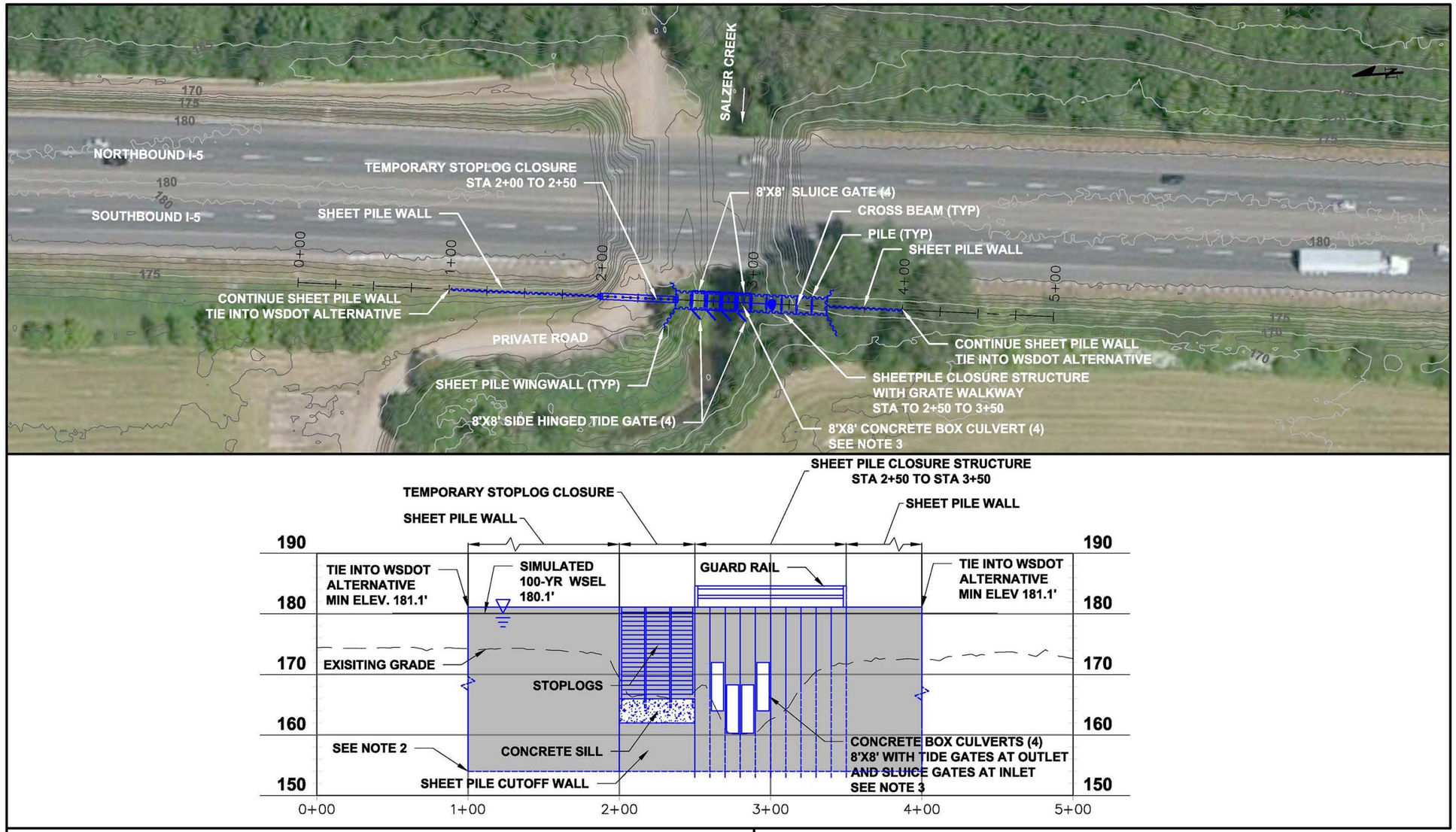
MAIN STREET REGRADE
CONCEPTUAL DESIGN
CITY OF CHEHALIS

Chehalis Basin Flood Study Small Projects

DATE
AUGUST 2014

FIGURE
4-7

Figure 4-8
Salzer Creek Closure Structure Conceptual Design City of Chehalis



NOTE:
1. CONCEPTUAL DESIGN FOR DISCUSSION ONLY. NOT FOR CONSTRUCTION.
2. ELEVATIONS OF STRUCTURAL ELEMENTS FOR ILLUSTRATION ONLY. DESIGN OF STRUCTURE WILL REQUIRE GEOTECHNICAL INFORMATION.
3. SIZE AND INVERT OF CULVERTS FOR ILLUSTRATION ONLY. SIZE AND INVERT OF CULVERTS TO BE DESIGNED WITH MORE DETAILED H&H INFORMATION AND CONSIDERATIONS FOR FISH PASSAGE.

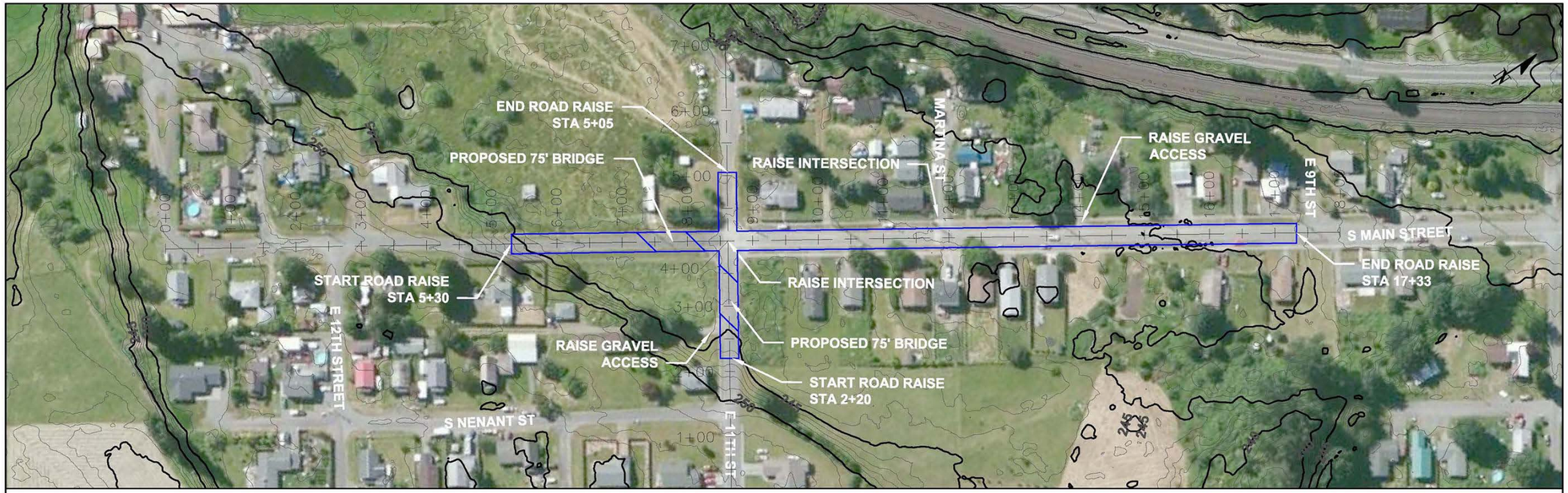
SALZER CREEK CLOSURE STRUCTURE
CONCEPTUAL DESIGN
CITY OF CHEHALIS

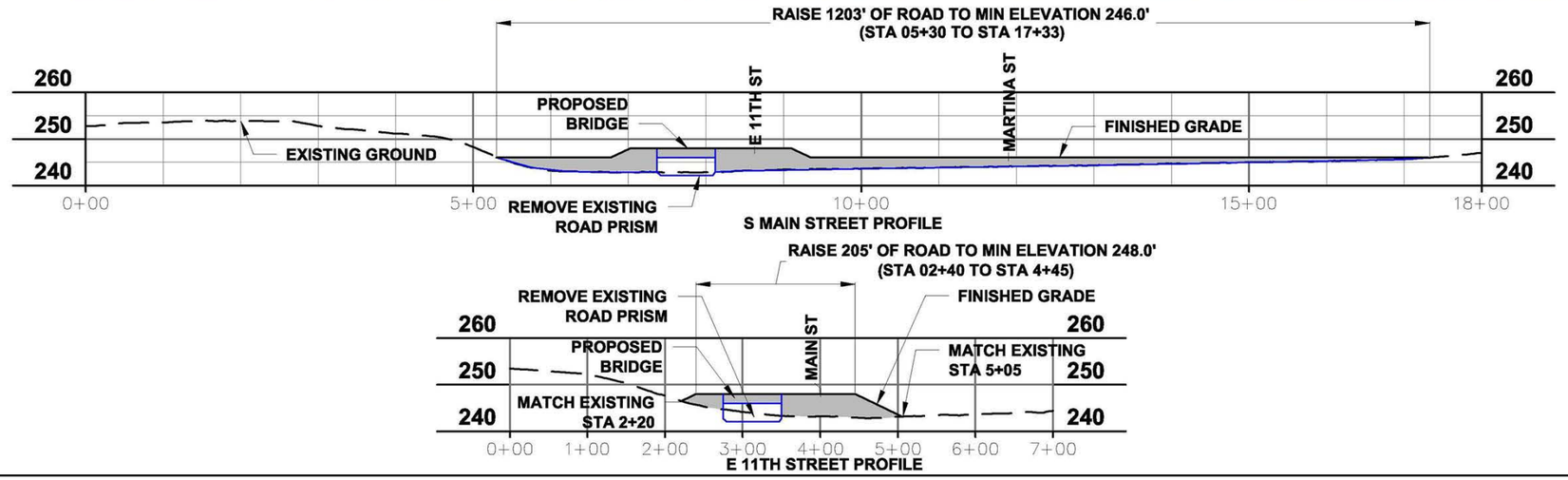
Chehalis Basin Flood Study Small Projects

DATE
AUGUST 2014

FIGURE
4-8

Figure 4-9
Main Street Reconstruction Conceptual Design Town of Bucoda





NOTE:
1. CONCEPTUAL DESIGN FOR DISCUSSION ONLY. NOT FOR CONSTRUCTION
2. IMPACTS TO PRIVATE DRIVEWAYS AND SIDEWALKS NOT SHOWN.

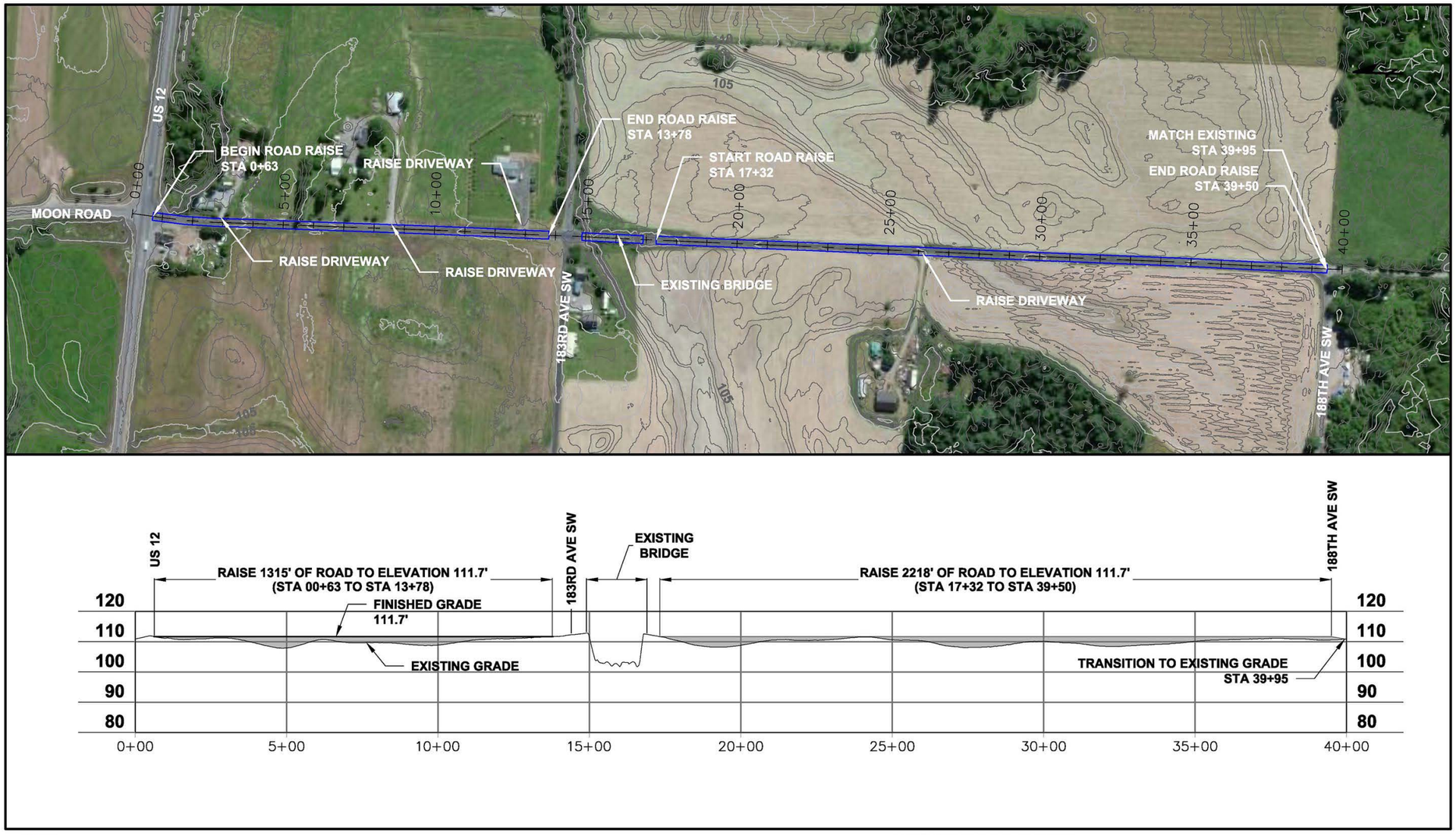
MAIN STREET RECONSTRUCTION
CONCEPTUAL DESIGN
TOWN OF BUCODA

Chehalis Basin Flood Study Small Projects

DATE
AUGUST 2014

FIGURE
4-9

Figure 4-10
Moon Road Raise Conceptual Design Chehalis Tribe



NOTE:
1. CONCEPTUAL DESIGN FOR DISCUSSION ONLY. NOT FOR CONSTRUCTION.

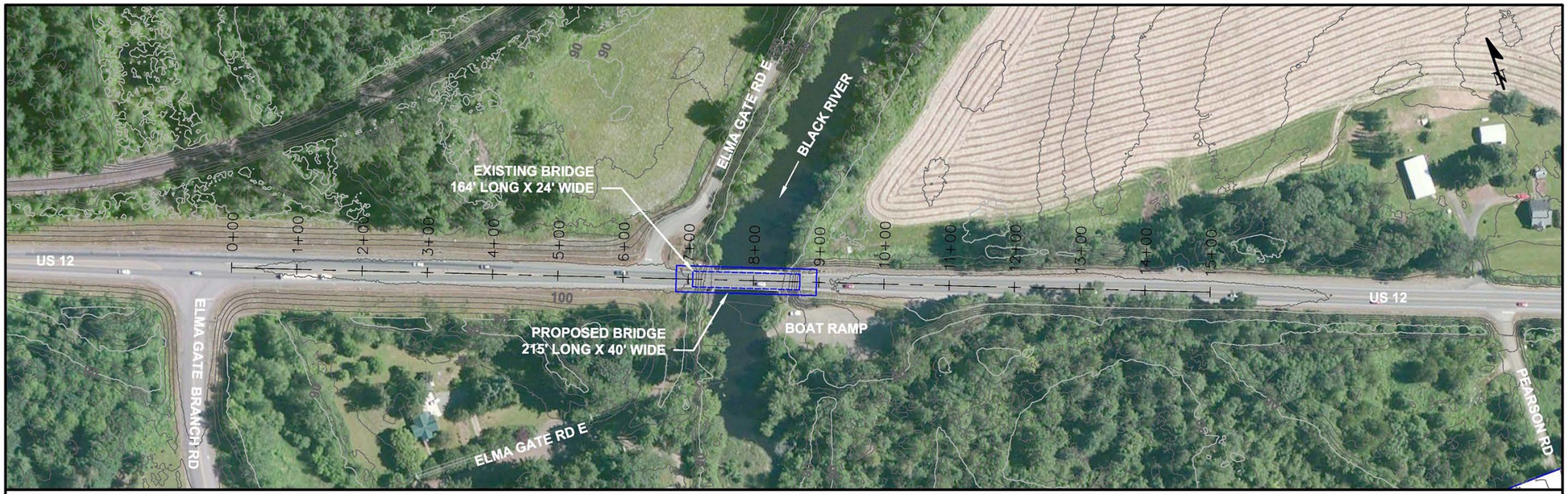
MOON ROAD RAISE
CONCEPTUAL DESIGN
CHEHALIS TRIBE

Chehalis Basin Flood Study Small Projects

DATE
AUGUST 2014

FIGURE
4-10

Figure 4-11
Black River Bridge Conceptual Design Chehalis Tribe



NOTE:
1. CONCEPTUAL DESIGN FOR DISCUSSION ONLY. NOT FOR CONSTRUCTION.
2. EXISTING AND PROPOSED BRIDGE LOCATIONS APPROXIMATE. PROPOSED GEOMETRY APPROXIMATELY LOCATED BASED ON DESCRIPTION IN BLACK RIVER BRIDGE FEASIBILITY STUDY (WSDOT, 2005).

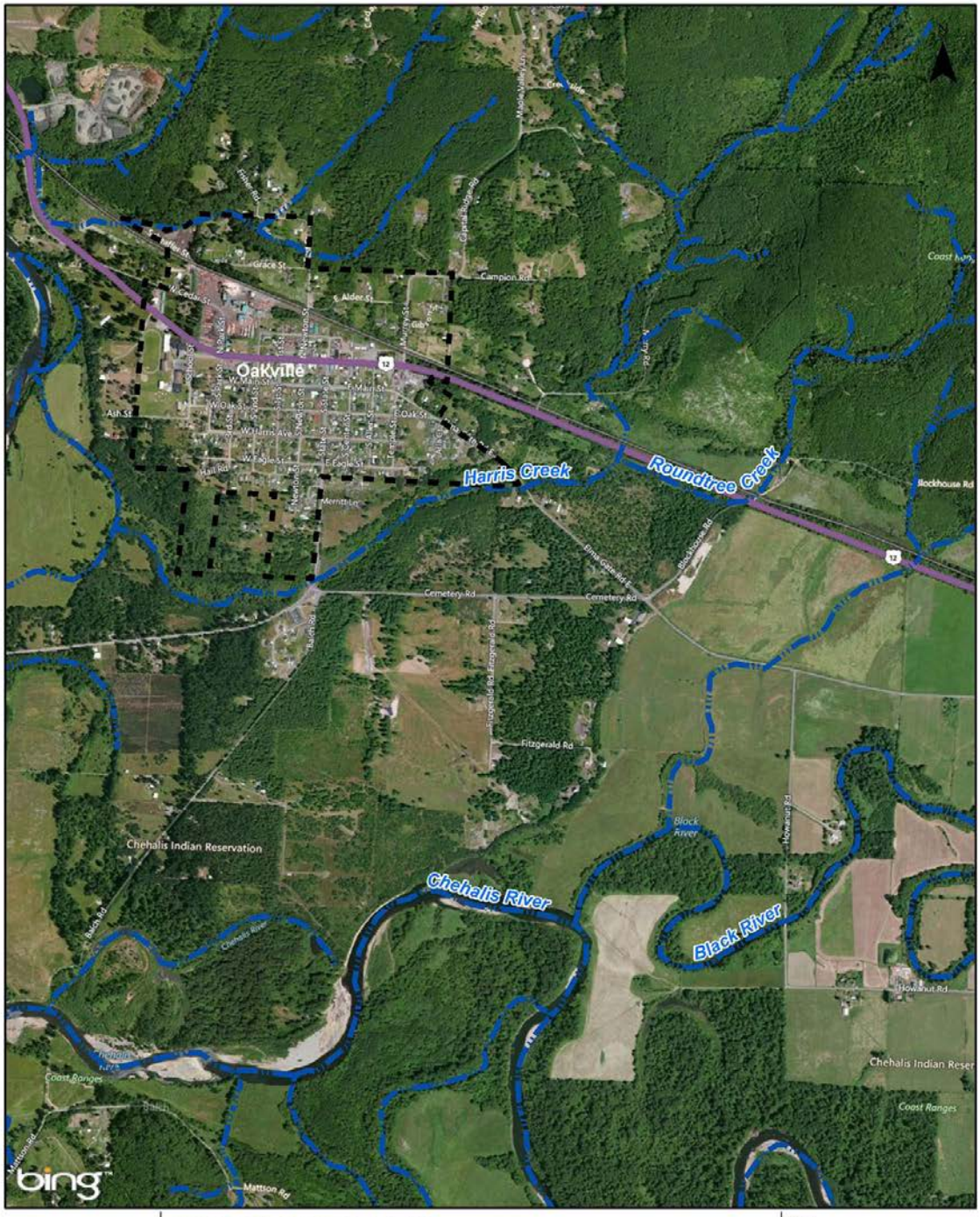
BLACK RIVER BRIDGE CONCEPTUAL DESIGN CHEHALIS TRIBE

Chehalis Basin Flood Study Small Projects

DATE
AUGUST 2014

FIGURE
4-11

Figure 4-12
Roundtree Creek Conceptual Study Chehalis Tribe



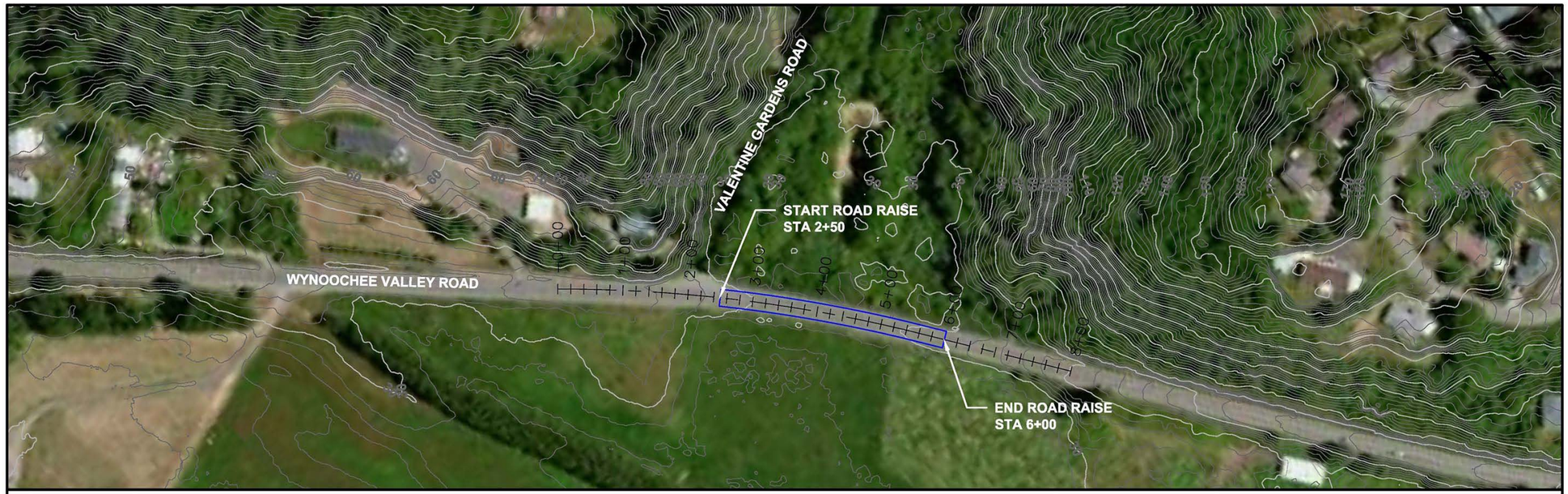
ROUNDTREE CREEK
CONCEPTUAL STUDY
CHEHALIS TRIBE

0 500 1,000 2,000
Feet

DATE
AUGUST 2014

FIGURE
4-12

Figure 4-13
Wynoochee Valley Road Raise Conceptual Design Grays Harbor County



NOTE:
1. CONCEPTUAL DESIGN FOR DISCUSSION ONLY. NOT FOR CONSTRUCTION.

HDR

WYNOOCHEE VALLEY ROAD RAISE
CONCEPTUAL DESIGN
GRAYS HARBOR COUNTY

Chehalis Basin Flood Study Small Projects

DATE
AUGUST 2014

FIGURE
4-10

Hydraulic Modeling

5 Hydraulic Modeling

Under a separate task for the Chehalis Basin Strategy, WSE made a major revision to an existing unsteady HEC-RAS (Hydrologic Engineering Center River Analysis System) hydraulic model of the Chehalis River Basin. The work undertaken to update and calibrate the model is fully documented in WSE's July 2014 technical memorandum (WSE 2014). The HEC-RAS model provides a suitable tool for evaluating the wide range of flood damage reduction projects being considered in the Chehalis Basin Strategy.

Hydraulic analyses using the revised HEC-RAS model were previously performed for numerous potential flood hazard reduction alternatives. Simulations were conducted for the existing (without-dam) condition as well as with the proposed dam/flood retention facility and the airport levee. Other simulations included evaluating WSDOT Alternative 1 (I-5 floodwalls and berms) and WSDOT Alternative 2 (raising I-5).

The HEC-RAS model is currently being applied to evaluate the effects, both positive and negative, of a suite of small-scale flood damage reduction projects. The projects included in the current modeling are described below. Simulation results, including model outputs in HEC-DSS format and flood inundation mapping in geographic information systems (GIS) format, are available for these model runs.

5.1 MODEL DEVELOPMENT

The HEC-RAS model was modified, where possible, to include the small-scale flood damage reduction projects. The individual projects, and the manner in which they were incorporated into the model, are documented in Table 5-1. Note that some of the projects do not yet have any design concepts, so they could not be incorporated into the model. For other projects, the model is not sufficiently detailed to provide meaningful results for evaluating small-scale projects.

All of the small-scale projects were incorporated into a single model geometry; that is, the small-scale projects were not modeled individually. Thus, the results of the small-scale project scenario reflect the suite of projects, and the effects of any single project cannot be definitively determined. Nevertheless, because the small-scale projects generally have only local hydraulic effects, and because the projects are typically located in separate areas from each other, the impacts and benefits of each project can generally be estimated from the model outputs.

Table 5-1
Hydraulic Modeling of Small-scale Flood Damage Reduction Projects

PROJECT	LOCATION	MANNER INCORPORATED INTO MODEL
Dillenbaugh Creek	Chehalis	Plug all openings in the model along I-5 from the SR6 interchange to the BNSF overpass to prevent any flow transfer west to east through these openings to the east side of I-5 within the city of Chehalis. Openings included were Dillenbaugh Creek near SR6 and the Tacoma Rail and BNSF overpasses, with the BNSF overpass plug also blocking the Dillenbaugh Creek channel.
Salzer Creek	Twin Cities	Add backflow prevention on the Salzer Creek bridge at I-5 to prevent any flow transfer from west to east in any simulated event.
Main Street Chehalis	Chehalis	Add a temporary stoplog structure along Main Street above the current 100-year flood level and add backflow prevention on the culvert under Main Street.
SR6 Project	Twin Cities	Raise SR6 above the current 100-year flood level and put bridges through the road fill to try to maintain the existing hydraulic conditions.
Black River Bridge	Near Oakville	Modify the bridge in the model to estimate the opening and size documented in the November 2005 WSDOT feasibility report (WSDOT 2005).
Moon Road	Chehalis Reservation	Raise Moon Road between US12 and 188th Avenue SW to match the elevation at the intersection of US12 and Moon Road. Existing bridge will remain.
Main Street Bridge	Bucoda	No hydraulic effects on the Chehalis River
Wynoochee Road	Montesano	The model does not show overtopping of the road, so the effects of this project cannot be modeled.
Kirkland Road	Napavine	Additional study is required for this project. There is no defined design at this time, so there is nothing to be modeled.
Roundtree Creek	Oakville	Additional study is required for this project. There is no defined design at this time, so there is nothing to be modeled.

Notes: SR6 = State Route 6
US12 = U.S. Highway 12
WSDOT = Washington State Department of Transportation

5.2 MODEL SCENARIOS

The HEC-RAS model was configured and run to evaluate four scenarios: (1) Small Projects Alone, (2) Small Projects + Dam Alternative, (3) Small Projects + WSDOT Alternative 1, and (4) Small Projects +Dam + WSDOT Alternative 1. For each of these scenarios, the following flood events were simulated: 2-year, 10-year, 20-year, 100-year, and 500-year. The December 2007 flood event was also simulated for each of the scenarios.

The results of the simulations are available in the form of detailed hydraulic outputs in HEC-DSS format. Model outputs at specific locations can be extracted as needed to facilitate assessment of the small-scale projects. The overall results of the modeling are summarized below and in Table 5-2.

5.3 MODEL RESULTS

Collectively, the small-scale project scenario does not have significant hydraulic effects, so the Small Projects Team does not expect any single project to have significant, widespread effects on flooding, either positively or negatively. Small-scale projects along I-5 might produce limited benefits during the largest floods without a concurrent WSDOT Alternative 1 and/or construction of the dam and raising the airport levee but might produce some benefit during smaller, more frequent events. Flood elevation benefits and impacts for each scenario were analyzed.

5.3.1 SMALL PROJECTS ALONE

Benefits. The proposed suite of small-scale projects would help reduce flooding in the southwest portion of the ***c***ity of Chehalis, allow Main Street/SR6 to remain open between Chehalis and Scheuber Road, reduce flood depths by several feet along the Miracle Mile, allow access to be maintained between Bucoda and south Bucoda, and provide a secondary access route between US12 and the Chehalis tribal casino. Some of the projects would extend *these* benefits to *events* equal or greater than the 100-year flood*,* while others would provide benefits only *during* smaller flood events. The most significant benefits of each modeled project, together with the maximum flood event at which *the team expects* the benefits to be provided, are summarized in Table 5-2.

For the Dillenbaugh Creek small project, which includes temporarily or permanently plugging all openings through I-5 between SR6 and the 13th Street interchange, the water levels east of the freeway near southwest Chehalis would be reduced dramatically for all events up to and including the 100-year flood. However, starting with the 100-year flood, there would be some overtopping of I-5, and some flooding of the areas east of I-5 might still occur. During the 500-year flood, overtopping of the existing freeway would be substantial, and the project is not expected to provide as much benefit.

The Main Street (Chehalis) project would prevent water from overtopping Main Street from south to north during events up to and including a 100-year flood. Note, however, that because the modeling of the small-scale projects included a suite of projects (including the Dillenbaugh Creek project), the actual benefits or impacts of the Main Street project by itself cannot be determined. If the Dillenbaugh Creek project is implemented, the Main Street project would be unnecessary, since Chehalis River flows would not reach the wetland south of Main Street, and thus flow would already be prevented from overtopping Main Street. If the Dillenbaugh Creek project is not implemented, additional modeling would be needed to evaluate the benefits and potential impacts of the Main Street project.

For the Salzer Creek small project, overtopping of I-5 in the existing condition renders this project somewhat useless unless it is completed in combination with either the WSDOT floodwalls and berms alternative (Alternative 1) or the proposed flood control retention facility on the upper Chehalis River. The amount of water overtopping I-5 in the baseline condition during a 100-year flood event dwarfs the amount of water backing up through the Salzer Creek bridge, so eliminating backflow is not in itself very beneficial to reducing flooding east of the freeway.

SR6 currently overtops west of I-5 during events equal or exceeding about a 10-year flood. The proposed small project would elevate the road and provide two large openings to allow floodwater to pass under the road. The proposed project would allow the road to remain open between I-5 and Scheuber Road up to and including a 500-year flood in the baseline condition. However, because flows under the bridge would be somewhat constricted compared to existing conditions, there would be some change in hydraulic conditions and water levels upstream and downstream of the site.

The Black River Bridge small project would increase the capacity of the existing bridge. This would result in lower upstream water levels in events up to the 20-year flood. For simulated events larger than the 20-year flood, the upstream water levels are not significantly reduced by this project, since Chehalis River backwater is the primary cause of flooding rather than the constriction at the current bridge.

The Moon Road small project, which proposes raising the level of Moon Road to the same elevation as US12, would not provide significant benefits during events greater than about a 2-year flood. There is currently a small bridge with a channel under Moon Road just south of US12 which passes some flow from east to west with higher flow being passed over the road. The modeling shows that, even if the road were raised, the bulk of the flow would still pass over the top of the road for events exceeding a 2-year flood.

The Main Street (Bucoda) project includes elevating Main Street and East 11th Street in Bucoda to provide access between the main part of town and the southern part of town. During large flood events (greater than about a 10-year flood), flow escapes of the Skookumchuck River and flows through town via the overflow swale that crosses Main Street. The proposed small project would require bridges on Main Street and East 11th Street to pass this flow under the elevated roads. The project design calls for elevating the roads above the 100-year flood elevation. Constricting the flow would, however, raise upstream water levels as discussed.

Impacts. The proposed suite of small-scale projects would result in slightly to significantly increased water levels at certain locations. During the 100-year flood event, the following water level increases would occur:

- 0.9 foot along the lower Newaukum River near road mile 1.0 resulting primarily from the Dillenbaugh Creek project
- 0.6 foot on the Chehalis River near the SR6/Scheuber Road intersection and approximately 0.4 foot near Donahue Road resulting from the SR6 project
- 0.2 foot on the Chehalis River near the downstream side of Salzer Creek Bridge (in the 20-year flood event) due to the Salzer Creek project (significant water level increases would not occur during larger floods due to the overtopping of I-5)
- Up to 2.0 feet along the overflow swale upstream of the Main Street/East 11th Street intersection in Bucoda

5.3.2 SMALL PROJECTS + DAM ALTERNATIVE

The Salzer Creek small project and to a lesser extent the Dillenbaugh Creek small projects are not viable as stand-alone projects because overtopping of I-5 at higher flood levels (100-year flood and above) would allow floodwaters to bypass the project backwater controls. With the dam in place, these projects would provide flood protection benefits up to higher return intervals. Both of these projects would provide protection to their target benefit area up to and including a 500-year event if the dam were in place.

Other small projects would perform similarly in the Small Projects + Dam Alternative scenario as they do in the Small Projects Alone scenario. The potential negative impacts of the small projects in this scenario would be similar to those of the Small Projects Alone scenario, although the increases in water levels due to the Salzer Creek project would be greater (up to 0.5 foot) and would extend to higher-flow events, similar to the expanded benefits when this project is considered in combination with the dam.

5.3.3 SMALL PROJECTS + WSDOT ALTERNATIVE 1

Similar to the Small Projects + Dam Alternative scenario, the Small Projects + WSDOT Alternative 1 scenario would allow the Salzer Creek and Dillenbaugh Creek small projects to provide flood protection benefits at a higher return interval. Both of these projects would provide protection to their target benefit area up to and including a 500-year event if the dam were in place. The modeling indicates that the SR6 project would be negatively affected by the WSDOT I-5 alternative as higher water levels downstream of the project would cause SR6 to overtop during a 500-year flood, while in the baseline condition overtopping would not occur during the 500-year flood.

Other small projects would perform similarly in the Small Projects + WSDOT Alternative 1 scenario as they do in the Small Projects Alone scenario. The potential negative impacts of the small projects in this scenario would be similar to those of the Small Projects Alone scenario, although the increases in water levels due to the Salzer Creek project would be greater (up to 0.5 foot) and would extend to higher-flow events, similar to the expanded benefits when this project is considered in combination with WSDOT Alternative 1.

5.3.4 SMALL PROJECTS + DAM + WSDOT ALTERNATIVE 1

The benefits and impacts in the Small Projects + Dam + WSDOT Alternative 1 scenario are similar to those for the Small Projects + Dam Alternative scenario.

Table 5-2
Benefits of Small-Scale Flood Reduction Projects

PROJECT	MOST SIGNIFICANT HYDRAULIC BENEFIT	MAXIMUM RECURRENCE INTERVAL FOR BENEFITS			
		SMALL PROJECTS ALONE	SMALL PROJECTS + DAM ALT	SMALL PROJECTS + WSDOT ALT 1	SMALL PROJECTS + DAM + WSDOT ALT 1
Dillenbaugh Creek	Prevents floodwater from passing under I-5 south of Main Street and eliminates flooding of southwest Chehalis	100-year	500-year	500-year	500-year
Salzer Creek	Prevents floodwater from backing up through the Salzer Creek bridge and increasing flooding to the Miracle Mile	20-year	500-year	500-year	500-year
Main Street Chehalis	Prevents floodwater from overtopping Main Street, allowing street to remain open and reducing flooding to the north	100-year	500-year	500-year	500-year
SR6 Project	Raises section of SR6 above 100-year flood levels, allowing access between I-5 and Scheuber Road	500-year	500-year	100-year	500-year
Black River Bridge	Increases capacity of Black River bridge, reducing upstream water levels during some floods	20-year	20-year	20-year	20-year

PROJECT	MOST SIGNIFICANT HYDRAULIC BENEFIT	MAXIMUM RECURRENCE INTERVAL FOR BENEFITS			
		SMALL PROJECTS ALONE	SMALL PROJECTS + DAM ALT	SMALL PROJECTS + WSDOT ALT 1	SMALL PROJECTS + DAM + WSDOT ALT 1
Moon Road	Prevents floodwater from overtopping Moon Road, allowing street to remain open	2-year	2-year	2-year	2-year
Main Street Bridge	Allows safe road access to south Bucoda during floods for emergency vehicles and residents	100-year	100-year	100-year	100-year
Wynoochee Road	No project modeled	NA	NA	NA	NA
Kirkland Road	No project modeled	NA	NA	NA	NA
Roundtree Creek	No project modeled	NA	NA	NA	NA

Notes:
ALT = Alternative
NA = Not applicable
WSDOT = Washington State Department of Transportation

6 Opinions of Probable Costs

6.1 METHODOLOGY, CONTINGENCIES, AND ASSUMPTIONS

The Small Projects Team prepared conceptual-level estimates of probable construction costs (2014 basis) for each of the 10 small projects selected for conceptual design. Quantities and costs could change drastically based on future planning, engineering decisions, and information about existing site conditions.

Unit cost information was obtained from a variety of sources, including the following:

- WSDOT Unit Bid Analysis Database
- WSDOT publications
    - 2011 Bridge Design Manual (M 23-50.06)
    - 2008 Planning-Level Cost Estimation Manual
- Previous cost estimates for similar studies in the region
- Private vendors
- The team's engineering judgment based on previous work experience
- RS Means

Due to the conceptual nature of the designs and the lack of available existing information, the Small Projects Team needed to incorporate contingencies into the cost estimate. Contingency factors were developed for the mobilization, erosion control, traffic control, design, permitting, and construction. Erosion control, traffic, and construction contingency factors were applied to the construction materials and labor cost. Mobilization and sales tax were applied to the construction subtotal. Design and permitting contingencies were applied to the base construction cost. Survey was assumed as a lump-sum cost and varied based on the size of the project. Table 6-1 summarizes the unit prices and contingency factors.

Table 6-1
Summary of Unit Price and Summary Factors Included in Cost Estimates

CONSTRUCTION MATERIALS COSTS		
ITEM	**UNITS**	**UNIT COST**
Excavation		
Excavation	CY	$25
Channel Excavation	CY	$30
Clearing and Grubbing	AC	$4,000
Transportation		

CONSTRUCTION MATERIALS COSTS		
ITEM	**UNITS**	**UNIT COST**
Planing Bituminous Pavement	SY	$10
Hot Mix Asphalt	TN	$80
Gravel Borrow Incl. Haul	TN	$9
Crushed Surfacing Base Course	TN	$20
Crushed Surfacing Top Course	TN	$20
Reinforced Concrete Retaining Wall	SF	$75
Beam Guardrail Type 31	LF	$25
Beam Guardrail Transition Section	EA	$3,000
Beam Guardrail Flared Terminal	EA	$2,000
Centerline Rumble Strip	MI	$1,500
Cement Concrete Sidewalk	SY	$30
Paved Access	EA	$10,000
Gravel Access	EA	$5,000
Driveway Access	EA	$2,000
Bridge	SF	$250
Structural		
PZ-35 Sheetpile	CWT	$93
Driving Sheetpile	SF	$8
W 12 × 26 Cross Beam	CWT	$56
W 30 × 116 Pile	CWT	$59
W 12 × 58 Stringer	CWT	$56
Driving Piles	EA	$575
Utility Grating	SF	$16
Handrail	LF	$8
8 × 8 Tide Gate	EA	$30,500
8 × 8 Sluice Gate	EA	$35,500
36-inch Flap Gate	EA	$6,000
Concrete Box Culvert	EA	$10,320
Fish Passage Box Culvert	EA	$30,000
Concrete (Foundation)	CY	$350
Stoplog Structure	SF	$125 to $160
Stream Restoration and Planting		
Engineered Streambed Material	CY	$60
Riprap	TN	$30
Quarry Spall	TN	$30
Root Wad with Log	EA	$700
Double Root Wad with Log	EA	$1,200

CONSTRUCTION MATERIALS COSTS		
ITEM	UNITS	UNIT COST
Channel Log Structure	EA	$1,600
Shrub (4-foot OC)	EA	$10
Deciduous Tree (8-foot OC)	EA	$12
Willow Stakes (1-foot OC)	EA	$4
Soil Amendment, Compost, 3-inch Depth	CY	$30
Other		
Storm Drainage	LS	Varies
Dewatering	LS	Varies
Construction Survey	LS	Varies
Contingency Factors		
Mobilization		10%
Erosion Control		5%
Traffic Control		6%
Engineering Design		10%
Environmental Permitting and Mitigation		5%
Construction		30%
Sales Tax		8%

Notes:
AC = acre
EA = each
CWT = centum weight
CY= cubic yard
LF = lineal foot
LS = lump sum
OC = on-center
SF = square foot
SY = square yard
TN = ton

Items not included in the estimate of probable costs include Operation and Maintenance, Property and Right-of-Way Acquisition, and Construction Management.

6.2 SMALL PROJECTS ESTIMATED COSTS

6.2.1 KIRKLAND ROAD STUDY

The cost of a study to investigate the flooding problems near Kirkland Road for the City of Napavine is estimated to be $40,000.

6.2.2 STATE ROUTE 6 FLOW BYPASS AND ROAD RAISE

The cost of the SR6 small project is estimated to be approximately $51.1 million. A summary of these estimated costs is provided in Table 6-2.

Table 6-2
Summary Cost Estimate for SR6 Small Project

CONCEPTUAL COST ESTIMATE				
ITEM	**QUANTITY**	**UNITS**	**UNIT COST**	**COST**
Planing Bituminous Pavement	20,133	SY	$10	$201,333
Gravel Borrow Incl. Haul	21,203	TN	$9	$190,823
Crushed Surfacing Base Course	6,512	TN	$20	$130,240
Hot Mix Asphalt	11,492	TN	$80	$919,328
Beam Guardrail Type 31	800	LF	$25	$20,000
Beam Guardrail Transition Section	8	EA	$3,000	$24,000
Beam Guardrail Flared Terminal	8	EA	$2,000	$16,000
Centerline Rumble Strip	1.4	MI	$1,500	$2,130
Paved Access	8	EA	$10,000	$80,000
Gravel Access	2	EA	$5,000	$10,000
Driveway Access	4	EA	$2,000	$8,000
Bridge	95,954	SF	$250	$23,988,500
Construction Materials and Labor Cost:				**$25,590,354**
Erosion Control (5%)				$1,279,518
Contingency (30%)				$7,677,106
Traffic Control (6%)				$1,535,421
Construction Subtotal:				**$36,082,400**
Mobilization (10%)				$3,608,240
Sales Tax (8%)				$2,886,592
Base Construction Cost:				**$42,577,232**
Engineering Design (10%)				$4,257,723
Environmental Permitting and Mitigation (5%)				$2,128,862
Construction Survey (LS)				$50,000
Total Cost				**$49,013,817**

6.2.3 DILLENBAUGH CREEK REALIGNMENT

The cost of the Dillenbaugh Creek small project is estimated to be approximately $10.8 million. A summary of the estimated costs is provided in Table 6-3.

Table 6-3
Summary Cost Estimate for Dillenbaugh Creek Small Project

CONCEPTUAL COST ESTIMATE				
ITEM	**QTY**	**UNITS**	**UNIT COST**	**COST**
Excavation	7,252	CY	$25	$181,296
Channel Excavation	1,102	CY	$30	33,056
Clearing and Grubbing	7	AC	$4,000	$27,709
Concrete (Foundation)	219	CY	$350	$76,481

CONCEPTUAL COST ESTIMATE				
ITEM	**QTY**	**UNITS**	**UNIT COST**	**COST**
Riprap	1,181	TN	$30	35,417
Quarry Spall	220	TN	$30	$6,611
Streambed Material	4,191	CY	$60	$251,444
PZ-35 Sheetpile	24,223	CWT	$93	$2,252,700
Driving Sheetpile	69,120	SF	$8	$552,960
W 12 × 26 Cross Beam	138	CWT	$56	$7,731
W 30 × 116 Pile	2,336	CWT	$59	$137,848
W 12 × 58 Stringer	342	CWT	$56	$19,130
Driving Piles	66	EA	$575	$37,950
Utility Grating	3,660	SF	$16	$59,658
Handrail	658	LF	$8	$5,264
8 ×x 8 Tide Gate	8	EA	$30,500	$244,000
8 × 8 Sluice Gate	8	EA	$35,500	$284,000
Concrete Box Culvert	7	EA	$10,320	$72,240
Fish Passage Box Culvert	3	EA	$30,000	$90,000
Stoplog Structure	1,125	SF	$160	$180,000
Root Wad with Log	180	EA	$700	$126,000
Double Root Wad with Log	36	EA	$1,200	$43,200
Channel Log Structure	36	EA	$1,600	$57,600
Shrub (4-foot OC)	12,334	EA	$10	$123,344
Deciduous Tree (8' OC)	3,375	EA	$12	$40,500
Willow Stakes (1-foot OC)	36,000	EA	$4	$144,000
Soil Amendment, Compost, 3-inch Depth	2,327	CY	$30	$69,819
Dewatering	1	LS	$30,000	$30,000
Construction Materials and Labor Cost:				**$5,189,959**
Erosion Control (5%)				$259,498
Contingency (30%)				$1,556,988
Construction Subtotal:				**$7,006,444**
Sales Tax (8%)				$560,516
Mobilization (10%)				$700,644
Base Construction Cost:				**$8,267,604**
Engineering Design (10%)				$826,760
Environmental Permitting and Mitigation (5%)				$413,380
Construction Survey (LS)				$50,000
Total Cost				**$9,557,745**

6.2.4 MAIN STREET – CITY OF CHEHALIS

A summary of the component and total combined costs for the Main Street flood control project in the city of Chehalis is provided in Table 6-4. The total cost for the project is estimated to be about $1.1 million.

Table 6-4
Summary Cost Estimate for City of Chehalis Main Street Small Project

CONCEPTUAL COST ESTIMATE				
ITEM	**QUANTITY**	**UNITS**	**UNIT COST**	**COST**
Excavation	490	CY	$25	$12,259
Cement Concrete Sidewalk	368	SY	$30	$11,033
Concrete (Foundation)	490	CY	$350	$171,630
36-inch Flap Gate	1	EA	$6,000	$6,000
Stoplog Structure	2648	SF	$125	$331,000
Construction Materials and Labor Cost:				**$531,922**
Erosion Control (5%)				$26,596
Contingency (30%)				$159,577
Construction Subtotal:				**$718,095**
Mobilization (10%)				$71,810
Sales Tax (8%)				$57,448
Base Construction Cost:				**$847,352**
Engineering Design (10%)				$84,735
Environmental Permitting and Mitigation (5%)				$42,368
Construction Survey (LS)				$15,000
Total Cost				**$989,455**

6.2.5 SALZER CREEK CLOSURE STRUCTURE

A summary of the component and total combined costs for the Salzer Creek Closure Structure is provided in Table 6-5. The estimated cost is about $4.0 million.

Table 6-5
Summary Cost Estimate for the Salzer Creek Small Project

CONCEPTUAL COST ESTIMATE				
ITEM	**TOTAL QTY**	**UNITS**	**UNIT COST**	**COST**
Excavation	37	CY	$25	$926
Channel Excavation	583	CY	$30	$17,500
Clearing and Grubbing	0.3	AC	$4,000	$1,341
Concrete (Foundation)	37	CY	$350	$12,963
Riprap	625	TN	$30	$18,750
Quarry Spall	117	TN	$30	$3,500
Streambed Material	83	CY	$60	$5,000

CONCEPTUAL COST ESTIMATE				
ITEM	TOTAL QTY	UNITS	UNIT COST	COST
PZ-35 Sheetpile	10,976	CWT	$93	$1,020,755
Driving Sheetpile	31,320	SF	$8	$250,560
W 12 × 26 Cross Beam	44	CWT	$56	$2,490
W 30 × 116 Pile	779	CWT	$59	$45,949
W 12 × 58 Stringer	112	CWT	$56	$6,272
Driving Piles	22	EA	$575	$12,650
Utility Grating	1,200	SF	$16	$19,560
Handrail	224	LF	$8	$1,792
8 × 8 Tide Gate	4	EA	$30,500	$122,000
8 × 8 Sluice Gate	4	EA	$35,500	$142,000
Concrete Box Culvert	4	EA	$10,320	$41,280
Stoplog Structure	1,000	SF	$160	$160,000
Shrub (4-foot OC)	913	EA	$10	$9,125
Soil Amendment, Compost, 3-inch Depth	135	CY	$30	$4,056
Dewatering	1	LS	$20,000	$20,000
Construction Materials and Labor Cost:				**$1,918,468**
Erosion Control (5%)				$95,923
Contingency (30%)				$575,540
Construction Subtotal:				**$2,589,932**
Mobilization (10%)				$258,993
Sales Tax (8%)				$207,195
Base Construction Cost:				**$3,056,119**
Engineering Design (10%)				$305,612
Environmental Permitting and Mitigation (5%)				$152,806
Construction Survey (LS)				$15,000
Total Cost				**$3,529,537**

6.2.6 MAIN STREET RECONSTRUCTION – TOWN OF BUCODA

The cost of the Main Street project in the town of Bucoda is estimated to be approximately $3.1 million. A summary of the estimated costs is provided in Table 6-6.

Table 6-6
Summary Cost Estimate for the Town of Bucoda Main Street Small Project

CONCEPTUAL COST ESTIMATE				
ITEM	QUANTITY	UNITS	UNIT COST	COST
Excavation	333	CY	$25	$8,333
Cement Concrete Sidewalk	850	SY	$30	$25,500
Gravel Borrow Incl. Haul	8,705	TN	$9	$78,346
Crushed Surfacing Top Course	413	TN	$20	$8,258

Hot Mix Asphalt	540	TN	$80	$43,163
Beam Guardrail Type 31	625	LF	$25	$15,625
Beam Guardrail Flared Terminal	8	EA	$2,000	$16,000
Paved Access	2	EA	$10,000	$20,000
Gravel Access	2	EA	$5,000	$10,000
Driveway Access	12	EA	$2,000	$24,000
Bridge	4,500	SF	$250	$1,125,000
Reinforced Concrete Retaining Wall	863	SF	$75	$64,688
Storm Drainage	1	LS	$100,000	$100,000
Construction Materials and Labor Cost:				**$1,538,914**
Erosion Control (5%)				$76,946
Contingency (30%)				$461,674
Traffic Control (6%)				$92,335
Construction Subtotal:				**$2,169,868**
Mobilization (10%)				$216,987
Sales Tax (8%)				$173,589
Base Construction Cost:				**$2,560,445**
Engineering Design (10%)				$256,044
Environmental Permitting and Mitigation (5%)				$128,022
Construction Survey (LS)				$50,000
Total Cost				**$2,994,511**

6.2.7 MOON ROAD RAISE

A summary of the component and total combined costs for the Moon Road Raise is provided in Table 6-7. The cost for the project is estimated to be approximately $750,000.

Table 6-7
Summary Cost Estimate for the Moon Road Small Project

CONCEPTUAL COST ESTIMATE				
ITEM	**QUANTITY**	**UNITS**	**UNIT COST**	**COST**
Planing Bituminous Pavement	8,959	SY	$10	$89,589
Gravel Borrow Incl. Haul	12,630	TN	$9	$113,666
Crushed Surfacing Top Course	939	TN	$20	$18,784
Hot Mix Asphalt	1,534	TN	$80	$122,724
Centerline Rumble Strip	0.7	MI	$1,500	$1,104
Paved Access	1	EA	$10,000	$10,000
Driveway Access	4	EA	$2,000	$8,000
Construction Materials and Labor Cost:				**$363,868**
Erosion Control (5%)				$18,193
Contingency (30%)				$109,160
Traffic Control (6%)				$21,832
Construction Subtotal:				**$513,053**
Mobilization (10%)				$51,305
Sales Tax (8%)				$41,044
Base Construction Cost:				**$605,403**
Engineering Design (10%)				$60,540
Environmental Permitting and Mitigation (5%)				$30,270
Construction Survey (LS)				$20,000
Total Cost				**$716,214**

6.2.8 BLACK RIVER BRIDGE

A preliminary cost estimate was taken from 2005 WSDOT Feasibility Study. Costs were increased with a Four-percent interest rate applied yearly on the original WSDOT total cost per the WSDOT Feasibility Study recommendation (Table 6-8).

Table 6-8
Summary Cost Estimate for the Black River Bridge Small Project

CONCEPTUAL COST ESTIMATE	
2005 Total Cost	$5,605,000
2014 Total Cost with 4% Inflation	$8,033,811

6.2.9 ROUNDTREE CREEK

The cost of a study to investigate the flooding problems associated with Roundtree Creek is estimated to be $40,000.

6.2.10 WYNOOCHEE VALLEY ROAD RAISE

A summary of the component and total combined costs for the Wynoochee Valley Road Raise is provided in Table 6-9. The total cost is estimated to be $187,000.

Table 6-9
Summary Cost Estimate for the Wynoochee Valley Road Small Project

CONCEPTUAL COST ESTIMATE				
ITEM	**QUANTITY**	**UNITS**	**UNIT COST**	**COST**
Planing Bituminous Pavement	6,700	SY	$10	$67,000
Gravel Borrow Incl. Haul	774	TN	$9	$6,966
Crushed Surfacing Top Course	172	TN	$20	$3,443
Hot Mix Asphalt	106	TN	$80	$8,498
Construction Materials and Labor Cost:				$85,907
Erosion Control (5%)				$4,295
Contingency (30%)				$25,772
Traffic Control (6%)				$5,154
Construction Subtotal:				**$121,129**
Mobilization (10%)				$12,113
Sales Tax (8%)				$9,690
Base Construction Cost:				**$142,933**
Engineering Design (10%)				$14,293
Environmental Permitting and Mitigation (5%)				$7,147
Construction Survey (LS)				$15,000
Total Cost				**$179,372**

6.3 SMALL PROJECT COST COMPARISON

The cost for the suite of 10 small projects is estimated to be approximately $79.1 million. A summary of the cost per project is provided in Table 6-10.

Table 6-10
Summary Cost Estimate for All 10 Small Projects

PROJECT COST (ROUNDED)	
Kirkland Road Study	$40,000
SR6 Flow Bypass and Road Raise	$49.0 Million
Dillenbaugh Creek Realignment	$9.6 Million
Main Street – City of Chehalis	$1.0 Million
Salzer Creek Closure Structure	$3.5 Million
Main Street Reconstruction – Town of Bucoda	$3.0 Million
Moon Road Raise	$716,000
Black River Bridge	$8 Million
Roundtree Creek Study	$40,000
Wynoochee Valley Road Raise	$179,000
Total Cost	**$75.1 Million**

Small Projects Summary, Recommendations, and Next Steps

7 Small Projects Summary, Recommendations, and Next Steps

In developing these recommendations, the Small Projects Team used the results from the prioritization process of all of the 10 small projects and the analysis for conceptual designs, hydraulic modeling, and probable costs for the 10 small projects shown.

7.1 SUMMARY OF 10 SMALL PROJECTS SELECTED FOR CONCEPTUAL DESIGN

- **Kirkland Road Study – City of Napavine**: Study to evaluate options. Estimated study cost approximately $40,000.
- **SR6 Flow Bypass and Road Raise – Lewis County:** Raise SR6 up to 4 feet for approximately 1.5 miles and construct bridges to bypass flows to maintain existing hydraulic conditions. Estimated cost approximately $51.1 million.
- **Dillenbaugh Creek Realignment – City of Chehalis:** Realign lower reach of Dillenbaugh Creek and plug multiple holes to east side of I-5. Estimated cost approximately $10.8 million.
- **Main Street– City of Chehalis:** Construct temporary stoplog structure and culvert flap gate to prevent flooding of Main Street. Estimated cost approximately $1.1 million.
- **Salzer Creek Backwater Control – Lewis County:** Construct backwater control structure and tide gates at I-5. Estimated cost approximately $4.0 million.
- **Main Street Reconstruction – Town of Bucoda:** Raise Main Street and 11th Street and construct bridges to provide access during major flood events. Estimated cost approximately $3.1 million.
- **Moon Road – Chehalis Tribe:** Raise low spots in Moon Road to provide alternative access to tribal facilities during minor flood events. Estimated cost approximately $750,000.
- **Black River Bridge – Chehalis Tribe:** Widen and lengthen US12 bridge. Estimated cost approximately $8 million.
- **Roundtree Creek Study – Chehalis Tribe:** Study to reduce flooding in Roundtree Creek and Harris Creek. Estimated study cost approximately $40,000.
- **Wynoochee Valley Road Raise – Grays Harbor County:** Raise low spot up to 2 feet for approximately 350 feet of road. Estimated cost approximately $187,000.

7.2 RECOMMENDATIONS AND NEXT STEPS

7.2.1 RECOMMENDATIONS

The Small Projects Team recommends considering the following small projects for future funding:

- Kirkland Road Study
- Roundtree Creek Study
- Wynoochee Valley Road Raise
- Dillenbaugh Creek Realignment

Future funding for these projects should be used to collect additional design information, perform additional hydraulic modeling, benefit cost analysis, feasibility studies and progress design. Additionally, coordination with future WSDOT alternatives and discussions with the private rail companies will need to occur to determine whether an agreement can be reached regarding closing or modifications to the rail lines during flood events.

The Small Projects Team also recommends funding the City of Cosmopolis Mill Creek project. The Mill Creek project was previously funded in the 2013–2015 biennium; however, the City returned a portion of its allocated funding with the expectation that the funds that were returned and additional funding would be provided through the Flood Authority for completing this project. The Flood Authority made the decision to reallocate funds to projects in Montesano that were more of an emergency nature, from funds previously allocated to Mill Creek, Satsop River restoration, and a Wishkah Road project.

The team recommends that the conceptual designs, hydraulic modeling, and estimated costs for the 10 projects discussed in the previous chapters be used and considered in the process described below.

7.2.2 NEXT STEPS

Because of the many sources of information about potential small projects that could be funded, and because of continuing interest in finding new projects for consideration, some proposed projects might not be included in the evaluation/ranking process after the initial project list was generated. The Flood Authority decided at its August 21, 2014, meeting that a revised single process should be used for identifying any small projects to be considered for funding in the next biennium. A form was developed and provided to local officials in the Chehalis Basin, the Chehalis Tribe, and state agencies for their use in identifying projects for future consideration. In addition, Flood Authority staff distributed the form directly to past local project contacts. The Flood Authority determined that no small project will be given further consideration for funding in the 2015–2017 biennium unless this form was completed and submitted by September 10, 2014, regardless of what preliminary evaluation has been done on a project.

The following evaluation process will be used for the project descriptions submitted by September 10, 2014:

- The Flood Authority's Project Committee will review and evaluate all projects and will develop recommendations for the Flood Authority's consideration at its September 18, 2014, meeting.
- The Project Committee will evaluate and rank projects between September 10 and September 18, 2014, based on:
    - Numerical scores (tabulated via an evaluation and scoring instrument)
    - Distribution throughout the basin
    - Funds requested versus funds historically available
- The Flood Authority will make a formal recommendation to the Governor's Workgroup in October 2014 on small project funding for the 2015–2017 biennium.

References

WSDOT (Washington State Department of Transportation), November 2005. US 12 Black River Bridge Feasibility Study. Olympia, Washington.

WSE (Watershed Science Engineering), July 2014. Chehalis Basin Strategy: Reducing Flood Damage and Enhancing Aquatic Species – Development and Calibration of Hydraulic Model. Seattle, Washington.

USACE (U.S. Army Corps of Engineers Seattle District). June 2003. Centralia Flood Damage Reduction Project, Final General Reevaluation Report. Seattle, Washington.