December 19, 2012

Dear Interested Party,

Attached please find the final report on the impacts of flooding in the Chehalis River Basin and potential flood hazard mitigation alternatives. The report provides the Washington State Legislature and other decision makers with information to aid decisions that will set a course for effective solutions to reduce the adverse impacts of flooding in the Basin and, at the same time, support the economic prosperity of Basin communities and the protection/restoration of fish populations and other natural resources.

The William D. Ruckelshaus Center, a joint effort of the University of Washington and Washington State University (more information available at www.ruckelshauscenter.edu), developed the report under contract with the Washington State Office of Financial Management (OFM) using technical information provided by state and federal agencies and other organizations.

In 2011, as part of the capital budget (ESHB 2020, Section 1033), the Washington State Legislature required 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 and design work. In response to the Legislative directive, this report compiles existing information on the potential flood hazard mitigation projects that seem of most interest to Basin leaders and decision makers at this time. Potential flood hazard mitigation benefits, adverse impacts, costs and implementation issues are summarized for each project where the information was available.

A draft report was made available for public review and comment from July 16– August 31, 2012. A separate report, The Washington State Department of Transportation (WSDOT) draft *I-5 Protection from 13th Street to Mellen Street near Centralia and Chehalis* report describes I-5 protection options in more detail and was available for public comment from August 17–31, 2012. Forty-nine comment letters or emails were received on the two reports; thirty-six on this report and thirteen on the WSDOT report. Of the 36 comments received on this report, 28 were personal reflections and stories on the impacts of flooding in the Chehalis Basin or brief comments on a preferred flood mitigation alternative. The majority of commenters expressed support for a water retention project on the upper mainstem Chehalis and expressed the opinion that such a facility is needed to provide flood protection for residents in the Basin. Fewer commenters expressed opposition to water retention, and instead advocated for other measures such as prohibiting new development in the floodplain, raising or buying out structures already in the floodplain, improving local government land use management practices, and improving forest practices to provide flood protection. Comments on both reports are included as Appendix E. The WSDOT I-5 alternatives report is included as Appendix F.

In June 2012, local community leaders and representatives of tribal governments met to discuss progress to date in flood hazard mitigation and additional potential flood hazard mitigation projects. One of the primary outcomes of this discussion was an overwhelming sense that policy makers and leaders are interested in a Basin-wide approach for the Chehalis.

In November 2012, a small work group of Chehalis Basin leaders convened by Governor Gregoire recommended a series of actions that, taken together, would represent a significant investment to reduce flood damages in the short term, enhance natural floodplain function and fisheries, and put the Basin on firm footing to make critical decisions about large scale projects. These include investments in (1) large-scale capital projects affecting a broad geographic area like a water retention facility, and/or improvements to protect Interstate 5; (2) smaller-scale capital projects with more localized benefits; (3) environmental projects to enhance overall conditions, aquatic habitat, and abundance of fish in the Basin; (4) land use management to help people already in the floodplain and reduce the potential that new development will increase flood damage; and, (5) an effective system of flood warning and emergency response.

Governor Gregoire endorsed the recommendations from the work group, and recommended $28 million to implement them in her 2013–15 biennium budget proposal to the Washington State Legislature. The Governor's leadership has been noted by many in the Basin as critical to the recent progress to move beyond study to action, protecting people and reducing future flood damage to the communities in the Basin.

Future floods will come; based on their history, the residents of the Basin will pull together to respond as they always have. The question people in the Basin are asking now is whether they and their leaders will build on the work of the last two years to make difficult decisions and invest in Basin-wide flood hazard mitigation for a better future.

Respectfully,

Jim Kramer

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Chehalis Basin Flood Hazard Mitigation Alternatives Report

December 19, 2012

Chehalis Basin Flood Hazard Mitigation Alternatives Report

DECEMBER 19, 2012

Unless otherwise noted, all photos in this report are courtesy of
The Chronicle, Centralia, Washington.

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Executive Summary

Flooding is a common occurrence in the Chehalis River Basin in southwest Washington. In 2007 and 2009, the Basin suffered two major floods only 14 months apart. The 2007 flood was by far the largest on record in the Basin; monetary damages alone topped $900 million. The two large flood events coming so close together extracted an incalculable physical and psychological toll on the Basin's residents. Flooding is a natural occurrence and supports significant ecological functions that benefit people, fish, wildlife, and the ecosystem as a whole. Flooding can also cause disastrous damage to human communities and infrastructure. It is not possible to stop flooding, but it is possible to reduce the negative impacts to human communities.

In 2011, as part of the capital budget (ESHB 2020, Section 1033), 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, state and federal agencies—to recommend priority flood hazard mitigation projects in the Chehalis River Basin for continued feasibility and design work. The purpose of this report is to provide the Washington State Legislature and other decision makers with information to aid their decisions to set the course for effective solutions to reduce the adverse impacts of flooding in the Basin and, at the same time, support the economic prosperity of communities in the Basin and protection/restoration of fish populations and other natural resources.

The William D. Ruckelshaus Center, a joint effort of the University of Washington and Washington State University (more information available at www.ruckelshauscenter.edu), developed the report under contract with OFM using technical information provided by state and federal agencies and other organizations.

Report Contents

In response to the Legislative directive, this report describes the Chehalis Basin, the flooding it has experienced, and work already underway to address flooding impacts. This work includes creation of a hydraulic model for the Chehalis mainstem, land management activities to control building and new fill in the floodplain, flood proofing, home elevation, and buyout programs, livestock and farm evacuation and sanctuary areas, and the early flood warning program.

The Report also describes potential future flood hazard mitigation options and approaches, and provides a series of recommendations for moving forward with flood hazard mitigation developed by Basin leaders.

Over the years many different flood hazard mitigation approaches have been suggested and studied, and individuals in the Basin have developed perspectives about which projects might be the most effective, based both on studies and their personal experiences with flooding. The potential flood hazard mitigation projects summarized in this report were included based on the Legislative requirements and the current focus of interested parties in the Basin. They are predominately oriented around the Twin Cities area because of the extensive work there by the U.S. Army Corps of Engineers (the Corps) and state and local governments over the past several decades. Other areas of the Basin have not been analyzed in as much detail with respect to flood relief, such as the areas downstream of the Twin Cities and upstream on the mainstem, South Fork, Bucoda and Napavine.

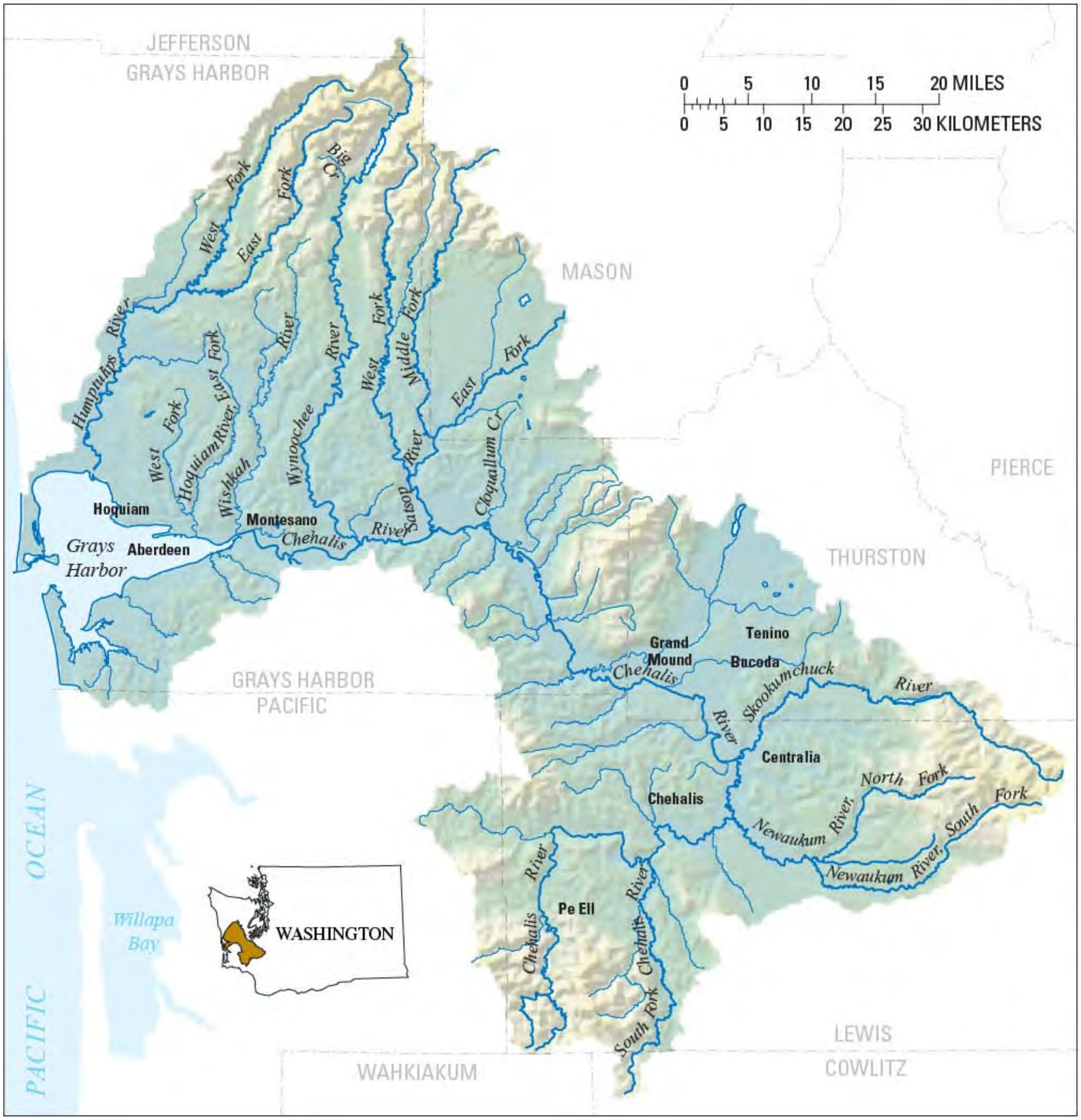
Potential flood hazard mitigation benefits, adverse impacts, costs and implementation issues where available are summarized for each project. Potential projects addressed by this report include:

- A multi-purpose water retention dam on the mainstem Chehalis River located upstream of Pe Ell;
- Improvements to the levee around the Chehalis-Centralia Airport;
- Flood walls and levees to protect Interstate 5 in the Chehalis/Centralia Area;
- Raising/improving the levee system around Centralia and Chehalis, (the Corps “Twin Cities Project”);
- Other potential construction projects and programmatic approaches, such as land use management, flood proofing, home elevations and buyouts, and livestock evacuation and sanctuary areas, and multiple local levee or other flood hazard mitigation construction projects and a number of additional alternatives to protect Interstate 5.

Projects and benefit/cost information are described in Section 3 of the report and, in detail, in the appendices.

In November 2012, a work group of Chehalis Basin leaders convened by Governor Gregoire recommended a series of actions that, taken together, would represent a significant investment to reduce flood damages in the short term, enhance natural floodplain function and fisheries, and put the Basin on firm footing to make critical decisions about large scale projects. These include investments in (1) large-scale capital projects affecting a broad geographic area like a water retention facility, and/or improvements to protect Interstate 5; (2) smaller-scale capital projects with more localized benefits; (3) environmental projects to enhance overall conditions, aquatic habitat, and abundance of fish in the Basin; (4) land use management to help people already in the floodplain and reduce the potential that new development will increase flood damage; and, (5) an effective system of flood warning and emergency response.

Chehalis River Basin



Potential Flood Hazard Mitigation Approaches Addressed in the Report

The report summarizes a number of potential flood hazard mitigation approaches and projects as directed by the Legislation. Basin leaders considered these projects when they developed their recommendations for how to move forward with flood hazard mitigation in the Chehalis.

WATER RETENTION PROJECT ON THE MAINSTEM

One of the main flood hazard mitigation options being considered is the potential for using water retention—a dam—on the Chehalis to control flood waters and mitigate flood damages. A number of locations were considered in the early analysis of potential water retention facilities. Although some residents, especially in the Boistfort valley, would still like to see a water retention project on the South Fork Chehalis, the project site still under consideration in the Basin is upstream of Pe Ell, on the upper mainstem Chehalis River. Two options for the structure are being considered: a flood control-only dam and a multi-purpose dam that could include power generation and water storage to augment summer flows in the mainstem. Either structure would have 80,000 acre-feet of dedicated flood control storage.

The conceptual cost estimate for construction of a flood control-only dam is $165 million; a multi-purpose dam is $245 million. This estimate is based on preliminary information and designs. Potentially significant cost considerations have been raised during studies conducted after the preliminary cost estimates, and in public comment.

In events such as the December 2007 flood, the dam currently under consideration is predicted to lower flood elevations in the upper watershed by six to twelve feet, by three to four feet in the Twin Cities, by two to three feet on the Chehalis Mainstem downstream of the Twin Cities, and by almost 2 feet at Montesano. Different levels of protection would be provided in different types of storm events.

Preliminary studies on a large upstream water retention structure have been done; however, at this time, it is not yet known whether this type of water retention structure is actually feasible. The next steps would be to refine the engineering designs, further study dam safety, and identify more specifically the implications for water quality, quantity, and aquatic species. When this additional information is available, the assessment of the economic benefits weighed against the cost of large upstream water retention will need further refinement.

It is known from the studies done over the last year that there would be environmental impacts, as well as the potential for environmental benefits, from a large upstream water retention structure. It is necessary to determine if the optimum structure is one that would remain open to the river (and to the passage of out migrating salmon) except during flooding, or one holding a permanent reservoir allowing the release of water during summer months with the potential to improve water quality downstream. It is also critical to better understand how and where fish currently use the river and to know what it will take to fully offset any risks to fish and water quality from water retention. Given the potential of large-scale water retention to significantly lower peak flood elevations during major floods and thereby provide Basin-wide flood damage reductions, answering these questions is an essential next step.

A dam would reduce flood elevations throughout the Basin, but it would not eliminate all flooding or fully protect Interstate 5 in all flood events considered. At the north end of the Airport levee, I-5 is lower than the levee. Constructing a dam and raising the airport levee together would not have kept I-5 open during the 2007 flood. In that situation, I-5 would still be under several inches of water north of the airport levee. This water would flow south down to the low point of I-5 at Chamber Way and cover the Interstate there with more than six feet of water. Water also would have been a few inches over I-5 at the SR 6 Interchange during another 2007 flood if a dam were built and the airport levee raised.

Although a dam on the upper Chehalis and raising the airport levee would not have kept I-5 open during the 2007 event, they would significantly reduce the chance of I-5 closing during a major flood. There are many other major flood scenarios (less severe than the 2007 flood) where a dam would provide enough protection to keep I-

5 open when it may have closed without a dam. In addition, a dam would reduce the duration of the closure of I-5 if it were overtopped by flood waters.

In summary, based on the studies to date and a technical workshop held May 21 and 24, 2012, a dam on the Chehalis mainstem would result in the greatest reduction of flooding Basin-wide of any considered project; It also has the highest risk for damage to ecological functions. The monetary calculation of benefits and costs for a dam may change significantly as additional information is developed, resulting in either an increase or decrease in the benefit-cost ratio.

PROTECTION OF I-5 AND THE CHEHALIS-CENTRALIA MUNICIPAL AIRPORT

Consistent with the Legislative requirements, WSDOT evaluated a number of potential projects intended to protect I-5 and the Chehalis-Centralia municipal airport. These included: raising I-5 using fill material, raising I-5 using a viaduct, relocating I-5 outside the flood area, using express lanes or temporary bypass lanes to route transportation around flooding on I-5, and protecting I-5 with walls and levees. The fill, viaduct, and relocation projects had cost estimates ranging from $350 million–$2 billion. The I-5 protection option summarized below would use walls and levees to protect the Interstate. It would involve building earthen levees and structural walls, replacing bridges with bottomless arches at Dillenbaugh and Salzer Creek, and providing stormwater treatment systems. It has a projected cost of $80–100 million. Protection of I-5 and the airport also may provide protection to homes and businesses in some parts of the Twin Cities, and may increase flood elevations in some other parts.

The airport levee part of the project would raise the existing 2.3 miles of earthen levee to an elevation three feet above the adopted 100-year flood level, as recently identified by FEMA. This is accomplished by widening the base of the levee and constructing it higher in a way that maintains existing side slopes. In addition to the improvements to the existing levee, the project would elevate Airport Road along the south side of the Airport and replace all utility infrastructure. The cost estimate for this project is approximately $3.2 million, with the roadway improvements responsible for the majority of the cost.

According to model results, protection of I-5 and the airport may provide protection to homes and businesses in some parts of the Twin Cities and may increase flood elevations in some other parts. Based on a preliminary analysis, in events such as the 2007 flood, it is predicted to completely protect (i.e., make dry) 460 residences and 140 commercial structures and lower flood elevations at 300 more residences and 140 more commercial structures. It is predicted to raise flood elevations by zero to one foot at the Newaukum confluence, Dillenbaugh Creek, and Mellen Street and one to two feet along the Airport levee, which would raise flood levels at a total of 120 residences and 30 commercial structures. Flood elevations downstream are predicted to increase by up to 0.1 feet (2007 and 100-year event) and 0.1 to 0.2 feet (1996 event). Increases in flood elevation that would be caused by the I-5/airport project would need to be addressed through mitigation efforts such as raising buildings, moving buildings, buyouts, and other measures. Impacts to fish and other natural resources have not been fully assessed and will need to be analyzed in more detail and fully mitigated. Cost estimates include funding for flood and natural resource mitigation.

US ARMY CORPS OF ENGINEERS LEVEE SYSTEM AROUND CENTRALIA AND CHEHALIS

In the 1980s, the Corps began to evaluate a plan to build 11 miles of new levees in the Chehalis River floodplain through Chehalis and Centralia. The basic plan was authorized for further analysis by Congress as the Corps of Engineers Centralia Flood Damage Reduction Project (aka the "Twin Cities Project"), but not funded for construction. The project evaluated by the Corps included levees on the Chehalis River, the lower two miles of Dillenbaugh and Salzer Creeks, and the lower Skookumchuck River.

Work on the Corps Twin Cities project was largely stopped in 2011, after it was determined that the proposed project, in the design as currently authorized by Congress, would not have protected I-5 during an adopted 100-year flood event, would have increased flooding upstream and downstream of the Twin Cities and, at a cost of $205 million, would not pass the Corps cost-benefit test. The Corps has issued a draft close-out report for the project that has four options for how to proceed. The Corps could decide to re-frame the project and move forward with individual pieces, or they could re-evaluate the project and conduct additional feasibility study work to determine if a different project approach might provide better benefit to cost ratios. The latter would require a local sponsor; either would require additional funding. Decisions on how the State of Washington will respond to the Corps close-out report will be made after the Legislative decisions for the next biennium.

POTENTIAL FLOOD HAZARD MITIGATION PROJECT COMBINATIONS: LARGE CAPITAL PROJECTS

Because of the complex hydrology and diverse geography and human communities in the Chehalis Basin, no single project can completely alleviate the adverse impacts of flooding. It is likely a combination of projects will be needed to maximize the benefits, address concerns, and resolve implementation issues. Even with combinations of projects, flooding will continue to impact people and property in the Basin. As an example, the proposed dam on the upper mainstem of the Chehalis would reduce flood scope (the “inundation area”) and depth throughout the Basin, but would not completely eliminate flooding in the upper watershed, or reduce flooding enough to reliably prevent overtopping of I-5 under all flood scenarios. Some projects decrease flood elevations in some places, but increase them in others. Some projects cause natural resource or other impacts, and some have the potential to improve natural resources and ecosystem function in some ways.

To show how potential flood hazard mitigation benefits might change if various projects were combined, spark conversation, and illustrate some of the potential trade-offs between large capital projects, the draft report described three example project combinations. Each provided a different mix of potential flood hazard mitigation benefits, potential natural resource risks and impacts, and costs. They were not presented as preferred or recommended options, only as examples. Comments on the project combinations described in the draft report were mixed, and none of the exact combinations described in the draft report are reflected in the recommendations forwarded to the Governor.

OTHER FLOOD HAZARD MITIGATION ALTERNATIVES

In addition to water retention, alternatives to protect I-5 and the municipal airport, and the Corps Twin Cities project, numerous other alternatives have been discussed that could provide flood relief and protection in the Chehalis Basin. These 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 floodplain function and storage. These projects are described in Appendix A, including, to the extent information is available, descriptions of their potential benefits, adverse impacts, costs and implementation issues.

The report describes an approach that relied on leveraging local projects to remove key obstructions in the floodplain and using programmatic changes to address potential future flood damages. Such an approach could include addressing culverts, bridges that cause localized flooding, prohibiting new development in the flood plain, raising or buying out structures already in the flood plain, improving other land use management practices, and improving forest practices to incentivize longer logging rotations. It also might include completing smaller construction projects in localized areas such as the Bucoda levee, and the Centralia-Chehalis Airport levee, protecting livestock and farm investment with farm/critter pads, and ensuring effective detour routes around I-5 to accommodate periodic closures during flooding. This kind of approach could be implemented and funded over time, throughout the Basin. The scope of such an approach, as well as the associated flood hazard reduction benefits and costs, have not, to date, been evaluated.

Looking Forward: A Basin Wide Approach

There is a long history of floods and studies in the Chehalis Basin. People in the Basin along with local, state, federal and tribal governments have been very successful in the immediate response and clean up of floods, and have initiated a number of actions to reduce flood damages in the future. There have been significant improvements in the flood warning system and understanding of how different storms affect flooding in the Basin as well as what different projects and programs can do to reduce flood damage. Local actions such as elevating homes, improving land use management and creating evacuation routes for livestock have been taken and continue. Community leaders and other interested parties see that now is the time to make decisions on next steps for the major structural flood hazard mitigation projects and any significant changes to programs that would more dramatically reduce future flood damage. They hope the 2013 Legislature will make decisions on funding for priority projects and programs that build on local actions.

In June 2012, local community leaders and representatives of tribal governments met to discuss progress to date in flood hazard mitigation and additional potential flood hazard mitigation projects. One of the primary outcomes of this discussion was an overwhelming sense that policy makers and leaders are interested in a Basin-wide approach for the Chehalis. Hallmarks of a Basin-wide approach include:

- Maximize benefits from flood damage reduction projects and minimize negative impacts throughout the Basin.
- Work for everyone in the Basin and not shift impacts from one community to another.
- Include a combination and sequence of projects in different places to address different aspects of the flooding; there are different perspectives on what combinations and sequences of projects are most appropriate.
- Include continued progress on many of the programmatic actions such as land use management.
- Protect and where possible restore floodplain function, while acknowledging and working with historical development within the floodplain.
- Do more than simply protect I-5; communities and people beyond the Interstate must be helped too.

A BASIN-LED PROCESS TO DEVELOP RECOMMENDATIONS

In August 2012, as a follow up to the draft report, and in recognition that a time for decision making has come, the Governor tasked a work group—David Burnett (Chehalis Tribe Chairman), Vickie Raines (Cosmopolis Mayor and Chehalis Flood Authority Chair), Karen Valenzuela (Thurston County Commissioner and Chehalis Flood Authority Vice Chair), J. Vander Stoep (private attorney and Chehalis Flood Authority Pe Ell Alternate), Jay Gordon (Farmer in lower Chehalis Basin and Washington Dairy Federation President) and Keith Phillips (Policy Advisor to Governor Gregoire)—to develop recommendations for flood damage reduction projects. The group was asked to develop recommendations that other Basin leaders and the Governor could consider for endorsement and action. Each member also was asked to interact with his/her respective constituents to inform the small group's discussions.

The group set out to make recommendations consistent with a Basin-wide approach to flood damage reduction. They believe a successful Basin-wide approach will maximize benefits and avoid or minimize adverse human and environmental impacts of flood damage reduction actions. It will protect key community infrastructure and maintain public services during emergencies. It will not solve one community's flooding problems by making another community's problems worse.

The group recognized that a Basin-wide approach to flood damage reduction must go hand in hand with improvements in the environmental health and resiliency of the Basin. Flood damage reduction projects must avoid or fully mitigate environmental impacts. Floodplains, water, and shorelines must be managed in ways that reduce future flood damage and enhance overall environmental conditions and habitat for aquatic species. Fish mitigation and enhancement projects must be implemented in concert with flood damage reduction projects. It is critical that harvestable resources of the basin are increased as flood damage is reduced.

The group also acknowledged that even with efforts to reduce flood damages, flooding is a natural occurrence and will continue to occur. Communities need to be as prepared as possible with flood warning and emergency response systems. Future development in the Basin should not put more people or development in harm's way, and should not increase damages or costs to people already living in and using the floodplain. By planning ahead, respecting what the river can do, and managing floodplains intelligently, Basin communities can reduce the risks from future floods.

RECOMMENDED ACTIONS

The work group recommended a five-part strategy for the 2013–2015 budget cycle based on a common understanding of how floods affect the Basin. The recommendations call for real improvements through implementation of a series of known smaller-scale projects and investments to reduce flood damage, and completion of the analysis needed for decisions about the best mix of additional large- and small-scale projects to significantly reduce flood damages in the future.

1. Finish the analysis necessary to determine the best option for large-scale capital projects that could significantly reduce flood damages across a large geographic area, and make a decision by December 2014 whether to move into project permitting. The large capital projects under consideration include upstream water retention and I-5 improvements. The analyses needed to support feasibility assessments for large-scale projects have many collateral benefits in the Basin, including benefits to the other work areas recommended by the work group.
2. Design and construct local projects that will provide immediate flood damage reduction including the protection of critical infrastructure, wellheads, wastewater treatment plants, roads, homes, and businesses. Concurrent with these projects, develop and implement a long-term strategy for localized flood damage reduction actions. With or without large-scale water retention, local projects will be needed to protect key infrastructure, control shoreline erosion, and improve water conveyance and drainage at key points in the Basin. A program of smaller projects aimed at protecting key infrastructure and priority areas through the Basin may provide a measureable reduction in damages from major floods. As the evaluations of large-scale water retention and I-5 protection alternatives are completed, the benefits from a combination of smaller projects across the Basin also should be explored, and we should continue to construct projects that provide near-term local flood damage reduction benefits. Further analysis of such a program will help determine how much damage reduction is possible, at what cost, and provide additional context for considering large-scale projects.
3. Implement projects that improve fish habitat and populations and floodplain functions in the Basin. Concurrent with initial projects, develop and implement a coordinated long-term strategy with goals and objectives for improving ecological function, aquatic habitat and abundance of fish in the Basin in conjunction with flood damage reduction actions. Appropriate management of floodplains, water, and shorelines can and must play a role in flood damage reduction, and must enhance the overall

environmental conditions and habitat for aquatic species, particularly salmon, in the Basin. It is critical that harvestable resources of the Basin are increased as flood damage is reduced.

4. Reduce the cost of repetitive damage to residences in the floodplain through a strategic program of buyouts and flood proofing, and encourage a comprehensive effort to prevent new development in the Basin from increasing flood damages. Progress on floodplain management policies and programs has been made, though additional improvements are both needed and possible. Further enhancements to state and local land use policies will help ensure new development and other land management activities do not increase the risk of additional flood-related damages and, to the extent possible, reduce damages and costs to existing development affected by flooding. It will also be important to continuously improve the information base and tools needed to understand flood impacts and to optimize actions to reduce flood damage while improving the environmental health of the Basin.
5. Ensure flood warning and flood preparedness systems remain ready and effective for the public and emergency responders.

There are differences of opinion amongst leaders in the Basin about the right balance for investment in each of the five categories of action, but there is broad agreement that some investment is needed in each category to substantially reduce flood damage. There also is agreement that it is possible to act now with certainty to implement some actions; other actions, including large-scale capital projects, need more feasibility analysis before decisions about the best way to proceed can be made.

The Governor's work group recognized that support would be needed for continued project management, technical work, and policy decisions to refine and implement a Basin-wide approach and coordinate capital investment.

The group recommended that the next Governor appoint a policy task force in spring 2013 to oversee initial implementation of this framework and make future recommendations to the Governor and Legislature about the feasibility of a water retention structure, preferred alternative for I-5, and next expenditures needed to continue implementation of the framework beyond 2015. They recommend that the Flood Authority should continue to serve as a sounding board, oversee implementation of the local capital projects funded in the 2013–15 biennium, and recommend local capital projects for the 2015–17 biennium. The Flood Authority should also oversee the strategy for reducing repetitive flood loss and land use management, evaluate a suite of local flood damage reduction projects, and implement and maintain the flood warning system. Finally, they recommended a technical steering committee should be convened to oversee the ecosystem enhancement and fish studies and dam scoping work, and make recommendations to the policy task force as necessary.

The group's recommendations were endorsed by the Chehalis Flood Authority.

Governor Gregoire also endorsed the recommendations of the work group. She included $28 million in her recommended 2013–2015 state capital budget to move forward with the recommended work.

Conclusion

The Chehalis Basin is poised to take important actions to invest in flood hazard mitigation now and for the future. Recent progress has been made in understanding the potential benefits, impacts, and costs of flood hazard mitigation project options, and creating a shared set of ideas about how to go about flood hazard mitigation and what a Basin-wide approach would mean.

The state is set for future decision making. Over the next two years significant investment will continue to be needed in actions to mitigate future flood hazards in the Chehalis Basin, improve natural resource function and conditions for fish populations, complete the assessments and studies needed to make decisions about which (if any) large-scale projects to move forward into permitting, and support collaboration and governance in the Basin. No single project, or even set of projects, will ever completely eliminate flooding in the Chehalis Basin, but the path is now clear for steps to be taken to significantly reduce the damages flooding visits on people and communities throughout the Basin now and in the future.

Introduction

Flooding is a common occurrence throughout the Chehalis River Basin. Accounts of flooding along the Chehalis, Newaukum, and Skookumchuck rivers, from Pe Ell and Boistfort to Centralia, Elma, Montesano, and Aberdeen have been documented since the time pioneers first settled in Lewis County, and before that by the area's indigenous tribes and nations. Basin residents are practiced at living with flooding and, in many ways, have done so successfully for many years.

"Since the 2007 flood our community in the upper watershed has not been the same, there is a sense of fear that it would happen again. Every time it rains hard, the fear comes back."

Basin resident

According to accounts since the 1930s, minor flooding generally occurs every 2 to 5 years, and major flooding roughly every 10 years. Yet, in 2007 and 2009 the Chehalis Basin was hit with two catastrophic floods only 14 months apart. The 2007 and 2009 floods affected all areas of the Basin, destroying homes and farms, killing livestock, and inundating businesses and infrastructure. Families took refuge on rooftops to await rescue. Interstate 5 was closed for days. Monetary damages from the 2007 flood alone topped $900 million.

Beyond the financial costs, the flooding extracted a physical and psychological toll on residents that is impossible to measure. As one long term resident said, "Since the 2007 flood our community in the upper watershed has not been the same, there is a sense of fear that it would happen again. Every time it rains hard, the fear comes back."

It is clear that actions are needed to better protect people and their livelihoods in the Basin. Many people in the Basin have expressed the need to break the cycle of flood, study, inaction, flood again. They want durable action, and they want it soon. As one resident expressed, "Do something, do it soon, and do it well."

The great success pointed to by many in the Chehalis Basin is the way that neighbors and governments pulled together to respond during the flood emergencies in 2007 and 2009, and then to cleanup and rebuild. Many now fear that the great tragedy will be if the Basin as a whole cannot band together behind priority flood hazard mitigation projects, with support from the region and state.

Future floods will come; based on their history, the residents of the Basin will work together to respond as they always have. The question people in the Basin are asking now is whether they and their leaders also can work together to make difficult decisions about how best to invest in Basin-wide flood hazard mitigation for a better future.

"The extraordinary outpouring [in 2007] of money, time and support from total strangers still chokes me up. I think they and the community fed off each other. We kept working because they were helping and they kept coming because I think they knew they were making a real difference in helping people help themselves."

Dave Fenn, Boistfort Valley Farmer

Goals for This Report

In 2011, as part of the capital budget (ESHB 2020, Section 1033) the Washington State Legislature required the Washington State 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 and design work.

The William D. Ruckelshaus Center, a joint effort of the University of Washington and Washington State University (more information available at www.ruckelshauscenter.edu), is under contract with the OFM to develop the report. The Ruckelshaus Center compiled and synthesized the available information on flooding and flood hazard mitigation alternatives in the Chehalis River Basin for this report; it did not provide additional technical evaluation or information.

In response to the charge from the Legislature, this report:

- Addresses the potential for flood hazard mitigation through upstream water retention facilities, including benefits and impacts to fish and potential mitigation of impacts;
- Describes the current alignment and design of federal flood levees proposed at Centralia and Chehalis, including the extent of protection provided to these communities, and any upstream or downstream effects of the levees;
- Evaluates alternative projects that could protect the interstate highway and the municipal airport at Centralia and Chehalis, and ensure access to medical and other critical community facilities during flood events;
- Discusses other alternatives that could provide flood relief and protection in the Basin, such as replacement of highway bridges that constrain floodwaters, flood easements on agricultural lands, livestock evacuation facilities and routes, small-scale water diversion and retention, use of riparian

habitat and environmental restoration projects to mitigate damage from floodwaters, and other projects or programs;

- Summarizes the benefits and costs of recommended projects, using available information and accepted benefit/cost methods; and,
- Identifies the responsible parties and procedures for making final decisions on funding, construction, and governance of recommended flood projects, any related and necessary government agreements, and a schedule for these decisions.

In response to the Legislative direction, this report is focused mostly on capital projects that can reduce flood damage. Although there are flooding issues throughout the Basin, there is more information about projects in the Twin Cities area due to the intensive study of flooding in that area over the past several decades. In addition fulfilling the Legislative requirements the report is intended to provide the human face of the flooding story, and to reflect the sense of history and place of the Chehalis River Basin.

"The visual is nothing like I've ever seen other than my recollection of Mount St. Helens"

Governor Christine Gregoire

This report is intended to provide the Legislature and other decision makers with information to make decisions that set a course for effective solutions to reduce the adverse impacts of flooding and support the economic prosperity of the communities in the Basin, fish, and other natural resources. It summarizes current information on the potential flood hazard mitigation projects that are of most interest in the Basin and to meet the requirements from the Legislature, and summarizes recommendations for priority flood hazard mitigation projects.

Governor Chris Gregoire speaks with Kathy Roberts after the flood of 2007 forced Ms. Roberts to leave her home for the shelter.

Public Review of Draft Report

A draft report was made available for public review and comment from July 16–August 31, 2012. Thirty-six comment letters or emails were received on the draft report. Of the 36 comments received, 28 were personal reflections and stories on the impacts of flooding in the Chehalis Basin or brief comments on a preferred flood mitigation alternative. The majority of commenters expressed support for a water retention project on the upper mainstem Chehalis and expressed the opinion that such a facility is needed to provide flood protection for residents in the Basin. Fewer commenters expressed opposition to a dam, and instead advocated for other measures such as prohibiting new development in the floodplain, raising or buying out structures already in the floodplain, improving local government land use management practices, and improving forest practices to provide flood protection.

A separate draft report, The Washington State Department of Transportation (WSDOT) draft *I-5 Protection from 13th Street to Mellen Street near Centralia and Chehalis* report describes I-5 protection options in more detail and was available for public comment from August 17–31, 2012. An additional thirteen comment letters or emails were received on the WSDOT I-5 alternatives report. Comments on the WSDOT I-5 alternatives report stressed the need to consider I-5 protection only as part of a larger effort to provide Basin-wide protection to people and communities, and expressed concern over potential impacts on quality of life and property values from express lane and temporary bypass options.

Comments on both reports are included as Appendix E. The WSDOT I-5 alternatives report is included as Appendix F.

February 1996 Flood Event

The February 1996 flood was the result of a large frontal storm with very broad rainfall from north of Seattle to southern Oregon. It had been extremely cold in the month prior to the storm, and there may have been some low-elevation snow accumulations. The 24-hour rainfall totals ranged from the 10+ year to 100+ year recurrence. At the time, it was the highest flood discharge for all major drainages in the Centralia/Chehalis valley, until the 2007 flood event.

The resulting flood was:

- **Largest observed in the historic record on the Skookumchuck River (71 years) and Newaukum River (71 years)**
- **Second largest observed in the historic record at Grand Mound (82 years), Porter (63 years), and Doty (71 years)**
- **Fourth largest observed in the historic record on the South Fork Chehalis (71 years)**

The total damage costs associated with the February 1996 event are up to $100 million:

- **Major flooding occurred in Grays Harbor, Lewis, and Thurston Counties**
- **Within the Urban Growth Areas of Centralia and Chehalis, 4,855 acres (or 33%) were inundated**
- **Interstate 5 was flooded and closed for four days**
- **75% of the Chehalis Reservation was covered in water, with measured flood depths up to 10'. Access routes including Howanut Road, Anderson Road, and Moon Road were under 1'-4' of fast-moving water, and U.S. Highway 12 was flooded.**

Navigating the Report

The rest of this report is divided into four sections. Section 1 gives a brief overview of the history of flooding in the Chehalis Basin, the different types of floods that are experienced, and types of flood damages. Section 2 describes the Basin. Section 3 describes current and potential future projects and programs to respond to flooding, flood hazard mitigation alternatives, and detailed responses to the six elements required by the Legislature. Section 4 describes conclusions, recommendations, and next steps.

CA provides details of the potential flood hazard mitigation benefits, adverse impacts, and implementation considerations for each flood hazard mitigation alternative under consideration. Appendix B is the final recommendations and framework from the Governor's work group. Appendix C is a description of potential project combinations that were included in the draft report. Appendix D is a compilation of individual stories and reflections on flooding and flood impacts shared by residents of the Basin. Appendix E is a summary of comments and responses on the draft report. Appendix F is the WSDOT report on alternatives to protection I-5 from flooding. Appendix G is a draft report from the Washington Department of Natural Resources (DNR) on forest practices in the Chehalis Basin, comments on the report, and information about the ongoing scientific debate about the contribution (if any) of forest practices to flooding. Appendix H is a report from the University of Washington Benefit-Cost Analysis Center, evaluating the benefit/cost information available for potential flood hazard mitigation projects in the Chehalis Basin. Appendix I summarizes information provided by Washington State Department of Fish and Wildlife on salmon returns in the Chehalis Basin. Appendix J is a draft report from WATERSHED Science & Engineering (WSE) on the Chehalis Basin Hydraulic Model. Appendix K is a bibliography of the information sources used in preparation of this Report.

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Section 1: The Problem

FLOOD STORY:
Dave Fenn - Boistfort Valley Farmer

My point is there was, and continues to this day, an extraordinary sense of community here. That was proven by the events following the flood and was true also in the Pe Ell, Doty area. By the way, "the flood" now means 2007. There was a community plan in place to respond to an emergency and it worked. The mobilizing of people to help each other was amazing. And then the outside help that arrived kept the locals going through to the end. An example of spontaneous help involved my daughter's family. They live on Ceres Hill Rd. near the confluence of the two forks. I called at daylight to tell them it looked as though the River would be higher than it had ever been and they needed to take their cars and tractor to the hill. They only had time to get to the car, stop and get the 80 something neighbor lady and drive up the hill. A neighbor on the hill took them in for several days, until they were able to clean the house enough to move back in the upstairs.

Dave Fenn (left) buys strawberries from his neighbor, farmer Mike Peroni. Photo by Joshua McNichols.

Then the outside help started arriving. Through donations and locals that had not been flooded, the Grange fed helpers and affected people for months. The Mormon Church sent hundreds, if not thousands, to the area to do the initial cleanup. Then churches and other organizations came for months to assist. The Mennonites had members come from as far as Vanderhoff, B.C. and New York state There were donations from everywhere to help rebuild. I had a church member from Tacoma tell of going to New Orleans to help rebuild and he was stunned by the difference between here and there. In New Orleans they were sitting and waiting for help. Here, everyone immediately had started helping each other begin the rebuilding process.

Even though there is a great sense of community and self reliance here and a heartwarming reaffirmation of the basic sense of human decency from the volunteer help, the flood has had serious consequences on the psyche and economics of the area. Several homes were removed, not to be rebuilt. Some good families moved away. There are potential serious restrictions on a number of homes and farms that may have long term effects on their use and value. Besides the money, people have spent untold hours dealing with cleanup and plans for the future. Flooding is a weight on the shoulders of the community.

1: The Problem

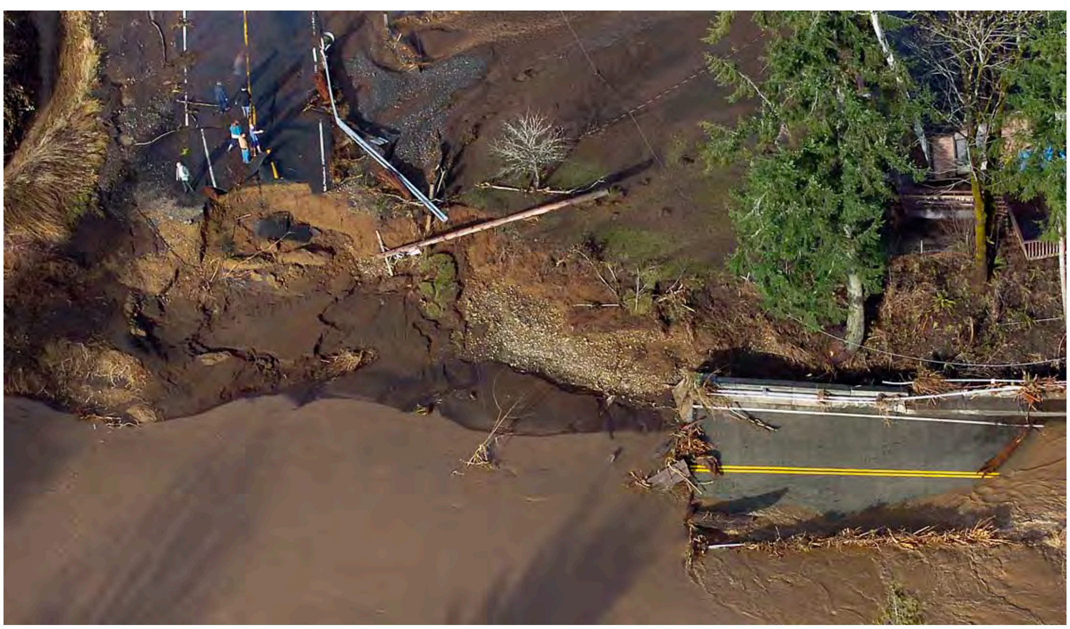
Floods are the most destructive natural hazard in the U.S., causing more deaths and financial loss in the 20th century than any other natural disaster. In the past 30 years, major flood events have occurred on the Chehalis River and its tributaries in Lewis, Thurston, and Grays Harbor Counties, and in the Chehalis Reservation in 1972, 1975, 1986, 1990, 1996, 2007, and 2009. The recent 1996, 2007, and 2009 floods caused extensive damage to private property, public buildings, roads, and bridges. Each of the recent floods closed Interstate 5 for days.

"We're very interested in moving ahead. There are a lot of people hurting. We have studied the issue to death."

Ron Averill, Lewis County Commissioner

Flooding in the Chehalis typically occurs during the fall and early winter months, with recent major flooding occurring in February 1996, December 2007, and January 2009. These three floods were among the largest on record, with peak annual flows that rank in the top five at U.S. Geological Survey (USGS) stream gages at the Chehalis River near Grand Mound, Newaukum River near Chehalis, and South Fork of the Chehalis. The gauge on the Chehalis River near Grand Mound shows that the five largest peak flows in the past 85 years, all of which exceeded 50,000 cubic feet per second (cfs), have occurred since 1986 (December 2007, February 1996, January 1990, November 1986, and January 2009). Significant widespread flooding and damage were associated with each of these events. These data support the perception that flooding has become worse in recent years. With the inclusion of the recent flood data in the historic record, the 100-year flood at the USGS gage at Grand Mound is now estimated to be 77,800 cubic feet per second (cfs). That is 39% higher than the 100-year flood estimate of 56,000 cfs calculated in 1982.

For the people and communities of the Basin, the cumulative psychological and financial impacts of flooding have been tremendous. They are eager to move beyond studies and find a long-term solution to flooding.



Flood Causes and Variability

Flooding in the Chehalis Basin is typically the result of heavy rain events, and, to a lesser degree, rain-on-snow events. The largest floods in western Washington are caused by intense precipitation due to atmospheric rivers or the so-called "Pineapple Express." Atmospheric rivers are generally characterized by relatively narrow bands of concentrated warm, low-level water vapor that produces large amounts of rain when they encounter mountain ranges.

In the Chehalis Basin, the track of an atmospheric river is an important factor in determining the extent and magnitude of floods. When storms are widespread over the Basin, they cause widespread flooding. When storms center over the Willapa Hills, they cause flooding in the upper Chehalis and, as the water moves downstream, throughout the Basin. When storms are centered over the Black Hills and Cascade foothills, they can cause flooding in the Skookumchuck and Newaukum Rivers and locally near the confluence of these rivers with the Chehalis in the Centralia/Chehalis area; however, they generally do not cause major flooding downstream on the Chehalis. Storms over the southern Olympics in the Satsop and Wynoochee Basins can cause flooding in the lower Chehalis, without having much effect in the upper Basin. Any riverine flood event can be exacerbated by high tides and tidal storm surges at the Grays Harbor estuary, affecting the coastal cities of Aberdeen, Hoquiam, and Cosmopolis. Tidal flooding also can occur in the absence of any significant river flows.

In addition to storm intensity and location, the Chehalis River Basin Comprehensive Flood Hazard Management Plan notes multiple factors that determine the extent and severity of flood damage in the Basin. These include:

- *Time of year*: Flooding in the Basin typically occurs during the fall and early winter months, with recent major flooding occurring between November and March.
- *Flood magnitude and duration*: The severity of floods varies depending on type, spatial extent, and duration of storms. The 1996, 2007 and 2009 flood events in the upper Basin occurred in a timeframe of a week or less, and the duration of flooding is influenced by soil saturation and other conditions prior to the storm event, as well as the length of the storm event itself.
- *Sediment transport and deposition*: Increased sediment loads due to flooding can result in deposition within active channels, and landslides that block channels and divert flow.
- *Land use/development*: Forestry operations, agriculture production, impervious surfaces, loss of vegetation, and structures and fill in the floodplain can all contribute to higher volumes and peak flows during floods.
- *Obstructions in the channel*: Obstructions include structures such as levees, bridges, and roads, as well as natural obstructions of debris formed during a particular flood event.

Forest practices in the upper portions of the watershed are perceived y some to create or exacerbate floods and flood damage. Some Basin residents speculate that short rotation times for harvest, clear cut practices, and harvest and road building on steep slopes leave an immature forest that is more susceptible to rain on snow events and landslides. These issues are addressed by the Washington State Forest Practices Act, but there is debate as to its success in addressing the issues and there is limited data on the status of the forests in the Chehalis Basin.

Land use management by local cities and counties has been criticized for allowing more development in the floodplain, increasing the number of homes and businesses at risk and worsening the flood damage on existing homes and businesses. Historically, many of the cities and towns as well as major infrastructure like I-5 were built in the floodplain in the Chehalis, similar to other communities in the Northwest. Except for infill in the cities and towns, new development in the floodplain has largely stopped based on development records and changes to local land use regulations. Under the current regulations in counties and cities in the Basin, there is not expected to be any significant new development of homes and business in the floodplain that would create measurable increases in flood damage.

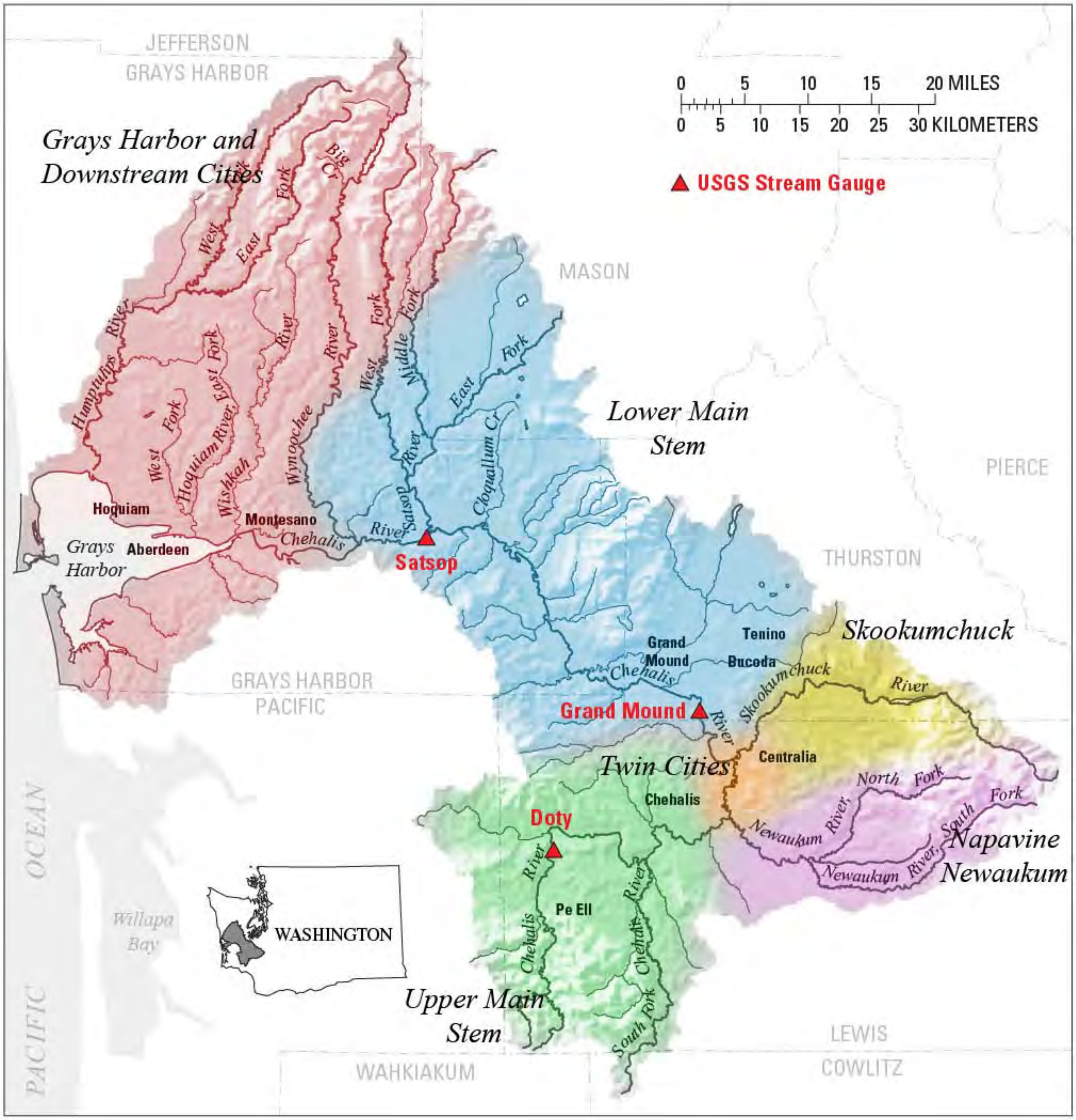
In an effort to further understand the variability of Chehalis River floods, WSE analyzed data from the top ten annual peaks at the USGS Grand Mound gage (just downstream of Centralia and Chehalis) and the corresponding peaks at major upstream USGS gages, including the South Fork of the Chehalis River at Doty, the Newaukum River, and the Skookumchuck River at Bucoda. A key finding of this analysis is that extreme flood events near Grand Mound are always accompanied by high flows in the Chehalis River headwaters above Doty.[1] WSE made the following observations:

1. A large flow on the Chehalis at Grand Mound has never been observed without a correspondingly large flow upstream on the Chehalis River at Doty.
2. A large flow at Doty is a reliable (although not perfect) indicator of a large flow downstream at Grand Mound.
3. A large flow on the Chehalis at Grand Mound can happen with or without a significant flow contribution from the Skookumchuck River. A large flow on the Skookumchuck is not a very good indicator of large flows downstream at Grand Mound.
4. Peak flows on the Newaukum River and South Fork Chehalis are similarly correlated to the downstream flows at Grand Mound; less so than the Doty flows but more so than the Skookumchuck flows.
5. Major flood events can be isolated on a single tributary or set of tributaries, and not affect the whole Basin. For example, the 1997 flood on the Satsop was the highest flood on record there, but did not cause major flooding anywhere else in the Basin.

To evaluate the efficacy of alternatives against the range of floods observed in the Chehalis Basin, the hydraulic modeling and analysis looked at four flood scenarios: the 1996 event, the 2007 event, the 2009 event, and a hypothetical 100-year flood. Each of these events was focused on a different part of the Basin, so they offer a wide range of conditions for evaluation of flood hazard mitigation alternatives.

[1] Of the top ten flood events in the past 80 years, two occurred in the 1930s when none of the other major USGS gages in the Basin were in operation.

Chehalis River Basin and Communities



December 2007 Flood Event

The December 2007 flood was the result of a classic atmospheric river (or Pineapple Express) event, characterized by heavy rainfall within a fairly narrow focus. The highest rainfall concentrations were in the Willapa Hills in the upper Chehalis Basin, which set records for 24-hour precipitation; the heaviest level of precipitation was concentrated in a span of 12 hours or less.

The resulting flood was:

- Largest observed in the historic record at Grand Mound (82 years), Porter (63 years), Doty (71 years), and the South Fork Chehalis (71 years).
- Third largest observed in the historic record on the Newaukum River (71 years).
- Only the 55th largest observed in the historic record on the Skookumchuck River.

The total damage costs associated with the December 2007 event are up to $900 million:

- Major flooding occurred in Grays Harbor, Lewis, and Thurston Counties .
- Damage from the flood had a disproportionate effect on the upper Basin.
- Within the Urban Growth Areas of Centralia and Chehalis, 3,708 acres (or 25%) were inundated.
- In the unincorporated areas of Lewis County, from Pe Ell to Adna, 10,702 acres (or 47%) of the total 22,919 acres zoned agricultural were flooded.
- Interstate 5 was covered by over 12’ of water in some locations, and was closed for four days.
- Homes in the central area of the Chehalis Reservation were inundated with up to 4’ of water. At the east end of the Reservation, water overtopped Anderson Road, and up to 2’ of water overtopped US Highway 12, and flowed into the Black River. At the west end of the Reservation, portions of Balch Road were damaged and the east approach to the Sickman-Ford Bridge was overtopped and damaged. Southeast of the Reservation, Independence Road was overtopped.
- Tremendous amounts of debris and logged timber flowed down from the South Fork and Mainstem Chehalis River.
- The Skookumchuck Dam was drawn down at the time of the flood, leaving the reservoir with more available storage than it would typically have. This may have played a role in reducing flood peaks downstream.

Flood Impacts

Flooding of the Chehalis River causes many impacts, including losses to homeowners and businesses, water pollution from storm runoff and sedimentation, agricultural losses, and damage to public infrastructure.

“You’re out there with people you’ve worked with for 20 years, and you see their livelihood gone.”

Lyle Heimbigner, USDA Grays Harbor-Lewis Farm Service Agency

PEOPLE AND HOMES

Millions of dollars in property damage has occurred due to flooding in the Chehalis Basin. Floods have caused countless residents to become trapped in their homes, destroyed sewer and drainage systems, contaminated drinking water supplies, and forced people to evacuate their homes, leaving personal belongings and sentimental possessions to be destroyed. The work needed to rebuild and treat homes damaged by flooding is costly, and the psychological damage to individuals and their families can take years to heal.

"[I remember] the longest night of one's life—working in the dark and the rain to save our animals, equipment and supplies while yelling "Get back in the house!!" to our three small children who 'wanted to help', standing knee deep in our carport, separated from us by 50 yards of rapidly rising flood water; checking the water level every 20-30 minutes until it reached its peak around 3:00 a.m. The pain and sorrow of friends and family—some who lost just a little, and some who lost almost everything, including the desire to go on. The disheartening sights and sounds—helicopters flying back and forth throughout the night rescuing those who were stranded on their rooftops; livestock and pets crying, frantically trying to escape the flood waters."

Julie Balmelli-Powe, Twin Cities resident

"There have been some where people get too hopeless and helpless and the pain of the moment overwhelms them. A lot of times, they're just fatigued, and they're so tired they can't see hope."

Tony Fielder, Red Cross Volunteer

FARMS/AGRICULTURAL LANDS/LIVESTOCK

Flooding and landslides in the Chehalis Basin have led to erosion that has damaged significant amounts of agricultural land. For example, silt and wood debris carried downstream in the 2007 flood was estimated to have affected 4,776 acres of agricultural land, with cleanup costs of over $2.3 million. Other impacts to farms and agricultural lands include lost, injured, or killed livestock, damage to fences, and damage to farm equipment such as loaders and tractors. The Lewis County Health Department counted a total of 1,600 commercial livestock, including 400 dairy cows that were lost in the 2007 flood in Lewis County. Close to $5 million of farm equipment was also damaged in the 2007 flood.

"Tragic stories still haunt us like the farmer who shot his whole bloodline of hand raised registered cattle, that after chasing them up on a hill, had followed him back to the barn where they had always felt safe—to him, shooting them was more merciful than watching them drown; sheep and cows stranded in barns, crawling on top of one another trying to stay above the water, some piles of dead animals reaching as high as the rafters, occasionally a bitter sweet ending with the animal on top surviving."

Julie Balmelli-Powe, Twin Cities resident

BUSINESS

Many businesses have suffered extensive damage to their property and equipment due to flooding, in addition to lost revenue during and after flooding. For some businesses, even if floods did not impact them directly, they may have to support employees who cannot come to work or local suppliers unable to meet their needs. More than 200 businesses were flooded in the 2007 flood. Many of these businesses were not aware of the potential severity of the 2007 flood, and did not have flood insurance, even if they had been flooded previously. The total business costs from the 2007 flood were estimated to be $45 million.

"It completely shut us down."

Darrel Sorenson, President and CEO of Sorensen's Transport Company based out of Chehalis. He estimated $1.5 million in losses from water damage due the overtopped Airport Dike in the 2007 flood, including loss of 12 tractors and a large amount of refrigerated goods.

TRANSPORTATION

Several bridges and other transportation infrastructure exist in the Chehalis Basin that have been impacted by flooding. In the upper Basin, there are at least 21 bridge crossings, and in the lower Basin, there are a similar number of crossings. The Sickman-Ford Bridge on the Chehalis Reservation and associated approaches in the Basin reduce the floodplain width, which results in a backwater condition during high flows. Road damage in the 2007 flood included $4.5 million worth to I-5 and State Route (SR) 6, and an additional $1.5

"Well, 12 years ago we had a flood, and it was 44 inches of water. This year [2007] it's about 78 or 80 inches."

Darris McDaniel, owner of Shop 'n Kart in Chehalis.

million to other Lewis County roads including SR 7 and U.S. Highway 12. The flood also damaged many logging roads, rail and air infrastructure, the Curtis Industrial Park rail line, railroad bridges, and culverts between the Port of Chehalis and Pe Ell.

INTERSTATE 5

Flooding in the Chehalis Basin has impacted access to Interstate 5, closing it for four days in 1996, four days in 2007, and two days in 2009. WSDOT estimated the total cost of freight delays along I-5 in 2007 at $47 million. This figure includes estimates of freight-related business losses and associated reductions in economic output, as well as an estimate of statewide economic impact, such as employment, personal income, and sales tax receipts. It does not include local economic impacts, impacts due to passenger vehicle delay, or roadway maintenance and repair.

January 2009 Flood Event

The January 2009 flood was the result of a major storm in the eastern and northern portions of the Chehalis Basin, and significant rain in the upper Chehalis. The January 2009 event also led to very high flows along the lower Basin tributaries, including the Satsop, Wynoochee, and Black Rivers. In comparison to the 2007 flood, the 2009 event appears to have been a result of more evenly-distributed precipitation.

The resulting flood was:

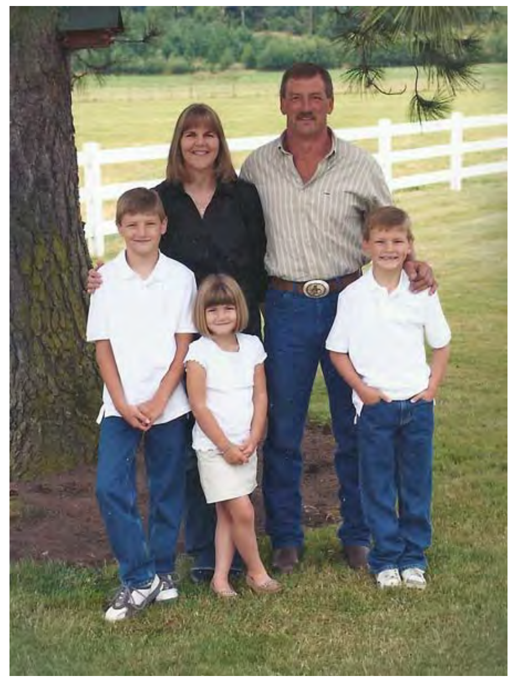
- **Second largest observed in the historic record on the South Fork Chehalis (after 2007) and Newaukum River (after 1996)**
- **Third largest observed in the historic record on the Chehalis River at Porter, Skookumchuck, and Wynoochee Rivers**
- **Fifth largest observed in the historic record at Grand Mound and on the Satsop River**

The total damage costs associated with the January 2009 event are not currently available; however I-5 was flooded and closed for two days.

Section 2: The Chehalis Basin

FLOOD STORY:
Julie Balmelli-Powe – Twin Cities Resident

When I think of the major flood events, there are so many memories. The helplessness of being cut off from everyone you care about, knowing that others are in need, but there is no way to reach them. The debris—everywhere—and I mean everywhere—dead things, yards and yards of plastic, jugs of oils and chemicals, fencing, haylage bales, commercial propane tanks, coolers, childrens' toys, wheels and tires, green house supplies, lumber, trees, piles of brush and dead grass, and lots and lots of garbage and mud—everywhere. The devastation of homes, farms, and businesses—all coated with 'flood mud'. The 'flood mud', like pudding, was in and on everything—crawl spaces, mailboxes and inside homes and outbuildings. Too soft to shovel, too thick to hose out.


Julie and her family.

During the 2007 flood, one could only imagine the tragedies happening elsewhere, though nothing you imagined was as bad as what really had. Families who the day before were secure in their homes, were now homeless with just the clothes on their backs; horses trying to swim to safety only to get caught in a fence under the water, unable to get free; having to listen to baby calves that were moved to a make-shift critter pad that never flooded before, crying in fear throughout the night, trying to escape the rising flood waters, but unable; and the rescuers who dropped everything to help those in need, only to return to the fire station to find themselves victims of the flood as the cars were now submerged.

Yet through all of this, I also remember a feeling of pride and thanksgiving in our communities. The resiliency of the communities, the generosity of friends, neighbors and total strangers willing to go miles and miles out of their way to bring food and supplies to those in need—everyone pitching in, helping out, rebuilding; FEMA employees thinking they were going to be swamped with people wanting their share of government handouts, surprised by how few showed up.

2: The Chehalis Basin

The Chehalis River flows approximately 125 miles, and drains an area of approximately 2,700 square miles in eight counties, including large portions of Grays Harbor, Lewis, and Thurston counties. It is the largest river basin in square-miles contained entirely in western Washington.

The Chehalis begins in the Willapa Hills, relatively low-lying, un-glaciated foothills and low mountains. It follows a relatively low gradient. Along its length, it draws water from three additional ranges: the Black Hills, the Cascade Foothills, and the southern Olympic Mountains. It is bounded by the Pacific Ocean to the west, the Deschutes River Basin and the Cascade Foothills to the east, the Olympic Mountains to the north, and the Willapa Hills and Cowlitz River Basin to the south.

In the upper portion of the Basin, the river valley is narrower and has less natural floodplain capacity. Development and major infrastructure, both I-5 and the main rail lines, cut through the middle of the valley and the river's floodplain. Much of the development has historically occurred in or near the floodplain. The lower Basin below Centralia is less populated, except for Aberdeen, Hoquiam, and Cosmopolis at the Grays Harbor estuary; where the valley is much wider and more predominantly in agriculture.

The total population in the Basin is approximately 140,000, concentrated in four major population centers: Chehalis (7,815) and Centralia (15,570) in the upper Basin, and Aberdeen (16,440) and Hoquiam (8,765) at the mouth of the Chehalis. The Confederated Tribes of the Chehalis Reservation are located near the mouth of the Black River on the mainstem of the Chehalis. The Quinault Indian Nation is located on the southwestern corner of the Olympic Peninsula, in Grays Harbor County. Both Tribes have fished and hunted in the Chehalis Basin from time immemorial.

"Special for me in the lower Basin is the natural environment, the forested hills, the wildlife all surrounding and comingling with a very fertile river valley. I have found the people mostly caring and friendly and have enjoyed being accepted as an oddity, an organic direct market farmer in a more traditional livestock based area."

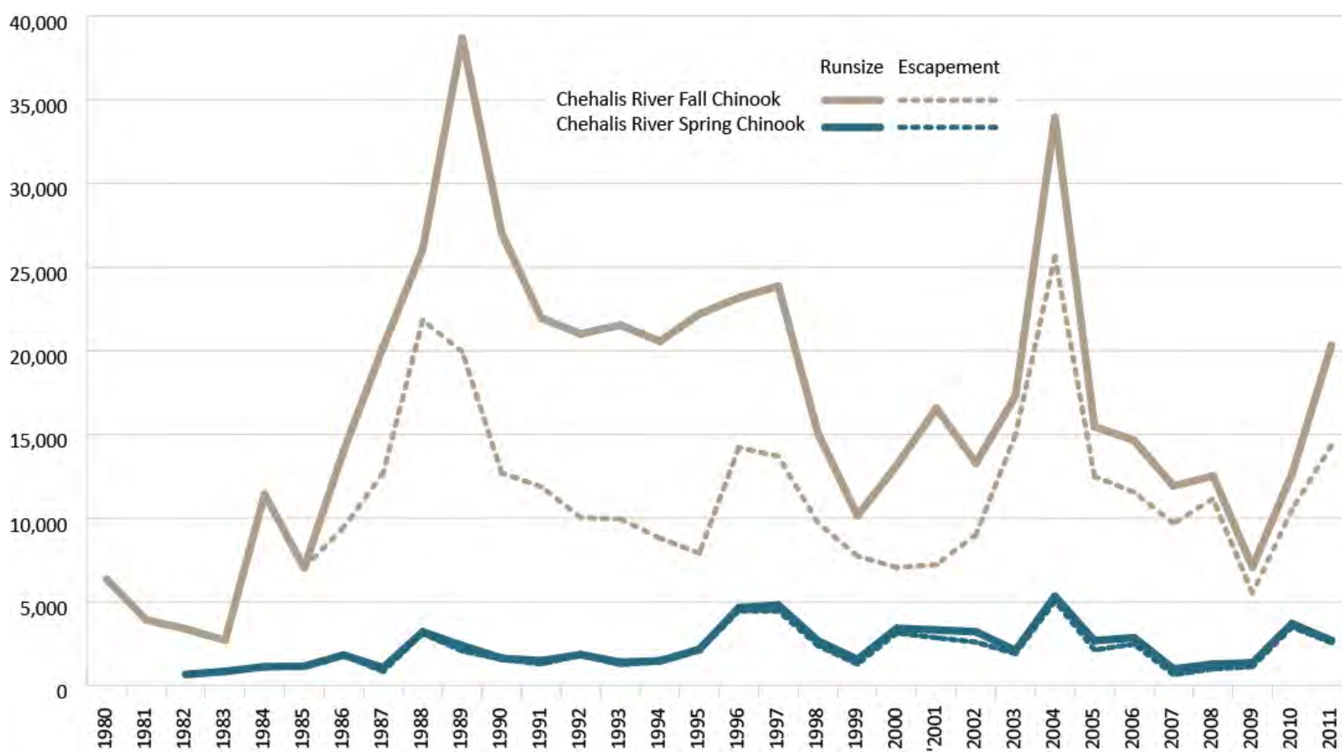
Steve Hallstrom, Farmer

Chehalis River Basin

The natural resources of the Chehalis Basin have supported tribes for centuries and continue to provide value to both the tribal and non-tribal people of the Basin. Farming, forestry, shellfish, and fishing continue to be core to the Chehalis River Basin economy. Salmon, in particular, play a major cultural, recreational, and economic role, and the protection and restoration of salmon habitat is a primary goal for many in the Basin. Figure 1 provides a summary from Washington Department of Fish and Wildlife of annual run sizes and spawning escapement numbers for Chehalis River fall and spring Chinook salmon for the years 1980–2011; Information for coho, chum, and steelhead are included in Appendix I. Annual fish harvest is calculated by determining the difference between the solid line representing runsize and the dotted line representing escapement for each year. The Chehalis supports a significant fish harvest in many years. In 2004, one of the best years for returning salmon in the last decade, tribal and non-tribal fishers in the Basin harvested over 290 spring Chinook, 3,200 steelhead, 8,200 fall Chinook and 71,000 coho.

Photo courtesy of Washington Department of Fish & Wildlife

Figure 1: Chehalis River Chinook Salmon Runsizes and Escapements, 1980 to 2011



Sub-areas

Flooding affects communities differently throughout the Basin. Factors such as the magnitude and duration of the flood, topography, historic land use patterns, population density, the presence of a major Interstate and other transportation infrastructure, and proximity to the Chehalis River and its various tributaries all play a role in how the people, property, and natural resources of the Basin live with the river and are impacted by floods. To better illustrate these differences, this report divides the Basin into six distinct sub-areas:

- Upper Mainstem
- Newaukum
- Twin Cities
- Skookumchuck
- Lower Mainstem
- Grays Harbor Cities and Tributaries

Upper Mainstem

The Chehalis River begins in the Willapa Hills, the lowest uplands in the Pacific Coast Range, upstream of Pe Ell. The Upper Mainstem area includes the mainstem of the Chehalis River and the South, East and West Forks of the River, upstream of their confluences with the Mainstem. The river begins in a relatively narrow valley, which then broadens out below the town of Pe Ell and on the South Fork at the Lewis County/Cowlitz County line.

The Upper Mainstem area includes the Boistfort Valley and the towns and communities of Pe Ell, Curtis, Adna, Dryad, and Doty. The Willapa Hills, and upland reaches of the Upper Mainstem, are dominated by commercial forestry. Agriculture, both dairies and vegetable farms, are located in the fertile lowland river valleys. Agriculture is vibrant in the area, with conventional farms and the recent addition of community supported agriculture (CSA) farms serving markets as far away as Seattle and Portland. The Boistfort Valley, in particular, is home to numerous farms and dairies, several of which have been devastated by flooding.

"At this point, you might as well laugh or you'll fall apart. It's just 40 years of your life floating by."

Cindy Dykstra. The Dykstras are dairy farmers in the Boistfort Valley near Curtis and lost their entire heard of 100 Holsteins in the 2007 flood.]

Photo courtesy of Boistfort Valley Farm

The Upper Mainstem area is highly vulnerable to flooding. Farmers and residents throughout this area have expressed concern that flood peaks along the Chehalis River seem to be rising faster and getting bigger; they are worried that this will continue. As agriculture continues to grow in the valley, some are losing confidence in the infrastructure in place to manage flood events; concern over the ability of farms to sustain repeated losses is growing.

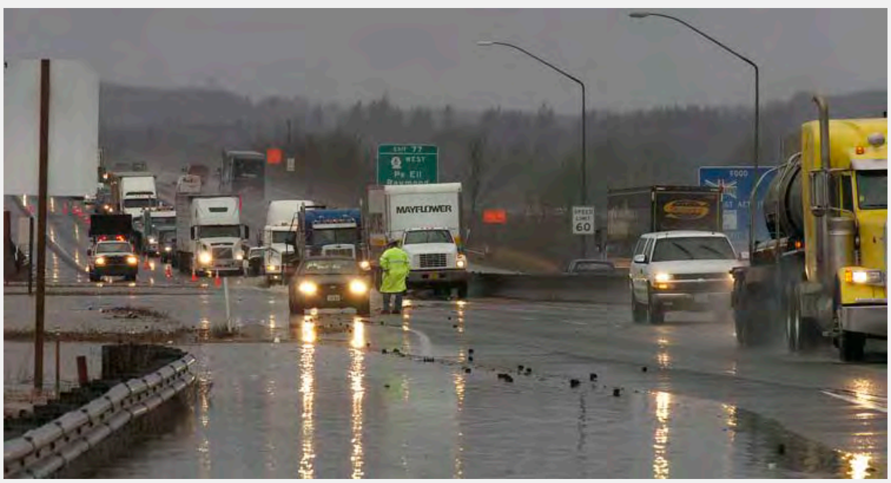
"In terms of the damage from the 2007 floods and our recovery, it's a difficult thing to talk about. We really did lose everything. Close to $80,000 in vehicles alone. Five tractors went under water. Our house was unlivable. Our cooler unit measuring 8'x28' floated away and landed on a car. My shop and tools were ruined and on and on and on."

Mike Peroni. The Peronis farm Boistfort Valley Farm, a CSA farm in Curtis.

Newaukum

The mainstem of the Newaukum River enters the Chehalis River just south of the City of Chehalis. The headwaters of both the North and South Forks of the Newaukum begin in steep hills and narrow valleys. Flowing west and southwest, these reaches gradually approach a broad, lowland valley where they converge and meander westerly to the Chehalis.

The Newaukum area is located in eastern Lewis County, south of Chehalis and contains the City of Napavine, the third largest city in Lewis County. Napavine is the most rapidly growing city in the County in terms of new home construction and commercial economic structures, such as Love's Truck Stop and the Richie Brother Auction house. The middle and upper portion of this section of the Basin is primarily in private timber management. Agriculture is the primary land use in the broad valley of the lowlands.



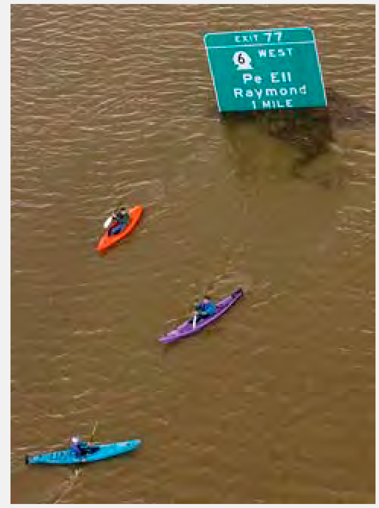
"Napavine people are good, the city is well run and it's a hometown kind of place that people love. Great school system, an in-town fire department, convenience store, barber, hair dresser, many upper end restaurants, gas stations with a brand new hotel being built with a small conference room attached, as well as additional retail space. You are never far away from a good conversation and good friends."

Lionel Pinn, Napavine City Council

Flooding is not a major problem through most of the upper reaches of the North and South Forks of the Newaukum River, but the broad valley in the lower reaches of the South Fork Newaukum River and the mainstem Newaukum River to the Chehalis River are much more susceptible to flood damages. The City of Napavine can be impacted by flooding from both the Newaukum and Chehalis Rivers. The Newaukum is the primary source of flood damage for the City, especially the Exit 72 region of I-5, which is hit the hardest by flood events. This area is home to several businesses and a key tax base for the City. When the Chehalis River reaches capacity during storm events, floodwaters push back on its creeks, streams, and into the Newaukum River, which can also affect Napavine. Local representatives are concerned that, given the right conditions, floodwaters will start to run back up river, from the north back to the south.

Twin Cities

The major population centers in the upper Chehalis River Basin are the "Twin Cities" of Chehalis and Centralia. The Twin Cities population is concentrated along the I-5 corridor in or near the floodplain. The east side of the river has been especially developed. This mostly urban area is the population center of Lewis County, the seat of government, and home to two ports, industrial parks, the first community college in Washington, a hospital, and commercial areas. It is the service center for the surrounding rural areas and a main stop on the route between Seattle and Portland. While natural resource industries used to be the dominant economic driver, communities have slowly been diversifying.



The Newaukum and Skookumchuck Rivers both join the Chehalis River at the Twin Cities. A number of major tributary streams also feed the Chehalis in this area—Salzer, Coal, Dillenbaugh and Prairie Creeks from the east and Lincoln, Scammon, and Coal creeks from the west.

"Well, 12 years ago we had a flood, and it was 44 inches of water. This year [2007] it's about 78 or 80 inches."

Darris McDaniel, owner of Shop 'n Kart in Chehalis

"[I remember] arriving home in Centralia from my job in Olympia, before I-5 closed. I remember walking to Safeway and the shelves being empty since shipments could not arrive. I remember walking on the closed freeway, and it seemed almost like a ghost road."

Edna Fund, Centralia City Council

The people, businesses, farms, and roads of the greater Twin Cities experience some of the most significant flooding and flood damage in the Chehalis Basin. The Chehalis-Centralia Airport and Twin City Town Center both have been covered in water. Floodwaters pool and back up waters into China and Salzer Creek, and the Skookumchuck River, causing I-5 to close in 1996, 2007, and 2009. Other routes into and out of communities are blocked during floods as well, restricting access to the major hospital for days at a time.

Skookumchuck

The Skookumchuck River rises in the western region of the Mount Baker-Snoqualmie National Forest and flows northwesterly to the town of Bucoda. The mainstem Skookumchuck has a steep gradient from the headwaters to Bucoda, where the gradient lessens significantly as the Skookumchuck makes its way to the confluence with the Chehalis River at Centralia.

The Skookumchuck area is located in northern Lewis County and southern Thurston County. Forestry is the primary land use in the headwaters; agriculture is dominant in the lowland Skookumchuck River Valley.

Most residents of the area are affected by flooding. Flooding closes roads and covers the farmland in the Skookumchuck River valley upstream of Chehalis. Bucoda is periodically inundated by floodwaters from the Skookumchuck, forcing many residents to evacuate their homes and farms. When SR 107 floods, it can isolate the entire town.

"During the 1996 flood, our entire town was almost completely isolated due to flood waters. We were worried that emergency vehicles could not get to us if there was a human tragedy."

Bucoda Mayor Alan Carr

The Skookumchuck Dam, which provides cooling water to the Alta Vista power plant, has at times provided limited flood storage upstream of Bloody Run Creek. In the 1996 flood, the Skookumchuck River caused significant damage. In the 2007 and 2009 flood, the pool behind the dam was not full and was able to retain flows, which likely mitigated flood impacts.

Lower Mainstem

In the Lower Mainstem area, or middle Chehalis Basin, the Chehalis River cuts through coastal hills and its valley forms a boundary between the Willapa Hills to the south and the Black Hills to the north. The Black River meanders gradually over its lowlands before merging with the Chehalis River near Oakville. This section of the Chehalis is largely unconstrained, with limited rip-rapping, channelization, and other flow-control measures.

Located primarily within Grays Harbor and Thurston County, this section of the Basin includes the towns and cities of Grand Mound, Oakville, Porter-Malone, Elma, and Montesano. This area is also home to the Confederated Tribes of the Chehalis Reservation. Upland communities here are focused primarily on commercial forestry. Along the Chehalis River and the lower reaches of the tributaries, a diverse mix of agriculture continues to grow, ranging from dairy and beef cattle, to bulbs and flowers, to vegetables. Low density, rural residential development is scattered along the main river.

"Here in the lower valley we appreciate the surrounding hills down to the valley floor; which blends into the perfect setting for industry, logging, farming, residential homes, fishing, hunting, recreation and our beautiful small cities and resourceful people. And all this is away from the hustle-bustle of the big city. Truly, this is what makes America."

Ken Estes, Mayor of Montesano

"They keep getting bigger, higher and more frequent, creating a question in the mind of 'how high will the next one be?'"

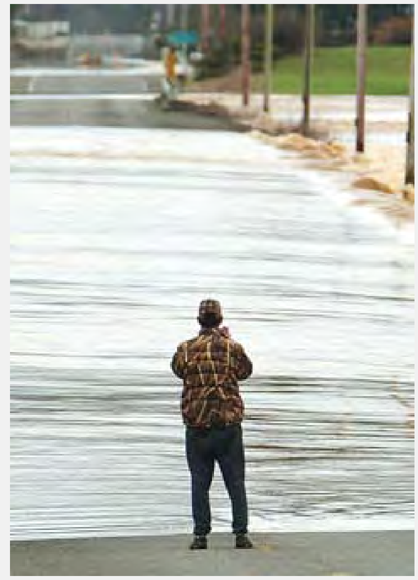
Jay Gordon, Farmer

Flooding in this part of the Basin regularly affects people, farms, and property. Landslides have at times closed SR 108 and other areas south of U.S. Highways 12 and 8. Flood waters damage city water and sewer lines and other public infrastructure, have covered three-quarters of the Chehalis Reservation, and restricted vital access routes such as Howanut Road, Anderson Road, Moon Road, Highway 12, and Sickman-Ford Bridge.

Grays Harbor Cities and Tributaries

The Chehalis River ends its journey to the Pacific at Grays Harbor. The floodplain widens out, bounded on the north by the Olympic Mountains. This reach contains the Satsop and Wynoochee Rivers, the largest tributaries in the Basin, and other smaller rivers such as the Humptulips, Wishkah, and Hoquiam.

The land throughout this reach of the Basin is predominantly National Forest or commercial forestland. Weyerhaeuser and Cosmo Specialty Fibers are the area's largest employers. As one moves closer into the estuary and the coast, other smaller industrial, retail, tourism, transportation, and marine related jobs support the local economies. Agriculture is expanding in the rich lowland soils and timber and commercial forestry continues to dominate in the hills to the north and south. The cities in this area include Aberdeen, Hoquiam and Cosmopolis.



County officials and residents in the Grays Harbor cities are increasingly concerned about the size and frequency of floods. Past flood events have caused landslides and injuries, closed schools and businesses, virtually isolated the City of Aberdeen, put US 101 under two feet of water, and recently caused a breach in the Mill Creek Dam in Cosmopolis. The lower elevation coastal areas that lie adjacent to rivers in the Grays Harbor area, like Aberdeen and Cosmopolis, are also subject to tidal fluctuations. Storm tides and high tides regularly cause backwater flooding in rivers, and the tidal fluctuations influence river flooding upstream.

"The lower Chehalis Valley is a place where most folks still know their neighbors, the valley floor is kept, tilled, tended and occupied by a small community of farmers, with a few fishermen, loggers and avid hunters. The area has had its share of economic struggles, but most farming and logging communities have, so our challenges are not all that different than other communities. The land has been in agriculture, relatively unchanged the past 50 or 60 years."

Jay Gordon, Farmer

"After catastrophic windstorms [in the December 2007 event] packing 80-plus mile per hour winds, roads in Grays Harbor County looked like they were littered with kindling as power poles, treetops, and branches slammed to the ground."

Lynn O'Conner, Emergency Operations center in Montesano

Section 3: Responding to Flooding

FLOOD STORY:
Susan and Rene Remund, Twin Cities Residents

It is probably difficult for people who have not experienced a devastating flood to understand the enormity of the losses.

While we work in Chehalis and Centralia, we live west of Chehalis on a small farm at Curtis. All but one of our pigs, two steers, and a pet goat drowned in the December 2007 flood. How the one pig survived, we don't know. She not only survived but farrowed three months later.


Susan in her kitchen after the flood.

Our 130 year old home was inundated to the top of the first floor, destroying everything not impervious to water and mud.

Our house guest, who has limited mobility, was alone in the home and feared the home would wash away or he would be trapped and drowned before he was rescued by boat from a porch roof. We learned later that one of our older neighbors was trapped in her manufactured home. The water pressure sealed her door and she could not get out. She was standing on her kitchen table putting farewell notes on the ceiling when her neighbor came in a boat, broke out a window, and rescued her.

The flood deposited approximately eight inches of clay and wood debris onto our property. Over 500 cubic yards of mud and debris were eventually removed from around our home, garage, and barn.

Within two days our neighbors and friends who were not flooded arrived to push the mud out of the house, haul away all the furnishings and appliances from the first floor and then strip the home to the studs. That work was followed by church groups, a local restaurant delivering soup at noon and the local Grange feeding flood victims and volunteer workers for many months.

After nearly five years the physical signs of the 2007 flood have been largely removed, but the fear of repeated flooding returns during every serious winter storm.

3: Responding to Flooding

This section describes the actions already underway to reduce the potential for future flood damage in the Chehalis Basin and options for future flood hazard mitigation actions. Combined benefits of flood control in the Basin can include:

- Avoided costs for damages to residential, commercial, industrial, and agricultural property;
- Avoided emergency assistance costs for flood victims;
- Sustained crop values for some farmers who would not be able to replant their fields the year following a flood;
- Increased residential and commercial property values;
- Avoided infrastructure damages and costs for infrastructure improvement; and
- Avoided impacts to fisheries habitat and water quality.

The focus of this report is mitigation of damage from major floods such as those that occurred in 1996, 2007 and 2009. There is more information about flood damage and potential flood hazard mitigation projects in the Twin Cities area because that area has been most studied. Flooding in other areas of the Basin is important, and more work is necessary to identify and describe projects needed to address flooding in these areas. A number of the projects and programs described below also could provide benefits for more frequent, smaller flood events. The objectives for flood hazard mitigation projects, as stated by interested parties in the Basin, include:

- Protect human health and safety, and protect livestock;
- Reduce or eliminate damage to homes, businesses, and property;
- Protect transportation routes;
- Mitigate environmental impacts;
- Increase watershed health and resiliency;
- Provide cost effective solutions; and
- Address climate change.

By taking a comprehensive basin-wide approach to flood protection, inclusive of communities affected by flooding, and areas that provide flood protection, the Chehalis River Basin Flood Authority is set at the right scale to integrate flood protection with development and conservation goals across jurisdictions, industries, ecosystems and communities."

Flood Protection and Ecosystem Services in the Chehalis River Basin, "Earth Economics," May 2010

People in the Chehalis River Basin have different ideas about how best to achieve these objectives. Some people are very interested in the large construction projects and the potential they have to provide flood hazard mitigation. Some people are more interested in approaches that emphasize smaller-scale more tailored solutions to local flooding problems combined with working with and improving the natural capacity of the Basin to handle floodwaters through protection and restoration of floodplain function. Some people observe that the investment that may be made in flood hazard mitigation in the Chehalis Basin presents a unique opportunity to look comprehensively across the Basin for projects that achieve multiple benefits—reducing flood hazards and improving watershed health and resiliency. Later in this report we describe a set of recommendations developed by a small work group of Basin leaders that strikes a balance between these different perspectives.

Work Already Underway

There is significant work already underway in the Basin to mitigate flood impacts, and much of this work has been initiated after the devastating floods of 2007 and 2009. Work already underway includes the following.

- **Creation of the flood authority**. The Chehalis Basin Flood Authority (Flood Authority) was created in response to the devastating flood of December 2007. The Flood Authority's stated purpose is to develop flood hazard mitigation measures throughout the Basin and to identify and implement flood control projects in the Basin.
- **Creation of a hydraulic model for the mainstem**. In the last year a hydraulic model has been created for the whole Chehalis Mainstem from Pe Ell to Aberdeen. The model allows predictions for the first time of the effects of flood hazard mitigation projects throughout the entire Basin.
- **Identification and analysis of potential flood hazard mitigation alternatives**. The Flood Authority has funded numerous studies throughout the Basin to understand the impacts of flooding and to explore potential alternatives to mitigate flood impacts. This includes the Chehalis River Basin Comprehensive Flood Hazard Management Plan (2010), the Earth Economics report on flood protection and ecosystem services in the Basin (2010), and various studies on potential water retention facilities (2010-2012); these recent analyses and reports have significantly narrowed the information gap about how different alternatives might perform in different parts of the Basin and about potential natural resource impacts and costs.
- **Land use and land management to control building and new fill in the floodplain**. City and county governments in the Chehalis Basin have a number of ongoing land use management actions that are intended to mitigate the negative effects of flooding. Most local governments meet or exceed the FEMA and state minimum requirements for restricting development and fill within the floodplain and for ensuring that development which does take place is appropriately flood proofed or elevated. In general, counties prohibit new lots that are wholly in the floodplain; cities allow some infill in the floodplain, but require flood proofing and new homes to be elevated. The requirements for elevation vary from one foot above the base flood elevations (100-year) to several feet above the flood of record (2007). In addition, Chehalis, Centralia, Lewis County and Thurston County participate in the Federal Emergency Management Agency (FEMA) Community Benefit Rating System and Grays Harbor County is considering applying. This voluntary, incentive-based system gives jurisdictions recognition and encourages community floodplain management activities that exceed the minimum National Flood Insurance Program requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risks. Figures 2 and 3 summarize land use policies and regulations currently in place in the Basin.

Figure 2: Community Rating Service Scores for Chehalis Basin Communities

		LEWIS COUNTY		THURSTON COUNTY		CENTRALIA		CHEHALIS	
CRS CATEGORY	MAXIMUM POSSIBLE POINTS	POINTS EARNED	%	POINTS EARNED	%	POINTS EARNED	%	POINTS EARNED	%
310 (Elevation Certificates)	162	67	41%	147	91%	127	78%	122	75%
420 (Open Space Preservation)	900	328	36%	352	39%	160	18%	261	29%
430 (Higher Regulatory Standards)	2740	391	14%	856	31%	519	19%	402	15%
450 (Stormwater Management)	670	374	56%	531	79%	495	74%	495	74%
520 (Acquisition and Relocation)	3200	100	3%	100	3%	105	3%	264	8%
530 (Flood Protection)	2800	42	2%	84	3%	409	15%	44	2%

Figure 3: Land Use Regulations for Chehalis Basin Communities

		GRAYS HARBOR COUNTY	LEWIS COUNTY	THURSTON COUNTY	ABERDEEN	BUCODA	CENTRALIA	CHEHALIS	MONTESANO	CHEHALIS TRIBES	NAPAVINE
Code Citation		Grays Harbor County Code 18.06	Lewis County Code 15.35	Thurston County Code 14.38	Aberdeen Municipal Code 15.52	Bucoda Municipal Code 15.24	Centralia Municipal Code 16.12	Chehalis Municipal Code 17.21	Montesano Municipal Code 17.40 Article II	Flood Damage Prevention Ordinance, Comprehensive Plan and Zoning Code	Napavine Municipal Code 15.12
Is your community's **floodway boundary definition** more restrictive than FEMA's?		No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Do you use a more restrictive **floodway development** standard than FEMA's?		No. DRAFT CODE: Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	No.	No specification in code.	Yes.
Do you use a more restrictive elevation standard for **development within a floodplain** than the FEMA standard?	*Resi-dential*	No.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes. Shoreline Management Act.	Yes.	Yes.
	Non-resi-dential	No. DRAFT CODE: Yes.	Yes.	Yes.	Yes.	No.	Yes.	Yes.	No.	Yes.	Yes.
Do you require a **set-back** from the OHWM?		Yes. Setback is per CAO and SMP.	Yes. Setback is per CAO.	Yes. Setback is per CAO.	No specification in code.	No specification in code.	Yes. Setback is per CAO.	No specificatio n in code.	Yes. Shoreline Management Act.	No specification in code.	No specification in code.
Do you allow **critical facilities** within the 500-year floodplain?		No specification in code.	Yes.	Yes.	Yes.	Yes.	Yes	Yes.	No specification in code.	No specification in code.	Yes.
Do you require all new development in the floodplain to **determine the BFE** if one has not already been determined?		No specification in code.	Yes.	Yes.	No specification in code.	No specification in code.	Yes.	Yes.	Yes, Shoreline certificate required.	No specification in code.	No specification in code.
Do you require new development to be elevated above the **flood of record?**		No.	Yes.	Yes.	No specification in code.	No specification in code.	No specification in code.	Yes. If higher than the BFE.	No specification in code.	No specification in code.	No specification in code.
Do you require an **elevation certificate** for all new construction?		Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.
Do you use a more restrictive standard for "**substantial damage**" than the 50% required by FEMA?		Yes.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Are there provisions for **compensatory storage** beyond basic NFIP standards?		Yes.	Yes.	No.	No.	No.	Yes.	Yes.	No.	No.	Unsure.

Work Already Underway—*Continued*

- **Flood proofing, home elevation, and buyout programs for structures already in the floodplain.** Flood proofing involves changes to a structure or property using berms, floodwalls, closures or sealants, to reduce or eliminate flood damage to buildings or property. It is used primarily for commercial structures and properties. Homes in the floodplain can be protected by home elevation, in which the structure is anchored against movement by floodwaters, and the first floor of living space, as well as all mechanical services, are at least one foot above the elevation of the adopted 100-year flood. Buyout programs can be used by jurisdictions to acquire properties and structures in the floodplain for eventual removal. Jurisdictions in the Basin have active flood proofing and home elevation programs. For example, the City of Centralia has raised 173 homes inside the city limits and has purchased three properties in the floodplain.
- **Livestock and farm evacuation areas ("critter pads").** A critter pad, or livestock flood sanctuary, is an area where approved fill material is used to raise the ground above the base flood elevation to provide a safe place for animals and farm equipment during floods. When flooding occurs, farmers move their livestock onto the pads to keep the animals out of the water's reach. Critter pads generally require special permitting and must be specifically designed to ensure they have a negligible impact on the floodplain. They generally may not be built within the boundaries of a river's floodway. A similar approach can be taken to create a safe area to protect critical farm equipment from flooding. The Thurston and Lewis County Conservation Districts are working with farmers to complete permitting and construction of critter pads in the Basin; at least four critter pads are planned in the upper watershed, Boistfort Valley, and Independence Valley. In addition, analysis is underway in the Grays Harbor area to determine the potential utility of critter pads in that area.
- **Early Flood Warning Program.** The Chehalis River Basin Early Flood Warning Program provides a publicly accessible, Internet-based flood data site (Contrail) which compiles and displays real-time data on rain, stream, reservoir, wind, temperature and other weather information. Users can access current conditions in the Basin along with the latest National Weather Service river forecasts, local road closures, and other flood preparedness information. The site also displays flood inundation maps to show where flooding is to be expected at each forecasted river stage.
- **The DOT Mellen to Blakeslee Bridge Project**. The $155 million WSDOT Mellen to Blakeslee (MTB) junction project, which broke ground in late May, will provide access to medical and other critical community facilities in Centralia during flood events up to the 2007 flood level. The first stage of projects is expected to be completed in spring 2013; the second will begin in the summer of 2013 and finish late in 2014 or early in 2015. The project includes connecting Louisiana Avenue and Airport Road, constructing a "shared use" path for pedestrians and cyclists, and re-constructing the Mellen Street interchange. Another element of the project is the addition of collector-distributor (CD) lanes alongside of the freeway between Mellen Street and Blakeslee Junction. The CD lanes will allow drivers to pass from Centralia to Chehalis without using I-5.
- **Forest Practices**. Approximately 84% of the land base in the Chehalis River Basin is forestland. Approximately 91% of that forestland is subject to the Washington Forest Practices Act and rules; the remaining forestland is federal or tribal land. Forest management activities such as timber harvest and forest road construction can increase the potential for flood damage unless the activities are controlled to minimize or mitigate adverse effects to these hydrologic cycle components. Washington State has a forest practices regulatory program which prescribes forest management practices to protect public resources such as water, fish and wildlife.

- **Action by individuals**. In addition to government actions to reduce flood damages, individuals throughout the Basin have taken action by flood proofing businesses, elevating homes, and creating evacuation routes and plans for farm equipment and livestock.

Additional Potential Flood Hazard Mitigation Projects

> **" In Lewis County neighbors help neighbors."**
>
> Rep. Richard DeBolt, R-Chehalis, United Way of Lewis County President

Flooding in the Chehalis Basin and potential flood hazard mitigation alternatives has been extensively studied. Beginning as early as the 1930s US Army Corps of Engineers (Corps) reports evaluated flooding in the Basin and potential flood hazard mitigation. WSDOT compiled syntheses reports on Chehalis flooding information in 2008 and again in 2012, and summarized more than 50 major studies created since 1948. Since the March 2012 synthesis report was finished four additional studies have become available, including the Anchor QEA Flood Storage Dam Fish Impact Study, the Washington Department of Natural Resources (DNR) draft Chehalis River Basin Forestland Section Report, the University of Washington Benefit-Cost Analysis Center Evaluation of Benefit-Cost Work Regarding Chehalis River Flood Control, and the WSE draft Chehalis Basin Hydraulic Modeling Report. In addition, the Lewis County Conservation District recently completed a Chehalis River Basin Studies Inventory and Evaluation.

Over the years many different flood hazard mitigation approaches have been suggested and studied, and individuals in the Basin have developed perspectives about which projects might be the most effective, based both on studies and their personal experiences with flooding. The potential flood hazard mitigation projects summarized in this report were included based on Legislative requirements and the current focus of interested parties in the Basin. They are predominately oriented around the Twin Cities area because of the extensive work there by the Corps and state and local governments over the past several decades. Other areas of the Basin have not been analyzed in detail with respect to flood relief, such as downstream of the Twin Cities and upstream on the mainstem, South Fork, Bucoda and Napavine.

Projects are grouped into two types: (1) capital- and construction-intensive projects that provide relatively large geographic effects; for example, a dam on the mainstem of the Chehalis; and (2) programmatic approaches that provide more individual or localized flood protection benefits; for example, elevating homes in the floodplain or creating farm livestock evacuation areas ("critter pads"). Of course, when applied broadly, even the smaller-scale, more individual projects can have significant regional benefits and costs. Similarly, there is a wide range of costs within the capital- and construction-intensive projects. For example, improvements to the airport levee alone are estimated at approximately $3.2 million, while construction of a dam upstream of Pe Ell is estimated at $245 million. There are many projects which do not have cost estimates. These include the floodwater bypasses, Skookumchuck levees, and the Bucoda levee. Projects that currently do not have cost estimates need more analysis of both project scope and impacts and costs. It will be possible to have additional cost information on some of the projects in the next few months.

Potential capital and construction-intensive projects include:

- Water retention facility on the mainstem—multi-purpose dam with 80,000 acre feet of dedicated flood control storage and 65,000 acre feet of flow augmentation/hydropower storage, located upstream of Pe Ell;
- Improvements to the levee around the Chehalis-Centralia Airport to raise the levee height to three feet above the adopted 100-year flood level;

- Flood walls to protect I-5 in the Chehalis/Centralia area including earthen levees and structural walls, replacing bridges with bottomless arches at Dillenbaugh and Salzer Creek, and providing stormwater treatment systems;
- Constructing new levees and raising and improving the existing Corps levees around Centralia and Chehalis—the "Twin Cities Project" which would involve levee systems along the Chehalis River from Dillenbaugh to Salzer Creeks, levees on the lower Skookumchuck, raising some structures, and modification of the Skookumchuck dam;
- Dredging and sediment management to lower the channel bottom by as much as 15' from approximately Mellen Street in Centralia to Lincoln Creek;
- Alleviating constrictions from roads and bridges, including evaluation of SR-6, Mellen Street, Galvin Road, and Sickman-Ford Bridge;
- Floodwater bypass routes/structures near Mellen Street and near Scheuber Road in Centralia and Chehalis, which would provide high-flow routes for floodwater to move past existing development and constrictions; and
- Local construction projects such as reconfiguration of the Skookumchuck levees to provide protection in the Edison District and other parts of Centralia, and the Bucoda levee.

Potential programmatic actions include:

- Additional land use and land management to control building and new fill in the floodplain;
- Additional flood proofing, home elevation, and buyout programs for structures already in the floodplain;
- Additional livestock and farm evacuation areas ("critter pads");
- Refinements to forest practices to increase water storage capacity provided by mature forests and improve water quality and habitat for fish;
- Improving riparian areas to reduce flood impacts and increase storage and improve habitat for fish;
- Additional bank erosion control to reduce loss of property;
- Restoration of wetlands and floodplain storage and connectivity that can provide floodwater storage and habitat benefits; and
- Flood projects in the Lower Chehalis Basin.

Information on the projects was compiled from a variety of available sources, including:

- 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 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;
- US Army Corps of Engineers Centralia Flood Risk Management Project Draft Close-Out 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 flood proofing, 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; and
- Technical and policy workshops held in the Basin in May and June 2012.

Information on potential flood hazard mitigation benefits was taken in large part from the WSE Chehalis River HEC-RAS hydraulic model runs that evaluated the performance of each alternative against four individual flood scenarios: the 1996 flood, 2007 flood, 2009 flood, and a simulated 100-year flood.

Appendix A presents a description of each project and summarizes existing information on each project's potential benefits, adverse impacts (such as increased flooding or natural resource impacts), costs, and implementation issues. In addition, the four projects specifically listed in the Legislative charge for this Report are described briefly below.

The Potential for Flood Hazard Mitigation through Upstream Water Retention Facilities

A number of potential locations were considered in the early analysis of potential water retention facilities, including locations on the Newaukum River, the Upper Chehalis and the South Fork Chehalis. Based on favorable topography and maximum drainage area, a single-purpose flood storage dam and a multi-purpose dam that provides flood control, stream augmentation, and hydropower were further analyzed at a site upstream of Pe Ell on the Upper Chehalis River and a site on the South Fork of the Chehalis River. Although some residents, especially in the Boistfort valley, would still like to see a water retention on the South Fork, the flood retention project site still under consideration in the Basin is a multi-purpose dam upstream of Pe Ell, on the Upper Chehalis River. The structure would have 80,000 ac-ft of dedicated flood control storage, a structural height of 288 feet, and flow augmentation/hydropower storage capacity of 65,000 ac-ft. In events such as the December 2007 flood, the dam currently under consideration is predicted to lower flood elevations in the upper watershed by 6–12 feet, by 3–4 feet in the Twin Cities, by 2–3 feet on the Chehalis Mainstem downstream of Twin Cities, and by almost 2 feet at Montesano.

According to the Anchor QEA Fish Impact Study, a dam could provide flow augmentation during summer months which may increase the number of spring Chinook salmon spawning in the upper mainstem of the river by 122%–146%; however, there is not agreement among technical experts about the certainty or extent of these potential benefits. The Anchor QEA Fish Impact study predicts reductions in winter steelhead populations to be 32%–81%, and reductions in coho salmon populations are predicted to be 28%–67%, for those fish that spawn in the upper mainstem of the river. These reductions would be largely due to a decreased quantity of habitat and increased percentage of fine sediments downstream of the dam; and, as with the Chinook estimates, there is not technical agreement on these ranges. Technical experts also have expressed uncertainty about the extent to which the inundated area of the reservoir might eliminate salmon spawning areas; if it does, this would create challenges both directly on the fishery and also for Clean Water Act compliance.

There are significant opportunities to improve fish habitat identified in the Anchor QEA Fish Enhancement Report and the Chehalis Basin Watershed Management Plan. As Basin leaders worked to develop recommendations that strike a balance between interests and alternatives for flood hazard mitigation, they emphasized that in any scenario improvement of conditions for fish and the Chehalis fishery must go hand in hand with flood hazard mitigation efforts.

A dam would reduce flood elevations throughout the Basin, but would not eliminate all flooding or fully protect I-5 in all flood events considered. At the north end of the Airport levee, I-5 is lower than the levee. Constructing a dam and raising the airport levee together would not have kept I-5 open during the 2007 flood. In that situation, I-5 would still be under several inches of water north of the airport levee. This water would flow south down to the low point of I-5 at Chamber Way and cover the Interstate there with more than six feet of water. Water also would have been a few inches over I-5 at the SR 6 Interchange during the 2007 flood even if a dam were built and the airport levee raised.

Although a dam on the upper Chehalis and raising the airport levee would not have kept I-5 open during the 2007 event, they would significantly reduce the chance of I-5 closing during a major flood. There are many other major flood scenarios (less severe than the 2007 flood) where a dam would provide enough protection to keep I-5 open when it may have closed without a dam. In addition, a dam would reduce the duration of the closure of I-5 if it were overtopped by flood waters.

Based on the design work to date by EES Consulting, construction costs for the dam are estimated at $245 million; these costs could increase as design progresses. A benefit-cost analysis (BCA) developed by EES Consulting estimated the monetary benefits of the multi-purpose dam, over a 50-year period, to have a net-present value of $334 million; the estimated monetary costs, over a 50-year period, were predicted to have a net-present value of $296 million, for a Benefit-Cost Ratio of 1.13. A review of the EES's BCA by the University of Washington Benefit-Cost Analysis Center (BCAC) concluded that the analysis is well developed technically and the methodology would be useful as costs and benefits become more certain. The BCAC highlighted the need to assess whether the $80 million in additional cost for the multi-purpose dam over the single purpose flood control dam would be the most effective expenditure of funds to achieve the non-flood reduction benefits, or whether spending those funds in other ways for fisheries, recreational and other purposes might gain more benefits.

In summary, based on the studies to date and a technical workshop held May 21 and 24, 2012, a dam on the mainstem would have the greatest reduction of flooding Basin-wide of any project and it also has the highest risk for damage to ecological functions. The monetary calculation of benefits and cost for a dam may change significantly as additional information is developed resulting in either an increase or decrease in the benefit-cost ratio.

The Current Alignment and Design of the Federal Flood Levees Proposed at Centralia and Chehalis

In the 1980s, the US Army Corps of Engineers began to evaluate flood hazard mitigation alternatives, including new levees, in the Chehalis River floodplain through Chehalis and Centralia. After several feasibility studies, project revisions and reformulations, a basic plan was authorized for further analysis by Congress as the Corps of Engineers Centralia Flood Damage Reduction Project (aka the "Twin Cities Project"), but not funded for construction. The project evaluated by the Corps included:

- Construction of a levee system designed to provide protection along the Chehalis River from approximately river mile (RM) 75 to RM 64 and along most of the lower two miles of both Dillenbaugh Creek and Salzer Creek.
- Construction of a levee along the lower approximately two miles of Skookumchuck River to the confluence with Coffee Creek that would provide protection for the adopted 100-year flood level.

- Raising the elevation of approximately eight structures that would incur induced damages from increased inundation as a result of the project, located near the Airport, I-5, Skookumchuck River, and Salzer Creek.
- Modification of Skookumchuck Dam to provide for an additional 11,000 ac-ft of flood storage. The project would limit outflows from the dam and attempt to keep the flow in the Skookumchuck River Channel at the Pearl Street Bridge at or below 5,000 cfs.

In events such as the adopted 100-year flood, the project was originally predicted to reduce flooding along the Skookumchuck River and drop flood peaks in the Twin Cities area, keeping most of Centralia dry in the Ford Prairie area, Zenkner Valley, and the Edison District. However, considering the updated hydrologic analysis that shows that the 100-year flood is now larger than previously thought, it is now known that the levees would not prevent widespread flooding in a 100-year event and would also not have prevented significant flooding in December 2007. While some locations in Centralia or Chehalis would show reduced flood levels, flood elevations are predicted to increase by up to 1.1 feet at the Newaukum confluence and up to 0.8 feet in other locations on the mainstem Chehalis downstream of the Twin Cities. The project would not protect I-5 from flooding in events such as the 2007 flood or in the 100-year flood event. In addition direct impacts to approximately 35 acres of wetlands and indirect impacts to approximately 235 acres of wetland floodplain and 244 acres of undeveloped non-wetland floodplain were predicted.

The Chehalis Basin Flood Authority website lists a number of municipalities and organizations that passed resolutions asking that the Twin Cities plan be shelved in favor of the study of upper Basin water retention; they are concerned that the Twin Cities project would not provide a truly Basin-wide approach to provide significant flood reduction for the families and communities in the upper Basin, and that water retention should be the preferred option. Work on the Twin Cities project was largely stopped by the Corps in 2011 after it determined that the proposed project would not protect I-5 during a 100-year flood event, would have increased flooding upstream and downstream of the Twin Cities and, at a cost of $205 million, would not pass the Corps cost-benefit test. However, there is still interest among parties in the Basin in reconfiguring and building some of the levees along the Skookumchuck in conjunction with other Basin flood reduction projects. The Corps has issued a draft close-out report for the project that has four options for how to proceed. The options include:

1. Terminate the project. Flood hazard mitigation might be pursued under the Chehalis Basin General Investigation (which would require a local sponsor) or as smaller components under the Continuing Authorities Program (CAP) authority.
2. Fully reformulate the project under a General Reevaluation Report.
3. Conduct a limited Post Authorization Change Report and remove unjustified separable elements or modify separable elements to a level where they are justified.
4. Conduct a limited Post Authorization Change Report as in bullet three, and concurrently proceed forward with a Basin-wide flood risk management study under the Chehalis Basin General Investigation.

As Basin leaders worked to develop recommendations that strike a balance between interests and alternatives for flood hazard mitigation, they did not recommend moving forward with all or parts of the Corps Twin City projects. Decisions on how the State of Washington will respond to the Corps close out report will be made after the Legislative decisions for the next biennium.

Alternative Projects that Could Protect the Interstate Highway and the Municipal Airport

Consistent with the Legislative requirements, WSDOT evaluated a number of projects to provide protection of I-5 and the Centralia/Chehalis municipal airport. These included: raising I-5 using fill material, raising I-5 using a viaduct, relocating I-5 outside the flood area, rerouting traffic from flooded areas using express lanes or temporary bypass lanes, and protecting I-5 with walls and levees. The fill, viaduct, and relocation projects had cost estimates ranging from \$350 million–\$2 billion. The I-5 protection option summarized below would use walls and levees to protect the Interstate. It would involve building earthen levees and structural walls, replacing bridges with bottomless arches at Dillenbaugh and Salzer Creek, and providing stormwater treatment systems and has a projected cost of \$80–\$100 million. It would reduce flooding for some homes and businesses and increase it for others.

The airport levee part of the project would raise the existing 2.3 miles of earthen levee to an elevation three feet above the adopted 100-year flood level as recently identified by FEMA. This is accomplished by widening the base of the levee and constructing it higher in a way that maintains existing side slopes. In addition to the improvements to the existing levee, the project would elevate Airport Road along the south side of the Airport and replace all utility infrastructure. The cost estimate for this project is approximately \$3.2 million, with the roadway improvements responsible for the majority of the cost.

Protection of I-5 and the airport provides collateral flood hazard mitigation to homes and businesses in some parts of the Twin Cities and increases flood elevations in some other parts. Based on a preliminary analysis, in events such as the 2007 flood, it would completely protect (i.e., make dry) 460 residences and 140 commercial structures and lower flood elevations at 300 more residences and 140 more commercial structures. It would raise flood elevations by 0–1 feet at the Newaukum confluence, Dillenbaugh Creek, and Mellen Street and 1–2 feet along the Airport levee, which would raise flood levels at a total of 120 residences and 30 commercial structures. Flood elevations downstream of the Twin Cities are predicted to increase by up to 0.1 feet in a 2007 and 100-year flood event, and 0.1–0.2 feet in a 1996 event. Increases in flood elevation that would be caused by the I-5/airport project would need to be addressed through mitigation measures such as raising buildings, moving buildings, buyouts, and other measures. Impacts to fish and other natural resources have not been fully assessed and will need to be analyzed in more detail.

In addition, as described earlier in the section on work already underway, the Mellen to Blakeslee junction project will provide access to medical and other critical community facilities in Centralia during flood events up to the 2007 flood level. It includes connecting Louisiana Avenue and Airport Road, constructing a “shared use” path for pedestrians and cyclists, re-constructing the Mellen Street interchange, and adding collector-distributor (CD) lanes alongside the Interstate between Mellen Street and Blakeslee Junction. The CD lanes will allow drivers to pass from Centralia to Chehalis without using I-5.

Policymakers, local officials, and Basin residents have repeatedly expressed a strong concern over pursuing only I-5 and airport projects, because these projects do not, in their view, offer enough flood hazard mitigation benefits to Basin people and communities. They are concerned that if I-5 and the airport are protected the momentum for additional flood hazard mitigation actions will dissipate, leaving the communities stranded. Some in the Basin are interested in approaches that acknowledge that, as part of living with flooding, I-5 will occasionally be overtopped; they suggest focusing on providing viable and reliable alternative routes for use during major flood events. As Basin leaders worked to develop recommendations that strike a balance between interests and alternatives for flood hazard mitigation, they recommended that alternatives for I-5 protection should continue to be explored as part of a larger effort to reduce flood damages throughout the Basin.

Other Alternatives that Could Provide Flood Relief and Protection in the Basin

In addition to water retention, the Corps Twin Cities project, and alternatives to protect I-5 and the municipal airport, there are numerous alternatives under discussion that could provide relief from flood damages and protection in the Chehalis Basis. These 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 floodplain function and storage. These projects are listed at the beginning of this Section and are described more fully in Appendix A, including, to the extent information is available, descriptions of their potential benefits, adverse impacts, costs and implementation issues. The recommendations for flood hazard mitigation work offered later in this report emphasize moving forward with a mix of smaller, more local, flood damage reduction projects, enhancing the natural function of the River and fisheries, programmatic approaches, and decision-making about large capital projects.

Crafting a Basin-Wide Approach

In June 2012, local community leaders and representatives of tribal governments met to discuss progress to date in flood hazard mitigation and additional potential flood hazard mitigation projects. One of the primary outcomes of this discussion was an overwhelming sense that policymakers and leaders are interested in a Basin-wide approach for the Chehalis. Individuals have different specific ideas about what a Basin-wide approach might look like, but a number of overall themes emerged:

- A Basin-wide approach needs to work for everyone in the Basin. It can't solve one area's problems by making another area's problems worse. Participants talked about every community "giving" something and every community "getting" something through a buffet of projects designed to optimize benefits and resources; and through approaches that maximize benefits and minimize negative impacts throughout the Basin.

"Lewis was Washington's first county in 1843 and its infrastructure has been developing ever since."

Ron Averill, Lewis County Commissioner

- A Basin-wide approach will be a combination and sequence of projects in different places to address different aspects of the flooding. Participants discussed "a host of projects" up and downstream to provide benefits not just during major floods, but also during the many smaller flood events.
- A Basin-wide approach likely will involve continued progress on many of the programmatic actions, including land use management, flood proofing, home raising and buyouts, critter and farm pads, riparian buffers, bank erosion control, and small-scale storage projects.
- A Basin-wide approach is more than simply protecting I-5; communities and people beyond the Interstate must be helped too.

- Historically, development has occurred in parts of the floodplain. Looking forward, solutions should optimize land use planning to prevent development that exacerbates the problem and to maintain, and where possible, improve floodplain function. But it is neither practical nor desirable to move whole cities and critical infrastructure; a Basin-wide approach needs to acknowledge and work with the development already in place.
- No alternatives will stop all flooding; a Basin-wide approach needs to understand that and work with nature.

Participants had different views about the extent to which any of the large construction projects should be part of the Basin-wide approach. Some participants strongly supported a dam on the upper Chehalis because of its ability to reduce flood levels throughout the Basin. These participants feel that the time to move forward with the dam is now, so that the benefits of water retention can be provided as soon as possible. Other participants expressed concern that a dam may not be feasible to permit and fund, and that even if it proved feasible, it might be better to spend the considerable investment in other ways. Some participants, while understanding and supportive of the need to find effective solutions to the damage flooding causes to human communities, were very skeptical of a dam due to the potential for high costs and lengthy time for construction, uncertainty about how effectively a dam could be operated, and the potential for a dam to adversely affect fish and other natural resources.

Some participants expressed concern about the potential timing of any of the larger, more construction-oriented projects, and the certainty around whether they could be built. Some participants favored approaches that would rely on smaller, more locally-tailored construction solutions, such as specific levee construction or improvement in specific locations, to protect certain neighborhoods and areas that are known to flood and particular bridge removals or improvements to address known constrictions. Participants discussed combining these smaller projects along with programmatic improvements that would continue to protect people and property already in the floodplain, such as land use planning, home elevations and buyouts, flood proofing, and critter pads.

Some participants emphasized the need to take a very long view and to be creative in thinking about what it would mean to successfully mitigate flood damages over the long-term. Some emphasized that flooding always has, and always will, be part of life in the Basin and work should focus on how to better live with the flooding by providing improved warning systems, fixing key health and safety concerns (such as through the current project to maintain access to the hospital in Centralia during floods), and increasing the "natural capital" of the Basin to better handle floodwaters through, for example, floodplain protection and restoration, riparian improvements, forest practice improvements, and small scale storage.

Participants discussed the need to make sure that any floodwaters that are moved out of the upper Basin more quickly are not simply moving adverse impacts downstream. Some participants described approaches that would start in the lower Basin to provide flood hazard mitigation and then move upstream. Participants recognized the special challenges in the lower Basin where the potential combination of floodwaters, storm surges, and high tides could prove catastrophic.

"One of the earliest floods was in November 1887. If there was an easy solution we would have solved it by now."

Edna Fund, Centralia City Council

"We were fortunate that the 2007 flood did not come at a time when we also had high tides, or the damage in our end of the Basin would have been much worse."

Vicki Raines, Mayor of Cosmopolis and Chair of Flood Authority

Many participants favored the idea of combinations of construction, programmatic, and natural capital approaches as a Basin-wide approach to flooding.

Potential Capital and Construction Project Combinations

Because of the complex hydrology and diverse geography and human communities in the Chehalis Basin, no single project can completely alleviate the adverse impacts of flooding. A combination of projects will be needed to maximize the benefits, address concerns, and resolve implementation issues. To spark conversation and illustrate some of the potential trade-offs between large capital projects, the draft report described three example project combinations.

- Combination 1 was made up of the WSDOT floodwalls and berms to protect I-5, the Airport levee improvements, and the Mellen Street and Scheuber Road floodwater bypasses. It also included a modified concept for Skookumchuck Levees from the Corps' Twin Cities project, and modification of the Sickman-Ford and Wakefield Road (South Elma) bridges.
- Combination 2 included a dam on the Chehalis Mainstem, the Airport levee improvements, and a small floodwall along I-5 near Dillenbaugh Creek (instead of the I-5 floodwalls and berms). Like Combination 1, it also included improvements to the Skookumchuck Levees.
- Combination 3 was made up of a dam on the Chehalis Mainstem, the Airport levee improvements, and floodwalls and berms to provide additional certainty about protection of I-5. As with the other two combinations, improvements to the Skookumchuck Levees, and modification of the Sickman-Ford and Wakefield Road (South Elma) bridges also were included. Combination 3 was essentially the same as Combination 1 except the dam on the Chehalis Mainstem was substituted for the Mellen Street and Scheuber Road floodwater bypasses.

The purpose of the project combinations was to show how potential flood hazard mitigation benefits might change if various projects were combined. Each provided a different mix of potential flood hazard mitigation benefits and potential natural resource risks and impacts, and costs. They were not presented as preferred or recommended options, only as examples. Detailed descriptions of the project combinations included in the draft report are provided in Appendix C. Comments on the project combinations were mixed, and none of the exact combinations described in the draft report are reflected in the recommendations forwarded to the Governor.

Local Projects and Programmatic Approaches

One of the clearest conclusions from this work to evaluate flood hazard mitigation options in the Chehalis is that no single project alone can accomplish a Basin-wide approach to flooding. None of the large construction alternatives currently under discussion address flooding on the Newaukum, or upstream in the Chehalis Tributaries such as flooding from the Skookumchuck River in Bucoda. Flooding in those areas would need to be addressed through identification of local projects (such as the levee under discussion in Bucoda) and through programmatic efforts such as additional home elevations or buyouts in the floodplain, flood proofing, livestock and farm pads, and land use management approaches and restoration projects to protect and where possible improve floodplain function and storage. Local projects and programmatic approaches also might be used to amplify the protection provided by large construction projects in Twin Cities and, in the case of a dam, on the Chehalis Mainstem. Policymakers in the Basin favor continuation and expansion of programmatic approaches as part of a Basin-wide approach.

A very different approach than reliance on major construction projects such as in the three project combinations described above would be to leverage local projects to remove key obstructions in the floodplain and use programmatic changes to address the flood damage. Such an approach could include:

- Widening of culverts, bridges, and dikes and levees that cause localized flooding, such as the Adna Levee/Culver project, the Sickman-Ford Bridge project, and the Satsop River project.
- Programmatic options such as maintaining the early warning system, prohibiting any new development in the floodplain, raising or buying out structures already in the floodplain, improving other land use management practices, and improving forest practices to incentivize longer logging rotations.
- Completing smaller construction projects in localized areas such as the Bucoda levee, and the Centralia-Chehalis airport levee.
- Protecting livestock and farm investment with farm/critter pads.
- Ensuring effective detour routes around I-5 to accommodate periodic closures during flooding.

This kind of approach would be implemented and funded over time throughout the Basin. The scope of such an approach, as well as the associated flood hazard reduction benefits, and costs, have not been evaluated.

In the 2010 Earth Economics study commissioned by the Flood Authority, "Flood Protection and Ecosystem Services in the Chehalis River Basin," the authors identify and estimate the economic value of natural systems (floodplains, forests, wetlands, free flowing rivers, permeable soils, etc) in the Chehalis River Basin, many of which provide flood protection. When these natural systems are impaired by built structures like roads or buildings, two costs are incurred: the loss of these free ecosystem services that protect against flooding, and the need to build additional structures (dams, levees, flood walls, etc.) to protect existing structures in the floodplain. The Earth Economics report identifies at least $11 billion or more worth of free ecosystem services in the Chehalis River Basin, the impairment of which should be part of the calculus of any benefit/cost analysis when considering some of the large capital flood protection projects discussed in the project combinations section above. The study found that “the best investments for achieving flood protection are likely a combination of natural capital, such as floodplains, selective built capital, such as dams and levees, and social capital, such as early warning systems and training.”

As Basin leaders worked to develop recommendations that strike a balance between interests and alternatives for flood hazard mitigation, they recommended moving forward with a set of local projects to make near-term progress to reduce potential future flood damages, and they recommended an exploration of the potential benefits of a combination of smaller projects across the Basin Further analysis of such a program should help determine how much damage reduction is possible, and at what cost, and provide additional context for considering large-scale projects.

Benefit-Cost Analyses in the Chehalis Basin

One of the requirements of the Legislature is that this Report summarize the benefits and costs of recommended projects, using available information and accepted benefit/cost methods. To meet this requirement, the Benefit-Cost Analysis Center (BCAC) at the University of Washington (http://evans.washington.edu/research/centers/benefit-cost-analysis/) analyzed existing benefit-cost analyses (BCAs) related to various proposed alternatives for mitigating flood damage in the Chehalis River Basin. The main objective was to review the existing BCAs and available data in terms of strengths, barriers to decision-making, and comparability to different flood hazard mitigation alternatives that have not had a formal BCA. A report of findings is provided in Appendix H.

The existing reports on the Chehalis Basin that were analyzed include:

- Anchor QEA - Chehalis River Flood Storage Dam Fish Population Impact Study
- EES Consulting - Chehalis River Flood Water Retention Project Phase IIB Feasibility Study
- Earth Economics - Flood Protection and Ecosystem Services in the Chehalis River Basin
- US Army Corps of Engineers - Centralia Flood Risk Management Project Draft Close-Out Report

The BCAC found that the existing BCAs for projects in the Chehalis Basin provide a solid framework for policymakers and other stakeholders to base decisions on the subjects of these BCAs and to conduct qualitative evaluations of benefits and costs for alternative projects in the Basin that have not had a formal BCA. This is because they provide clear causal linkages between costs and resultant project benefits, and use detailed flood damage assessment methodologies. For these reasons, flood model and damage estimates produced by EES can be used as a basis for considering the flood prevention or mitigation value of other alternatives. Policymakers and stakeholders can use these estimated damages as a guide for thinking about what the returns to other projects might be as well. The report also found that the prior BCAs provide clarity in relation to assumptions and methods. This helps establish a framework for discussing points of disagreement in the various findings and allows stakeholders to explore the implications of differing assumptions in the models.

Specific to the water retention facility, the BCAC confirmed that the methodology used in the EES BCA is appropriate and the assumptions are reasonable. They also pointed out there are a significant number of assumptions in the analysis that have a high level of uncertainty like the total cost of the project, impact on fisheries and mitigation costs. These uncertainties can affect the final conclusion of the benefit cost ratio and should be revisited as more information is available.

BCAC highlighted several other issues that must be taken into consideration when making inter-project comparisons. First, while BCA is an attempt to maximize social welfare and identify the most efficient projects, it does not take into account factors such as equity or security which may be important considerations for decision-makers. Second, while the existing BCAs provide useful baseline comparisons, they are for individual projects, and do not reflect future changes in the Basin that will happen regardless of if a particular project is implemented (for example, taking into account how continued home elevations, bank erosion control projects, or other smaller scale projects would affect the benefits or costs of large-scale projects like the WSDOT improvements to I-5 or water retention). Third, it is important to consider both net benefits and the benefit-cost ratio of projects. While a project may have a higher benefit-cost ratio than others, the net benefits it provides may be significantly less. Lastly, the report highlights the importance of properly reflecting uncertainty. Summarizing a project using a single point estimate, such as a benefit-cost ratio, is insufficient because it does not adequately reflect the full range of potential outcomes. Each of these findings is more fully explained in Appendix H.

There were a number of comments on the BCAC analysis. Some commenters expressed concern that the BCAC analysis understated the value of a dam on the upper Chehalis; others expressed concern over the BCAC methodology, or questioned the value of BCAC in informing decisions about public projects. BCAC is only one element that will inform future decision making about flood hazard mitigation projects. For any large capital project that would move forward into permitting, additional BCAC work would be needed and additional opportunities for public consideration of benefits and costs should be provided as part of any permitting process.

Section 4: Recommendations and Next Steps

FLOOD STORY:
Michelle Schilter, Adna Resident/Farmer

I write to you regarding the flooding that affected my family in December 2007. We were woken up very early in the morning from a friend of ours that lived on Ceres Hill in Boistfort asking if they could come to our home with their children to escape the water approaching their house. It was quite a startling phone call but it did nothing to prepare us for the nightmare that would descend upon our life approximately 6 hours later. In between that phone call and 2:00 p.m., we managed to evacuate our dairy calves from their hutches (they would have all perished), disconnect and move milk pumps to "higher ground" (not high enough), chain our propane tank to concrete posts, and evacuate our 3 children to a different location. We watched as the water entered our home at about 4:00 p.m. and the water leave our home at 7:45 p.m. My husband, hired hand, and myself slept in the attic of our residence, listening to the evacuation helicopters fly the valley all night. We woke up to a nightmare, a nightmare I never want to repeat. Through the generosity of family, friends, and strangers we were able to rebuild our home and dairy.

Michelle and her family.

I share this story because flood mitigation is crucial to the survival of our dairy, our family, and our community. We need action now and we need to look at all options. My family, my three children, my dairy, and my community cannot live through another catastrophic flood like December 2007.

Section 4: Recommendations and Next Steps

As part of the effort to report on potential flood hazard mitigation projects and alternatives in the Chehalis Basin, over 25 individual and project-combination alternatives were modeled against four potential storm events (storm types) generating over 120,000 points of information. Flood control and mitigation has been actively studied in the Basin since at least the 1930s. While there is a wealth of information, data and studies, critical information is still needed for some potential projects and programs to more precisely understand potential benefits and costs. Some projects have been studied intensively; others are just ideas. Flood hazard in the Basin is like many systemic issues facing a community—there is no solution that solves the problem once and for all; and, of course flooding also is a natural occurrence one that has benefits for fish, wildlife and watershed function.

For now we have:

- Clear information about the major causes of the flooding and different types of storm events and floods.
- A more robust system for flood warning and flood response.
- A significant and ongoing effort by local governments in the Basin to limit increases in flood damage through land use management.
- Identification of the major construction projects of interest in the Basin that have the potential to further reduce flood damage to human communities.

There are different ideas about how best to achieve flood hazard mitigation. Some people are very interested in the large construction projects and their potential. Some people are more interested in approaches that emphasize smaller-scale more tailored solutions to local flooding problems combined with working with and improving the natural capacity of the Basin to handle floodwaters through protection and restoration of floodplain function. Some people are focused on using flood hazard mitigation investment as an opportunity to look comprehensively across the Basin for projects that achieve multiple benefits—reducing flood hazards and improving watershed health and resiliency. Many people seem open to parts of all of these points of view and are looking for combinations of projects that can most effectively and reliably provide protection to the most people in the Basin.

In August 2012, as a follow up to the draft report, and in recognition that a time for decision making has come, the Governor tasked a work group—David Burnett (Chehalis Tribe Chairman), Vickie Raines (Cosmopolis Mayor and Chehalis Flood Authority Chair), Karen Valenzuela (Thurston County Commissioner and Chehalis Flood Authority Vice Chair), J. Vander Stoep (private attorney and Chehalis Flood Authority Pe Ell Alternate), Jay Gordon (Farmer in lower Chehalis Basin and Washington Dairy Federation President) and Keith Phillips (Policy

Advisor to Governor Gregoire)—to develop recommendations for flood damage reduction projects. The group was asked to develop recommendations that other Basin leaders and the Governor could consider for endorsement and action. Each member also was asked to interact with his/her respective constituents to inform the small group's discussions.

The group set out to make recommendations consistent with a Basin-wide approach to flood damage reduction. They believe a successful Basin-wide approach will maximize benefits and avoid or minimize adverse human and environmental impacts of flood damage reduction actions. It will protect key community infrastructure and maintain public services during emergencies. It will not solve one community's flooding problems by making another community's problems worse.

The group recognized that a Basin-wide approach to flood damage reduction must go hand in hand with improvements in the environmental health and resiliency of the Basin. Flood damage reduction projects must avoid or fully mitigate environmental impacts. Floodplains, water, and shorelines must be managed in ways that reduce future flood damage and enhance overall environmental conditions and habitat for aquatic species. Fish mitigation and enhancement projects must be implemented in concert with flood damage reduction projects. It is critical that harvestable resources of the basin are increased as flood damage is reduced.

The group also acknowledged that even with efforts to reduce flood damages, flooding is a natural occurrence and will continue to occur. Communities need to be as prepared as possible with flood warning and emergency response systems. Future development in the Basin should not put more people or development in harm's way, and should not increase damages or costs to people already living in and using the floodplain. By planning ahead, respecting what the river can do, and managing floodplains intelligently, the Basin can reduce the risks from future floods.

The work group recommended a five-part strategy for the 2013-2015 budget cycle based on a common understanding of how floods affect the Basin. The recommendations call for real improvements through implementation of a series of known smaller-scale projects and investments to reduce flood damage, and completion of the analysis needed for decisions about the best mix of additional large and small-scale projects to significantly reduce flood damages in the future and are comprised of the following.

Large-Scale Capital Projects

The work group recommended that we finish the analysis necessary to determine the best option for large-scale capital projects that could significantly reduce flood damages across a large geographic area, and make a decision by December 2014 whether to move into project permitting. The large capital projects under consideration include upstream water retention and I-5 improvements.

The work group observed that while preliminary feasibility studies on a large upstream water retention structure have been done, at this time, it is not yet known whether this type of water retention structure is actually feasible. The next steps are to refine the engineering designs, further study dam safety, and identify more specifically the implications for water quality, quantity, and aquatic species. When this additional information is available, the assessment of the economic benefits weighed against its cost of large upstream water retention will need further refinement.

Studies done over the last year indicate that there will be environmental impacts, and there is the potential for environmental benefits, from a large upstream water retention structure. We need to know if the optimum structure is one that would remain open to the river (and to the passage of out migrating salmon) except during flooding, or if the optimum structure would be one holding a permanent reservoir allowing the release of water during summer months with the potential to improve water quality downstream. We need to better understand how and where fish currently use the river and to know what it will take to fully offset any risks to fish and water quality from water retention. In order to build the necessary coalition of support, we need to determine whether and how a large-scale water retention structure could be packaged with other investments to significantly improve the conditions for fish in the Basin.

The work group recommends that given the potential of large-scale water retention to significantly lower peak flood elevations during major floods and thereby provide Basin-wide flood damage reductions, answering these questions should be a primary task for the coming biennium. Many of the analyses contemplated also would support other work in the Basin including smaller-scale capital projects, fish and ecosystem enhancement efforts, and land-use management.

Even with an upstream water retention structure, I-5 would still require major flood protection investments in Chehalis and Centralia, though the investments would be smaller than otherwise would be needed. The work group also recommends that as the evaluation of a large upstream water retention facility is completed, there also is a need to complete evaluation of I-5 protection alternatives.

Smaller-Scale Local Projects

The work group observed that with or without large-scale water retention, local projects will be needed to protect key infrastructure, control shoreline erosion, and improve water conveyance and drainage at key points in the Basin. A program of smaller projects aimed at protecting key infrastructure and priority areas through the Basin may provide a measureable reduction in damages from major floods.

The work group recommends design and construction of local projects to provide immediate flood damage reduction including the protection of critical infrastructure, wellheads, wastewater treatment plants, roads, homes and businesses. Concurrent with these projects, they recommend development and implementation of a long-term strategy for localized flood damage reduction actions. As the evaluations of large-scale water retention and I-5 protection alternatives are completed, the benefits from a combination of smaller projects across the Basin should be explored, and we should continue to construct projects that provide near-term local flood damage reduction benefits. Further analysis of such a program will help determine how much damage reduction is possible, and at what cost, and provide additional context for considering large-scale projects.

Fish and Ecosystem Enhancement Projects

The work group recommends a continued effort to explore options for a range of actions that can serve multiple benefits of flood damage reduction and environmental enhancement. They also recommend development of a coordinated Basin-wide strategy with goals and objectives for enhancement of aquatic species and restoration of ecological functions in concert with flood damage reduction. While this work is ongoing, the work group recommends implementation of known projects that improve fish habitat and populations and floodplain functions in the Basin. Appropriate management of floodplains, water, and shorelines can and must play a role in flood damage reduction, and must enhance the overall environmental conditions and habitat for aquatic species, particularly salmon, in the Basin. It is critical that harvestable resources of the Basin are increased as flood damage is reduced.

Land Use, Flood warning, and Emergency Response

The Basin has significantly improved its flood warning system, and individual Basin governments continue to improve their emergency preparedness efforts. Progress on floodplain management policies and programs also has been made, though additional improvements are both needed and possible. Further enhancements to state and local land use policies will help ensure new development and other land management activities do not increase the risk of additional flood-related damages and, to the extent possible, reduce damages and costs to existing development affected by flooding. It will also be important to continuously improve the information base and tools needed to understand flood impacts and to optimize actions to reduce flood damage while improving the environmental health of the Basin.

The workgroup recommends that we reduce the cost of repetitive damage to residences in the floodplain through a strategic program of buyouts and flood proofing, and encourage a comprehensive effort to prevent new development in the Basin from increasing damages. The workgroup further recommends ensuring flood warning and flood preparedness systems remain ready and effective for the public and emergency responders.

The work group's recommendations were endorsed by the Chehalis Flood Authority. Governor Gregoire also endorsed the work group recommendations. She included $28 million in her recommended 2013–2015 state capital budget to move forward with the recommended work.

Moving Ahead to Realize the Work Group's Framework

The Governor's work group recognized that support will be needed for both continued management and technical work and policy decisions to refine and implement a Basin-wide approach and coordinate capital investment.

The work group recommends that the next Governor appoint a policy task force in spring 2013 to oversee initial implementation of this framework and make future recommendations to the Governor and Legislature about the feasibility of a water retention structure, preferred alternative for I-5, and next expenditures needed to continue implementation of the framework beyond 2015. They recommend that the Flood Authority should continue to serve as a sounding board, oversee implementation of the local capital projects funded in the 2013–15 biennium, and recommend local capital projects for the 2015–17 biennium. The Flood Authority should also oversee the strategy for reducing repetitive flood loss and land use management, evaluate a suite of local flood damage reduction projects, and implement and maintain the flood warning system. Finally, they recommend a technical steering committee should be convened to oversee the ecosystem enhancement and fish studies and dam scoping work, and make recommendations to the policy task force as necessary.

The Chehalis Basin is poised to take important actions to invest in flood hazard mitigation now and for the future. Recent progress in understanding the potential benefits, impacts, and costs of flood hazard mitigation project options, creating a shared set of ideas about how to go about flood hazard mitigation and what a Basin-wide approach would mean has set the stage for future decision making.

Over the next two and a half years significant investment in actions to mitigate future flood hazards in the Chehalis, improve natural resource function and conditions for fish populations, complete the assessments and studies needed to make decisions about which (if any) large-scale projects to move forward into permitting, and support collaboration and governance in the Basin will continue to be important. No single project, or even set of projects, will ever completely eliminate flooding in the Chehalis, but we can and will take steps to significantly reduce the damages flooding visits on people and communities throughout the Basin.

APPENDICES

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Appendix A: Flood Hazard Mitigation Alternatives – Project Descriptions

Contents

Appendix A: Flood Hazard Mitigation Alternatives – Project Descriptions

This appendix provides details of the potential flood hazard mitigation benefits, adverse impacts, and implementation considerations for each flood hazard mitigation alternative under consideration; alternatives selected were based on the current focus of interested parties in the Basin. Projects are grouped into two types: (1) capital and construction intensive projects that provide relatively large geographic effects, for example, a dam on the mainstem of the Chehalis; and (2) programmatic approaches that provide more individual or localized flood protection benefits, for example, elevating homes in the flood plain or creating farm livestock evacuation areas (so called “critter pads”). Of course, when applied broadly, even the smaller scale, more individual projects can have significant regional benefits and costs. Similarly within the capital and construction-intensive projects there is a wide range of costs, for example, improvements to the airport levee alone are estimated at approximately $3.2 million while construction of a dam upstream of Pe Ell is estimated at $245 million.

Potential large-scale, construction-intensive projects include:

- Water retention project on the mainstem (a dam upstream of Pe Ell);
- Localized I-5 protection and airport levee improvements;
- I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee;
- Raising/improving the US Army Corps of Engineers levee system around Centralia and Chehalis;
- Dredging and sediment management;
- Alleviating constrictions from roads and bridges; and,
- Flood water bypass routes/structures near Mellen Street and near Scheuber Road in Centralia and Chehalis.

Potential smaller-scale projects and programmatic actions include:

- Additional land use and land management to control building and new fill in the floodplain;
- Additional flood proofing, home elevation, and buyout programs for structures already in the floodplain;
- Additional livestock and farm evacuation areas (“critter pads”);
- Refinements to forest practices to increase water storage capacity provided by mature forests and improve water quality and habitat for fish;
- Improving riparian areas to reduce flood impacts and increase storage and improve habitat for fish;
- Additional bank erosion control to reduce loss of property; and,
- Flood Projects in the Lower Chehalis Basin.

Information on the projects was compiled from a variety of available sources, including:

- 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 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;
- US Army Corps of Engineers Centralia Flood Risk Management Project Draft Close-Out 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 flood proofing, 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; and,
- Technical and policy workshops held in the Basin in May and June 2012.

Capital and Construction-Intensive Projects

The projects summarized here are relatively large-scale capital and construction intensive projects that provide relatively large geographic effects, for example, a dam on the mainstem of the Chehalis. Each project includes a brief description in terms of project details and background, as well as a separate discussion of potential benefits, concerns, and implementation issues.

Information on potential flood hazard mitigation benefits was taken in large part from WSE Chehalis HEC-RAS hydraulic model runs that evaluated the performance of each alternative against four individual flood scenarios: the 1996 flood, 2007 flood, 2009 flood, and a simulated 100-year flood.

WATER RETENTION PROJECT ON THE MAINSTEM CHEHALIS RIVER

Following the severe flood in 2007, the Chehalis Basin Flood Authority began to evaluate whether flood retention structures in the Chehalis River Basin might be part of a solution to basin-wide flooding. This built on early work by the US Army Corps of Engineers and the Lewis County Public Utilities District. After reviewing several sites, the flood retention project site under consideration is a multi-purpose dam located upstream of Pe Ell on the Upper Chehalis River. The structure would have 80,000 ac-ft of dedicated flood control storage, a structural height of 288', flow augmentation/hydropower storage capacity of 65,000 ac-ft, and an estimated construction cost of $245 million. Based on recent estimated model results from the Chehalis HEC-RAS model, the multi-purpose dam would need to be combined with improvements to the Airport Levee and a section of I-5 north of the 13th Street interchange to achieve the benefits estimated in the EES Phase IIB study. A single-purpose flood storage structure has also been examined. While a single-purpose structure may not have the potential environmental benefits of the proposed multipurpose structure, it may help reduce some of the potential impact.

What are the potential benefits of the water retention facility?

- The Chehalis HEC-RAS model predicts that in a simulated 100-year flood the project lowers flood elevations in the upper watershed 4-10 feet, 2-3 feet in Twin Cities, 1-2 feet at other locations on the mainstem downstream of the Twin Cities, and 0.7 feet at Montesano.
- The Chehalis HEC-RAS model predicts that in the 2007 flood the project lowers flood elevations in the upper watershed 6-12 feet, 3-4 feet in Twin Cities, 2-3 feet at other locations on the mainstem downstream of the Twin Cities, and 1.7 feet at Montesano.
- The Anchor QEA model predicts a 122%–146% increase in spring Chinook abundance, if the dam is operated to maximize fish habitat through water releases.
- The Anchor QEA model predicts flow augmentation in the summer months can enable higher concentrations of dissolved oxygen at times, depending on how the dam is constructed and operated, leading to improved productivity of the Chehalis River system.
- The Anchor QEA model predicts the additional 65,000 acre-feet of storage can be used for controlled release in the summer, which may reduce water temperature at times, depending on how the dam is constructed and operated.
- Some technical experts indicate that the water retention facility would address local concerns about higher and faster flood peaks in the upper watershed during the 2007 flood in particular.
- The project would provide capacity to manage for changing climate conditions by providing storage for both high and low flows.
- A benefit cost analysis by EES Consultants estimated a significant benefit to the upper watershed and Twin Cities area. The Chehalis HEC-RAS model predicts reductions in flood elevations downstream to Aberdeen. The benefit resulting from reductions in downstream flood elevations has not been calculated but would increase the benefit above what was calculated by EES in the IIB Study.

What are the potential concerns associated with the water retention facility?

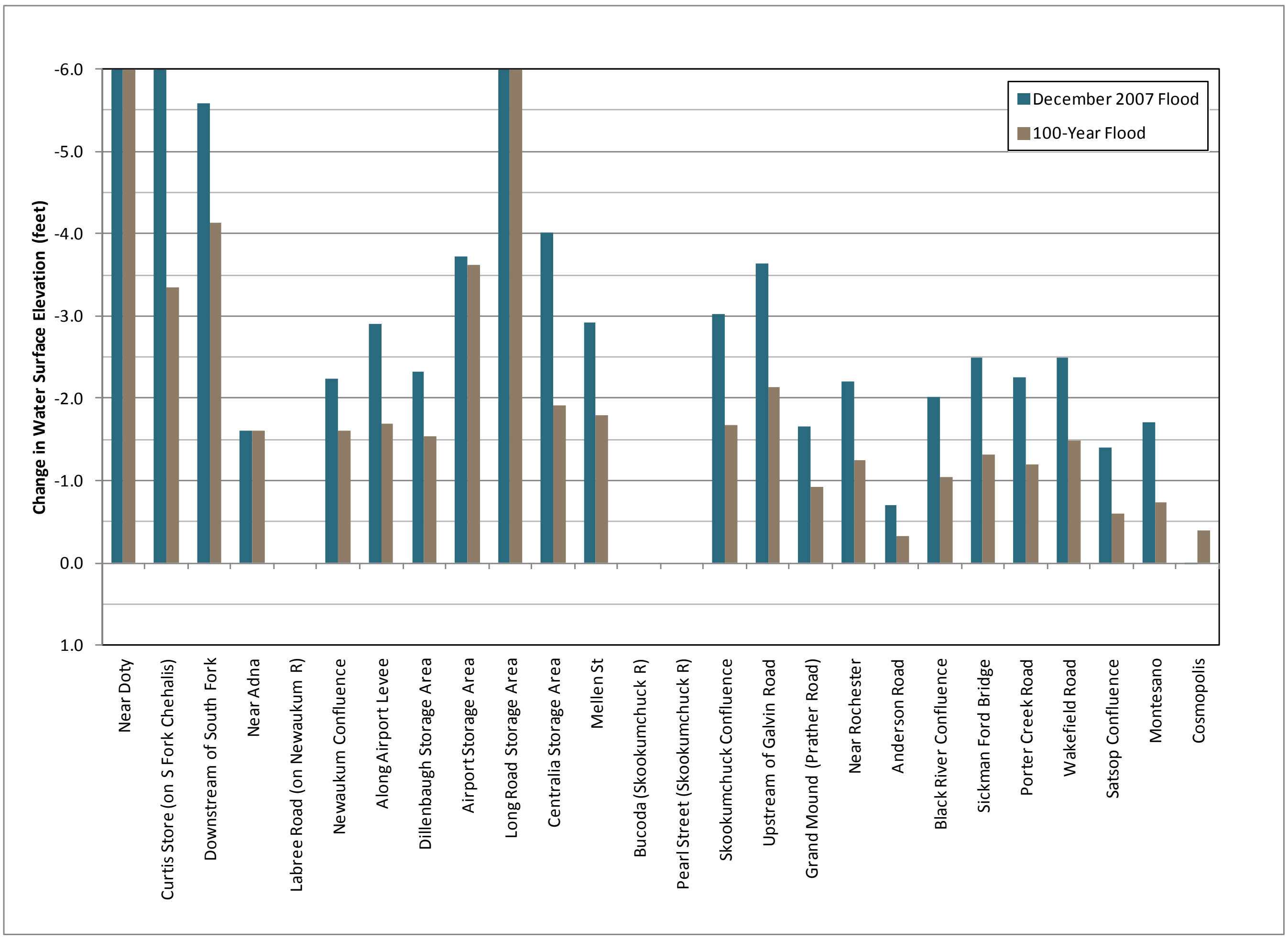
- The Chehalis HEC-RAS model predicts that in extreme storm events like 1996, 2007 or 2009, the proposed dam alone would not completely prevent flooding to I-5, particularly in areas near the Chehalis-Centralia airport and along Dillenbaugh Creek. In several areas flood waters in a 2007 event would be only a few inches from the roadway surface. Additional projects would have to be combined with the dam to completely prevent I-5 flooding.
- The Anchor QEA model predicts a 28%–81% reduction in winter steelhead and coho salmon populations.
- The Anchor QEA model predicts that dam releases at times may reduce concentrations of dissolved oxygen, depending on how the dam is constructed and operated. These reduced oxygen levels may not be incompliance with the State's Water Quality Standards.
- The Anchor QEA model predicts higher water temperatures at times, depending on how the dam is constructed and operated. These elevated temperatures may not be incompliance with the State's Water Quality Standards.
- The inundated area of the reservoir would eliminate salmonid spawning areas, which creates challenges both directly on the fishery and also for Clean Water Act compliance.
- DFW staff have commented that the Anchor QEA model may not accurately reflect uncertainties about spring Chinook juvenile rearing behavior, adaptation timing, predator response, and the effect of optimized water releases downstream of the proposed site. They also commented that a dam could have negative effects on spring Chinook populations in the short and long terms. The dam site is a high hazard condition site because of the downstream proximity of Pe Ell; construction and operation of a high hazard condition dam could significantly increase the costs of the dam.
- Mitigation of fisheries and other environmental impacts could significantly increase the cost of the dam.

What are the potential implementation issues for a water retention facility?

- There is limited federal funding for new large scale projects like water retention and the project would have to show a benefit/cost ratio of greater than one to be eligible for federal funding under the Water Resources Development Act, which the EES analysis estimates it would.
- Project design is still in early phase and cost estimates may change significantly.
- There is a need for significant additional technical and design work if the project moves forward, including for fish passage facilities.
- The process for approval and construction of a dam can take 8–15+ years, with many opportunities for challenge by opponents.

Table 1 describes the effect of the potential mainstem dam, in terms of changes in water surface elevation, at various USGS stream gages in the Chehalis Basin in a December 2007 and 100-year flood event.

Table 1: Effect of Potential Mainstem Dam Flood Relief Alternative



LOCALIZED I-5 PROTECTION AND AIRPORT LEVEE IMPROVEMENTS

Over the past few years the Chehalis-Centralia Airport has been working on a project to enhance the Airport Levee. The airport levee enhancement project is designed to provide protection for the Airport and, to a lesser degree, I-5.

The airport levee project would involve raising the existing 2.3 miles of earthen levee to an elevation three feet above the 100-year flood level as recently identified by FEMA. This is accomplished by widening the base of the levee and constructing it higher in a way that maintains existing side slopes. In addition to the improvements to the existing levee, the project would elevate Airport Road along the south side of the Airport and replace all utility infrastructure. The cost estimate for this project is ~$3.2 million, with the roadway improvements responsible for the majority of the cost. However, to achieve protection of the airport area in a 100-year event, some additional localized flood protection improvements would be needed along I-5 north of Salzer Creek and south by Dillenbaugh Creek.

What are the potential benefits of the Airport Levee Improvements?

- Improvements to the levee would protect the airport and business along I-5 from flooding during a 100-year flood event, if combined with other projects.

What are the potential concerns associated with the Airport Levee improvements?

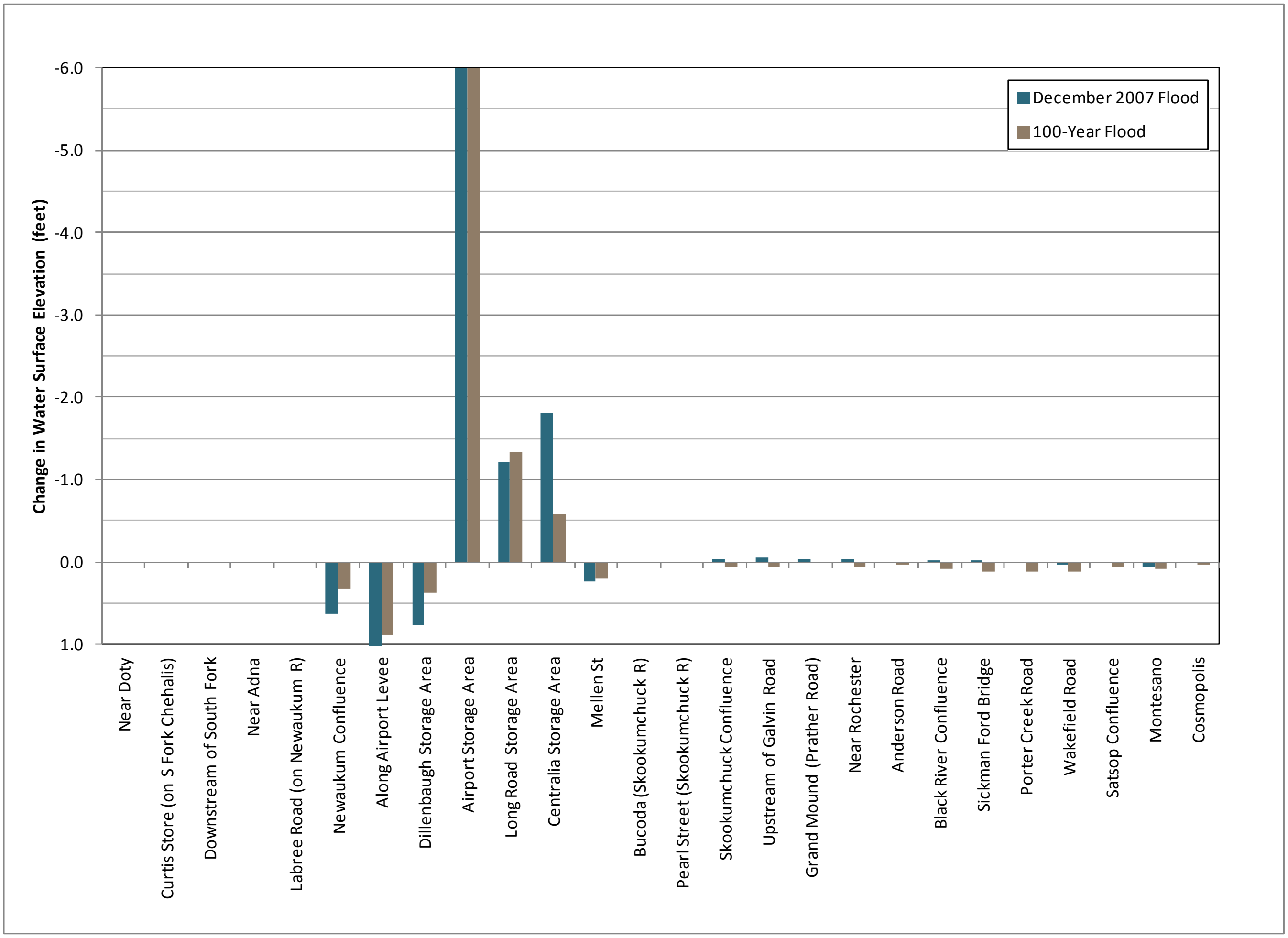
- The Chehalis HEC-RAS model predicts up to a 1.2 foot increase in flood elevations in 2007 and 100-year flood events in some locations if the Airport levee is improved.

What are the implementation issues associated with the Airport Levee improvements?

- The Airport levee by itself would increase flood elevations in some locations; these impacts would need to be minimized or mitigated in some manner.

Table 2 describes the effect of the potential airport levee improvements, in terms of changes in water surface elevation, at various USGS stream gages in the Chehalis Basin in a December 2007 and 100-year flood event.

Table 2: Effect of Potential Airport Levee Improvement Flood Relief Alternative



I-5 LEVEES AND WALLS, RAISE AIRPORT LEVEE, NEW SW CHEHALIS LEVEE

Flooding in the Chehalis Basin has impacted access to I-5, closing it for four days in 1996, four days in 2007, and two days in 2009. The Washington State Department of Transportation (WSDOT) estimated the total loss in economic output to the state economy due to the closure of I-5 in 2007 at $47 million. The major costs from I-5 closure are freight delays, but closures also impact private operating companies from logistical and scheduling costs, and indirect market costs.

The Mellen Street to Blakeslee Junction (MTB) project now underway will provide limited access to the hospital in Centralia during flood events from downtown Centralia. In addition, the 2011 Washington State Legislature and the Washington State Office of Finance Management (OFM) directed WSDOT to evaluate alternative projects that could protect I-5 and the municipal airport at Centralia and Chehalis. OFM contracted with WSDOT to perform the work on I-5 alternatives. Project alternatives evaluated include I-5 raise and widen only, I-5 express lanes, I-5 temporary bypass, I-5 viaduct, I-5 relocation and I-5 levees and walls, raise Airport Levee, new SW Chehalis levee. The raise and widen, express lane, temporary bypass, viaduct, and relocation projects had cost estimates ranging from $120 million–$2 billion.

The option summarized below is to protect I-5 with a combination of five miles of earthen levees and structural walls along I-5, two miles of improvements to the existing Chehalis-Centralia Airport levee, and a new one-mile-long levee in southwest Chehalis, which has a projected cost of $80–$100 million. This project also would involve replacing five bridges (four over Dillenbaugh Creek and one over Salzer Creek) with bottomless box culverts, and construction of stormwater treatment areas to store and treat stormwater runoff from I-5.

What are the potential benefits of the project?

- The Chehalis HEC-RAS model predicts that the I-5 levees and walls would protect the interstate from flooding under the 100-year flood, and 2007 and 2009 events. The walls and levees would provide a minimum of 3 feet of freeboard above predicted 100-year flood elevations for an additional margin of safety and to address potential changes in climate and floods.
- The Chehalis HEC-RAS model predicts the project would lower the flood elevations in parts of the Twin Cities by as much as 1.8 feet in an event like the 2007 flood.
- Based on a preliminary analysis by WSDOT[2], in events such as the 2007 flood, it would completely protect (i.e., make dry) 460 residences and 140 commercial structures and lower flood elevations at 300 more residences and 140 more commercial structures.

What are the potential concerns associated with the project?

- The cost of the I-5 levees and walls is significant and funding for major capital projects is difficult to secure in current economic times.
- The Chehalis HEC-RAS model predicts flood elevations in the area west of I-5 and west of the Airport levee, which is closer to the river and more rural, to increase between 0.2 and 1.8 feet, but by as much as 2.0 feet in some locations in a 2007 flood event and between 0.2 and 1.2 feet in most areas, and by as much as 1.3 feet in some locations in a 100-year flood event.
- The Twin Cities may be affected by visual impacts of walls along the interstate.

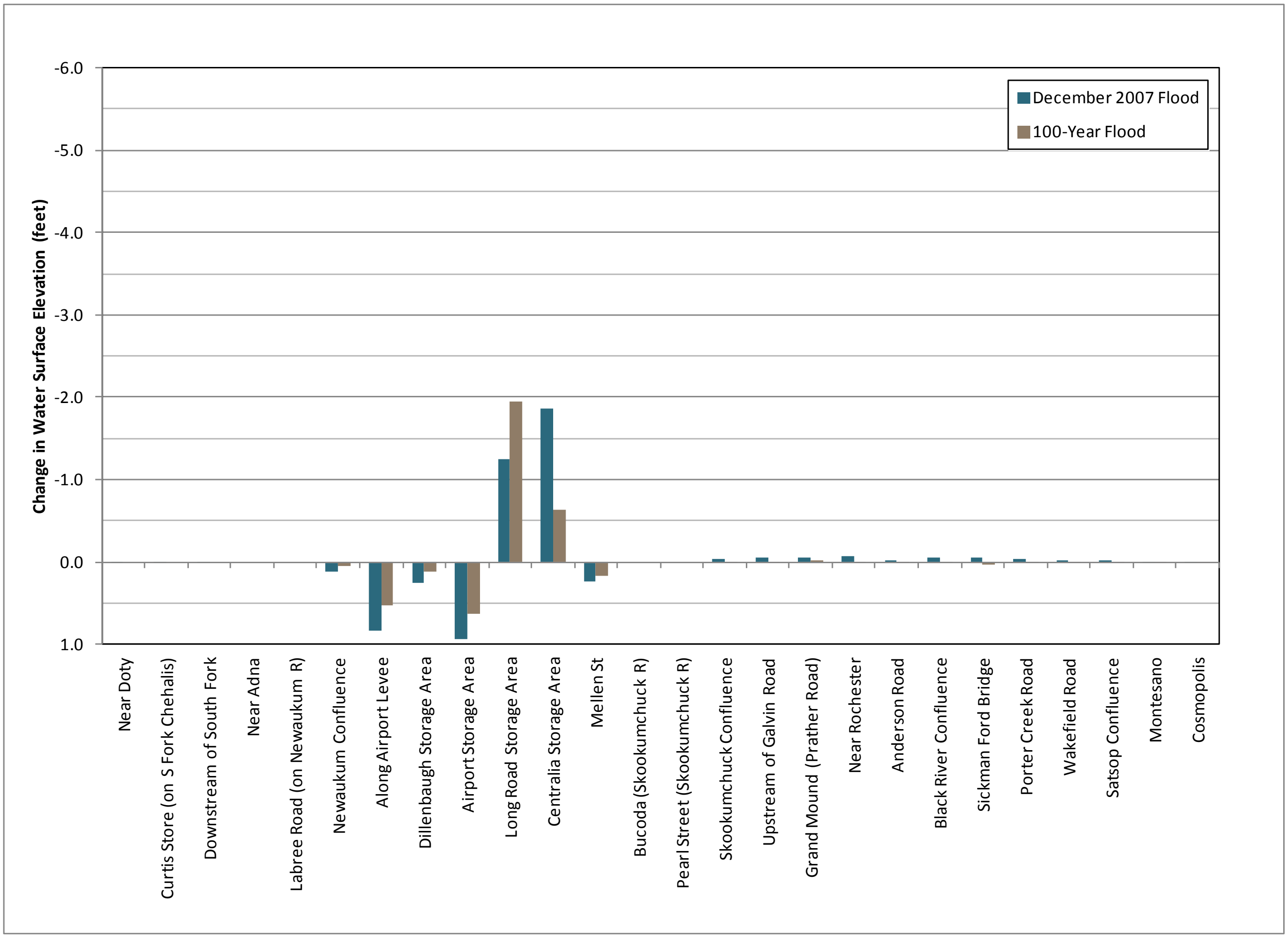
What are some of the major implementation issues?

- Some wetland and stream courses may be impacted, and mitigation will be required.
- The project would increase flood elevations in some locations; these impacts would need to be minimized or mitigated in some manner.

Table 3 describes the effect of the potential flood walls and levees to protect Interstate-5, in terms of changes in water surface elevation, at various USGS stream gages in the Chehalis Basin in a December 2007 and 100-year flood event.

[2] WSDOT was asked to provide an estimate of the number of residences and commercial structures that would be affected by different flood hazard mitigation projects in the Twin Cities area.

Table 3: Effect of Potential Flood Walls and Levees to Protect Interstate-5 Flood Relief Alternative



CORPS TWIN CITIES PROJECT - RAISING/IMPROVING THE US ARMY CORPS OF ENGINEERS LEVEE SYSTEM AROUND CENTRALIA AND CHEHALIS

In the 1980s, the US Army Corps of Engineers began to evaluate flood hazard mitigation alternatives, including new levees, in the Chehalis River floodplain through Chehalis and Centralia. After several feasibility studies, project revisions and reformulations, a basic plan was authorized for further analysis, but not funded for construction, by Congress as the Corps of Engineers Centralia Flood Damage Reduction Project (aka the "Twin Cities Project"). Work on the Twin City plan was largely stopped by the Corps in 2011 after the Corps determined that the proposed project would not have protected I-5 during the 2007 flood, would have increased flooding upstream and downstream and, at a cost of over $200 million, would not pass the Corps cost-benefit test.

The proposed project evaluated by the Corps included:

- Construction of a levee system designed to provide protection along the Chehalis River from approximately river mile (RM) 75 to RM 64 and along most of the lower 2 miles of both Dillenbaugh Creek and Salzer Creek.
- Construction of a levee along the lower approximately 2 miles of Skookumchuck River to the confluence with Coffee Creek that would provide protection at the 100-year flood level.

- Raising the elevation of approximately eight structures that would incur induced damages from increased inundation as a result of the project, located near the Airport, Interstate-5, Skookumchuck River, and Salzer Creek.
- Modification of Skookumchuck Dam to provide for an additional 11,000 acre-feet of flood storage. The project would limit outflows from the dam and attempt to keep the flow in the Skookumchuck River Channel at the Pearl Street Bridge at or below 5,000 cfs, with an option to increase capacity to 20,000 acre-feet upon further investigation and at the sponsor's option.
- Total estimated cost of $205 million (January 2012).

However, there is still interest among some parties in the Basin in reconfiguring and building some of the levees along the Skookumchuck. These levees would decrease flooding in Centralia from the Skookumchuck River that is not solved by other flood projects. The Corps has issued a draft close-out report for the project that has four options for how to proceed. The options include:

- Terminate the project; flood hazard mitigation might be pursued under the Chehalis Basin General Investigation (which would require a local sponsor) or as smaller components under the Continuing Authorities Program (CAP) authority.
- Fully reformulate the project under a General Reevaluation Report.
- Conduct a limited Post Authorization Change Report and remove unjustified separable elements or modify separable elements to a level where they are justified.
- Move forward with a Post Authorization Change Report concurrently with a Basin wide flood risk management study under the Chehalis Basin General Investigation.

Decisions on how the State of Washington will respond to the Corps close out report will be made as part of the development of recommendations for priority flood hazard mitigation projects in the Basin.

What are the potential benefits of the Corps Twin Cities project?

- The HEC-RAS model predicts that in the 2007 and 100-year flood the project reduces flooding in the Skookumchuck River and drops flood peaks in the Twin Cities area, keeping most of Centralia dry in the Ford Prairie area, Zenkner Valley, and the Edison District.
- The HEC-RAS model predicts that the project reduces the occurrence of flooding to I-5, but not in all storm events examined.

What are the potential concerns associated with the Corps Twin Cities project?

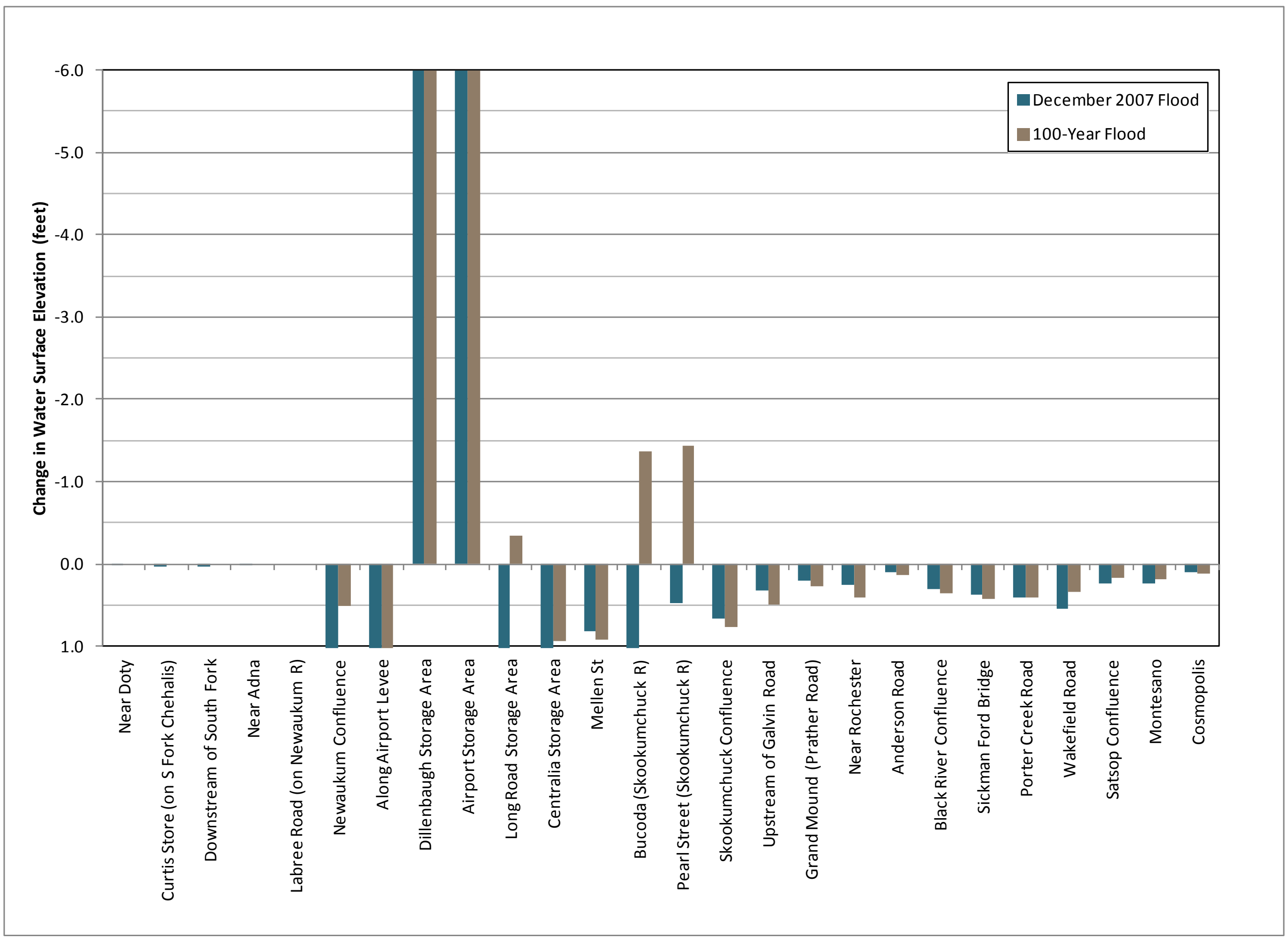
- The HEC-RAS model predict that in the 2007 event the project increases flood elevations up to 1 foot at the Newaukum confluence and up to 0.8 feet in other locations on the mainstem downstream of the Twin Cities.
- The current analyses show that in some cases, such as in December 2007 when flows in the Skookumchuck River were less than 5,000 cfs, the proposed operations at Skookumchuck dam could actually increase flows in the Skookumchuck River as opposed to reduce it.
- The HEC-RAS model and Corps Closeout report predicts that the project does not protect I-5 from flooding in all storm events, including 2007, and therefore the avoided costs of raising I-5 cannot be included in the Corps' cost-benefit analysis.
- The Corps Closeout Report estimated direct impacts to approximately 35 acres of wetlands and indirect effects to approximately 235 acres of wetland floodplain and 244 acres of undeveloped non-wetland floodplain.

What are some of the major implementation issues of the Corps Twin Cities project?

- The Corps Closeout Report notes that if the project were approved, the design and construction after authorization would take multiple years to complete.
- A number of entities throughout the Chehalis River Basin have voiced their opposition to the project.
- Some technical experts have noted that changes to the spillway of Skookumchuck dam still need to be evaluated, and it is uncertain if owners of Skookumchuck dam would allow it to be used for flood control. Eventually, the dam would need to be in public ownership to allow for the Corps to invest in flood control improvements, so a public agency would have to be identified who would be willing to own and operate the dam

Table 4 describes the effect of the Corps Twin Cities project, in terms of changes in water surface elevation, at various USGS stream gages in the Chehalis Basin in a December 2007 and 100-year flood event.

Table 4: Effect of Potential Corps Twin Cities Project Flood Relief Alternative



DREDGING/CHANNEL EXCAVATION

In the past, the Corps also evaluated a project to dredge or excavate the mainstem Chehalis River channel downstream of Mellen Street. WSE modeled a dredge/excavation project similar to the Corps investigated project, which would extend from just downstream of Mellen Street to just downstream of Lincoln Creek (RM 67.29 to RM 60.51). The excavation would have a 120 foot bottom width, trapezoidal channel, and would lower the channel bottom by as much as 15 feet in some locations (tapering into the existing channel at the upstream and downstream ends). According to PIE's Chehalis River Basin Flood Reduction Report (1998), there is a natural rise in the river bottom in this area; the substrate is most likely bedrock that would require blasting for removal. Part of the area under consideration for dredging is fairly high quality riparian zone dominated by black cottonwood, red alder, Douglas fir, Western red cedar, with an understory of salmonberry, snowberry, and other native shrubs and herbs. The portions of the area considered for dredging have good quality spawning habitat adjacent to it in the Chehalis River, and have a high quality riparian zone with seasonally connected side channels. Habitat diversity, species diversity, wetlands and refugia are good quality (Corps Closeout Report).

Dredging of the Chehalis River would also require some dredging in the lower reaches of the Skookumchuck River. Model cross sections between the mouth of the Skookumchuck River and RM 3.32 were cut to create a 20 foot wide trapezoidal channel in order to tie the Skookumchuck River channel into the lowered Chehalis River channel and provide model stability.

What are the potential benefits of dredging and channel excavation?

- The Chehalis HEC-RAS model predicts the project reduces flood elevations by up to 2 feet in Centralia and by about 1 foot along the airport levee.

What are the potential concerns of dredging and channel excavation?

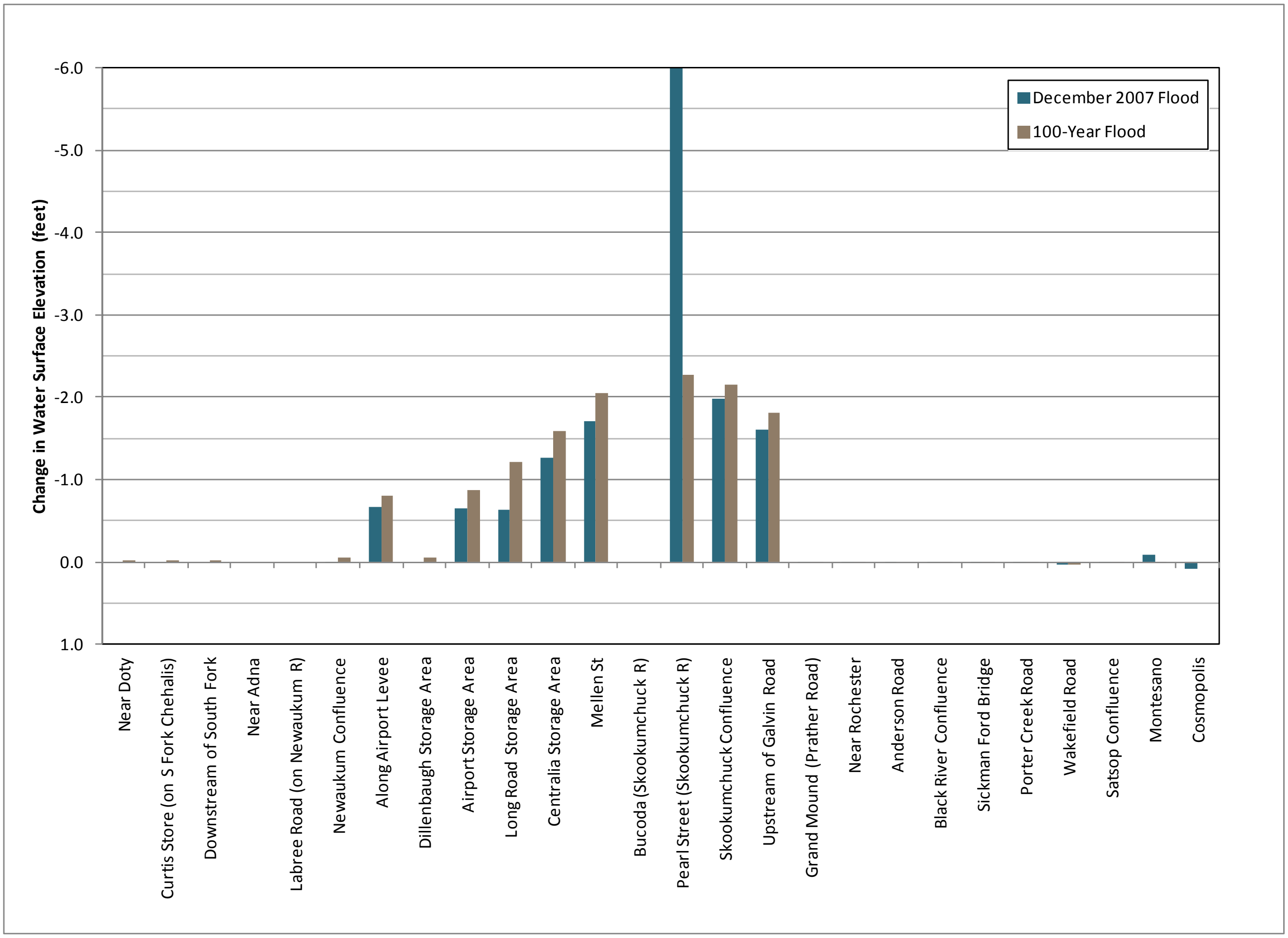
- The P.I.E. report states that channel dredging in this reach of the Chehalis River could result in potentially significant environmental impacts and would raise issues related to permitting feasibility.
- The Chehalis HEC-RAS model predicts that downstream flows and water levels would be increased (generally by less than 0.1 feet).
- Technical experts noted that the project would damage high quality habitat near the WDFW Pheasant Farm, with a potential to negatively impact Chinook, coho, and other species, that it is the only riparian forest in the area for miles, and also provides public access.
- The cost and/or feasibility of the dredging/sediment management project have not been evaluated.

What are some of the major implementation issues of dredging and channel excavation?

- The P.I.E. Report notes that long-term operation and maintenance would be required.
- The P.I.E. report states that water quality in the Chehalis River would likely be affected during construction as a result of sediment releases.
- Secondary impacts (groundwater, side channel disconnections) of the dredge/excavation project have not been evaluated.
- There could be significant permit issues with this project.

Table 5 describes the effect of the potential dredging and channel excavation project, in terms of changes in water surface elevation, at various USGS stream gages in the Chehalis Basin in a December 2007 and 100-year flood event.

Table 5: Effect of Potential Dredging and Channel Excavation Project Flood Relief Alternative



ALLEVIATING CONSTRICTIONS FROM ROADS AND BRIDGES

Road and bridge restrictions throughout the Chehalis Basin can constrain the flow of the Chehalis River and its tributaries during flood events. Major floods have resulted in bridges overtopping and the inundation of access roads; damage has occurred in areas such as upstream of SR-6, Mellen Street, Galvin Road, the Sickman-Ford Bridge, Porter Creek Road, and Wakefield Road. Modifications of the SR-6 Bridge and Mellen St. Bridge were proposed in the PIE Chehalis River Basin Flood Reduction Report (1998), and projects involving modifications to Sickman-Ford Bridge and Galvin Road were referenced in the Comprehensive Flood Hazard Management Plan for Confederated Tribes of the Chehalis Reservation. In fact, the Chehalis Tribe has evaluated options for changes to the Sickman-Ford Bridge and developed a scope for additional engineering design. Modifications to the Porter Creek Road and Wakefield Road (South Elma Bridge) were suggested as possible flood relief projects during lower basin stakeholder meetings in June 2012.

To better understand the potential for reduced flood impacts, various road and bridge removal projects were modeled using the Chehalis HEC-RAS model, including:

- Removing all bridges and approach fills in the entire model
- Removing the bridge and approach fill of SR-6

- Removing the bridge and approach fills of Mellen Street
- Removing the Bridge and approach fills of Galvin Road
- Removing the bridge and approach fills of Sickman-Ford Bridge
- Removing the bridge and approach fills of Porter Creek Road Bridge
- Removing the bridge and approach fills of Wakefield Road (South Elma) Bridge

Due to time and budget constraints bridge removals were modeled by simply removing the bridge structure, approach fills, and upstream and downstream ineffective flow areas from the model. That is, the entire bridge and approach was removed rather than modified. Obviously, this could create significant concerns for transportation and new bridges and approach roads would likely be necessary in some or all locations to replace the existing structures. The purpose of the current modeling effort was to identify the maximum possible benefit that could be derived from bridge removals so that future analysis efforts could be prioritized to structures that showed some possibility of reducing flooding rather than simply to bridges that have been previously identified as concerns.

What are the potential benefits of removing road/bridge constrictions?

- The Chehalis HEC-RAS model predicts removing all bridge/road restrictions results in a maximum 1.3 foot decrease in flood elevations in areas just upstream of some of the bridges, although in general decreases in flood elevations from the bridge removals are small to non-existent.
- The Chehalis HEC-RAS model predicts that complete removal of the Sickman-Ford Bridge and its associated approach fills would lower flood elevations just upstream of the bridge by 1.4 feet (the Chehalis Tribe is currently proposing an option that would drop flood elevation by 0.5 feet at a cost of $2 million.
- WDFW staff indicated that removal of bridges and constrictions could create some benefits for fish habitat and passage.

What are the potential concerns of removing road/bridge constrictions?

- River crossings are vital to transportation, commerce, and public safety and as such it would be necessary to replace some or all of the removed bridges with new roads and bridges. These new roads and bridges could have their own impacts on flooding.
- Benefits of bridge removal are typically only seen for a short reach upstream of the bridge. Removing constrictions and passing more floodwater downstream may exacerbate downstream flood problems. The model predicts increases of up to xx feet downstream of some bridge removals.

What are some of the major implementation issues of removing road/bridge constrictions?

- The cost and/or practicality of the individual bridge removals have not been evaluated, except for Sickman-Ford.

Table 6 describes the effect of the potential removal of all bridges and approach fills project, in terms of changes in water surface elevation, at various USGS stream gages in the Chehalis Basin in a December 2007 and 100-year flood event.

Table 7 describes the effect of the potential removal of Sickman-Ford Bridge project, in terms of changes in water surface elevation, at various USGS stream gages in the Chehalis Basin in a December 2007 and 100-year flood event.

Table 6: Effect of Potential Removal of all Bridges and Approach Fills Project Flood Relief Alternative

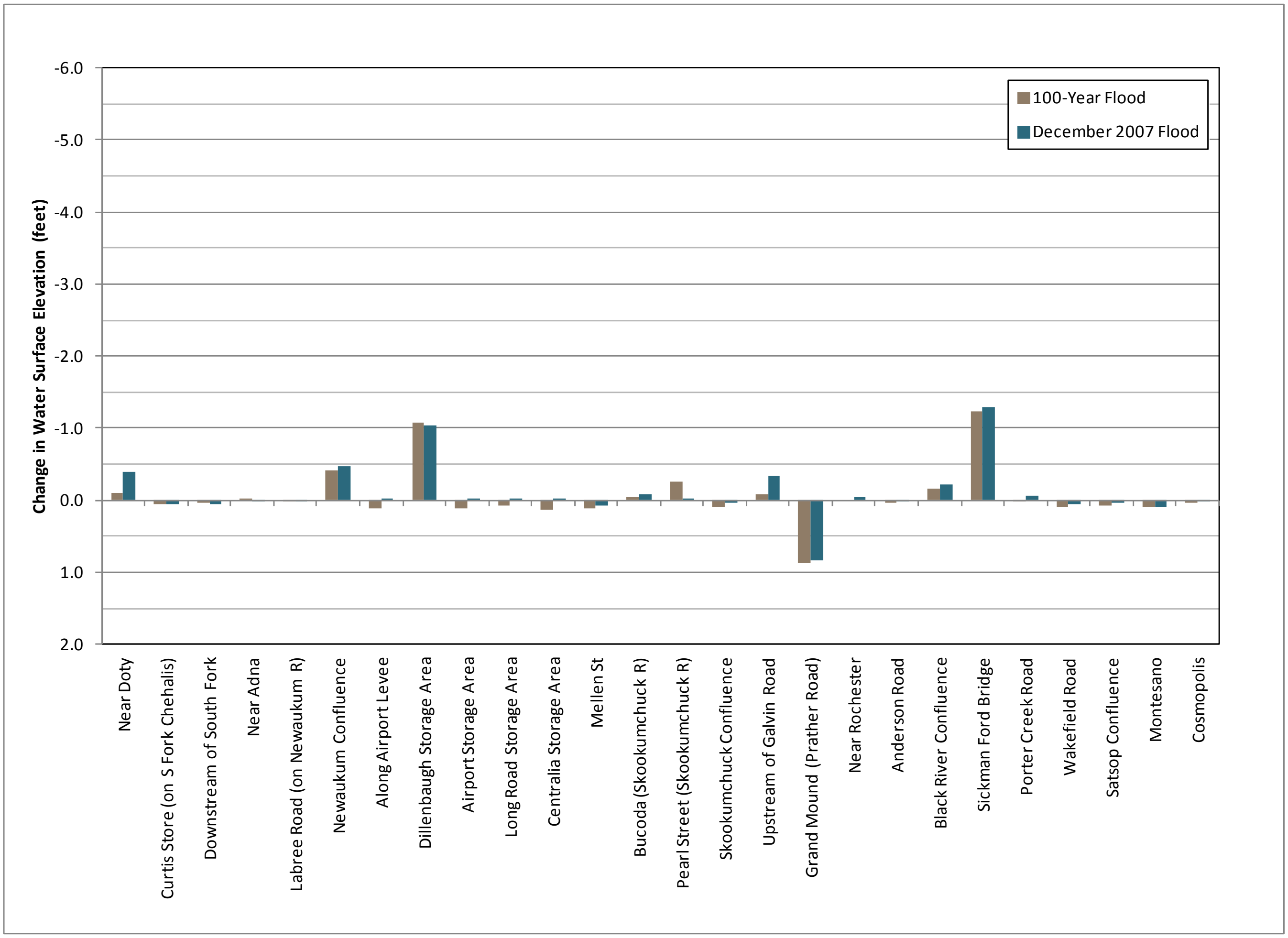
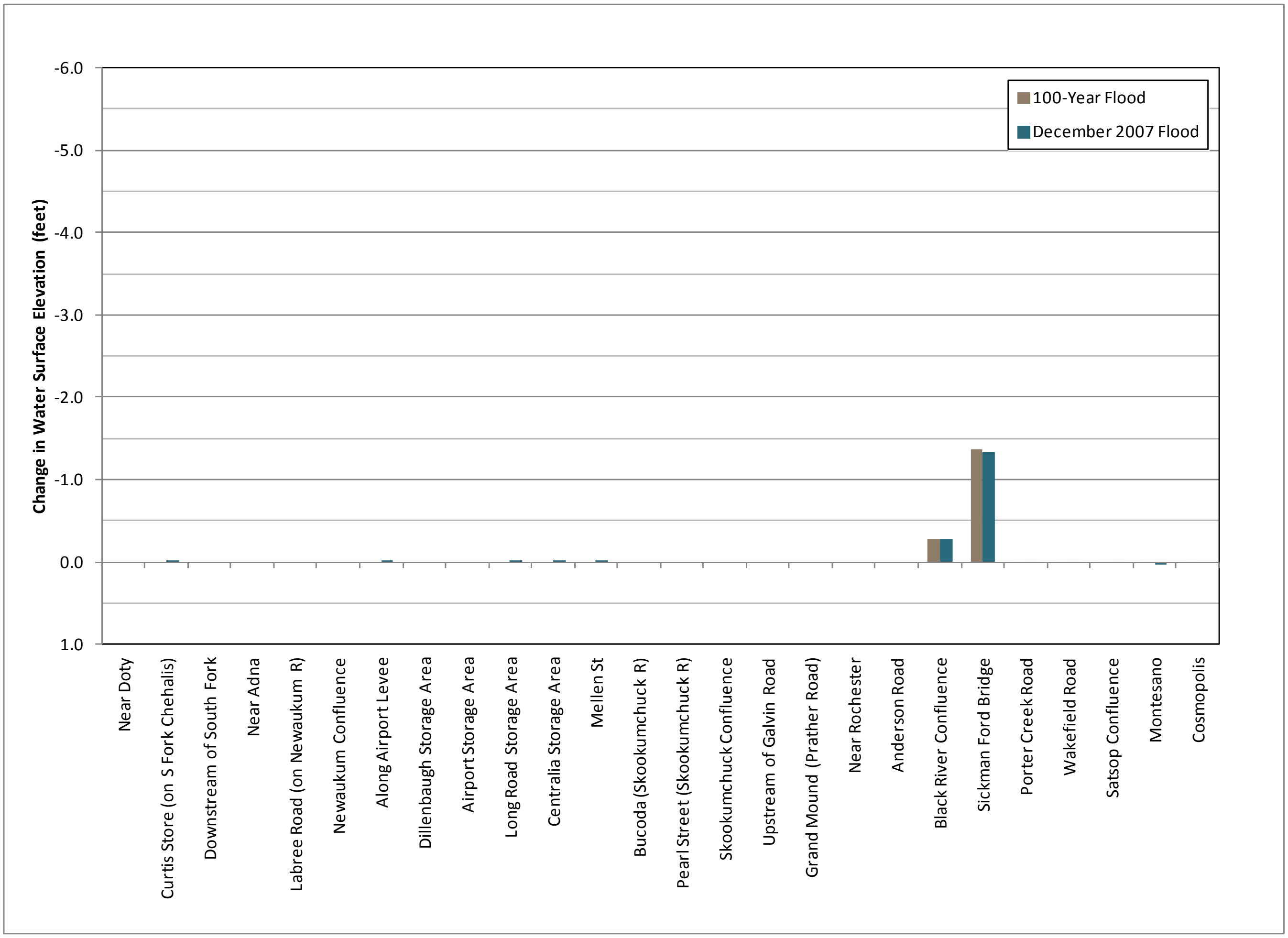


Table 7: Effect of Potential Removal of Sickman-Ford Bridge Project Flood Relief Alternative



FLOOD BYPASS ROUTES/STRUCTURES NEAR MELLEN STREET AND NEAR SCHEUBER ROAD IN CENTRALIA AND CHEHALIS

Historically, the bridge at Mellen Street has been suggested by some as a significant cause of flood impacts in the Twin Cities area. However, the Chehalis HEC-RAS model predicts that there would be little benefit from removing the bridge, in part because the natural topography, even without the bridge, acts as a constriction on flood waters. A different alternative would be to construct a high flow bypass from the left edge of the Chehalis River floodplain upstream of Mellen Street (RM 67.7) to downstream of the Skookumchuck River confluence (RM 66.16). The bypass channel would be approximately 700 feet wide and flow depths would be up to 10 feet deep in a flood such as December 2007.

The Chehalis River downstream of State Highway 603 flows parallel to Highway 6 for approximately 2.5 miles before turning north and flowing under the SR-6 highway bridge near the City of Chehalis. Water overtopping the highway upstream of the Newaukum River confluence enters the Scheuber Bypass reach that reconnects to the Chehalis River downstream of SR-6 near the Chehalis-Centralia Airport, effectively bypassing city of Chehalis. The Scheuber Bypass Alternative would provide culvert or bridge connections under the highway to pass additional flow downstream and into the bypass, with the goal of reducing peak flood levels within the City of Chehalis. A modeled connection was made by placing a large opening within a portion of the lateral structure representing Highway 6 near River mile 77.3.

What are the potential benefits of the Mellen and Scheuber bypasses?

- The Chehalis HEC-RAS model predicts flood elevations reduced by up to 3 feet or more at the Mellen Street Bridge and by about 1.5 feet along the airport levee.
- The Chehalis HEC-RAS model predicts flood elevations in Centralia east of I-5 could be reduced by 2.7 feet.
- Some technical experts see the project as an opportunity for fish habitat restoration or ecological enhancement (e.g., off channel areas, wetlands, etc.).
- Local planners identified the opportunity for community open space and potential active recreation with certain design alternatives, but expressed concerns with permanent water features.

What are the potential concerns of creating the Mellen and Scheuber bypasses?

- The Chehalis HEC-RAS model predicts downstream flows and water levels could be increased by up to 0.25 feet.
- WDFW staff expressed concern about the potential for the project to become a “fish sink” where fish are moved into the area during flood events and then trapped.
- There may be historical and cultural artifacts in the area.

What are some of the major implementation issues of the Mellen and Scheuber bypasses?

- Additional issues, not anticipated based on the conceptual idea, might arise during the design phase.
- Existing development within the bypass area would have to be relocated and the feasibility of this has not been evaluated.
- The cost and/or feasibility of the bypass have not been evaluated.

Table 8 describes the effect of the potential Mellen Street Bypass project, in terms of changes in water surface elevation, at various USGS stream gages in the Chehalis Basin in a December 2007 and 100-year flood event.

Table 9 describes the effect of the potential removal of Scheuber Road Bypass project, in terms of changes in water surface elevation, at various USGS stream gages in the Chehalis Basin in a December 2007 and 100-year flood event.

Table 8: Effect of Potential Mellen Street Bypass Project Flood Relief Alternative

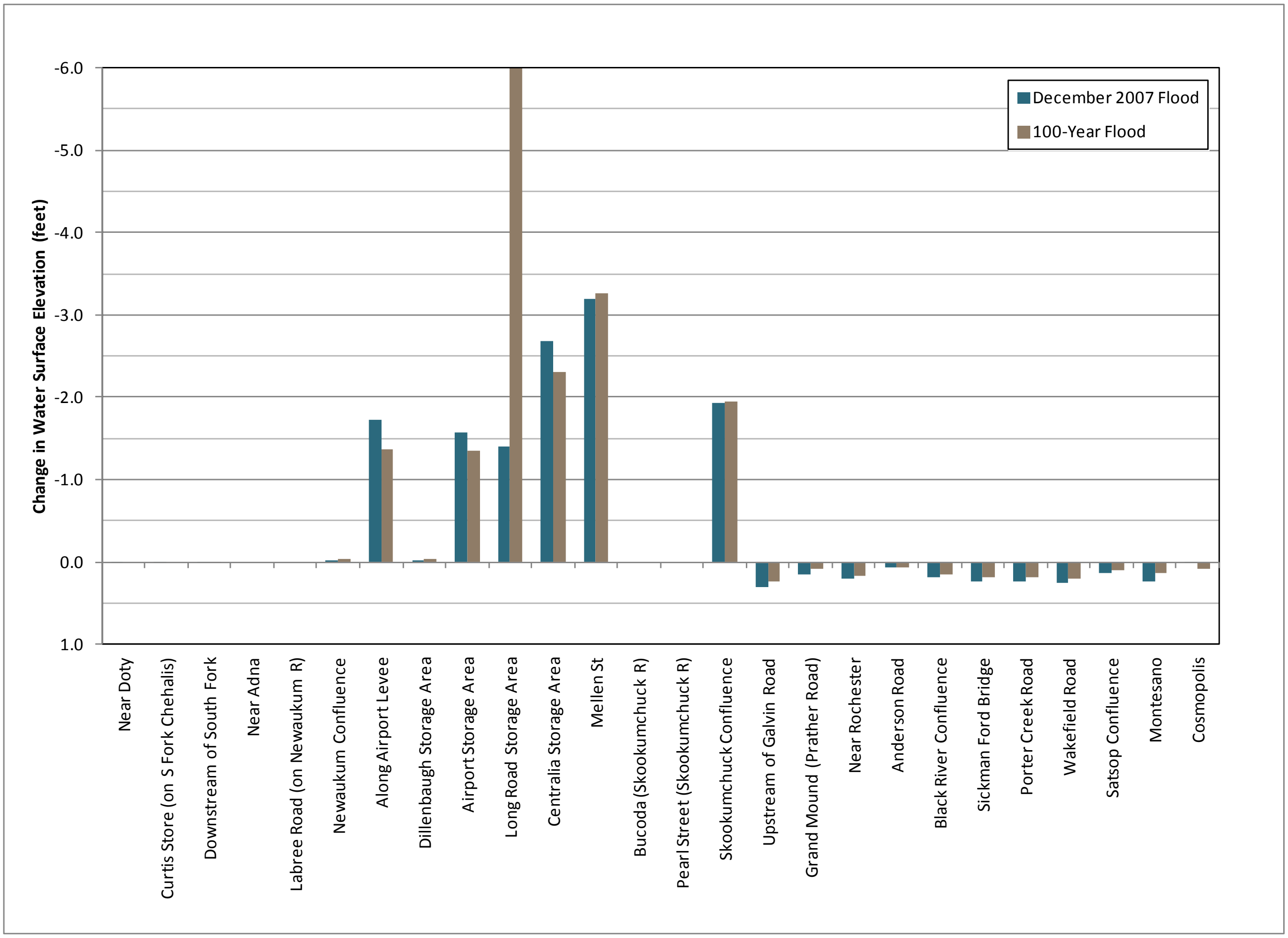
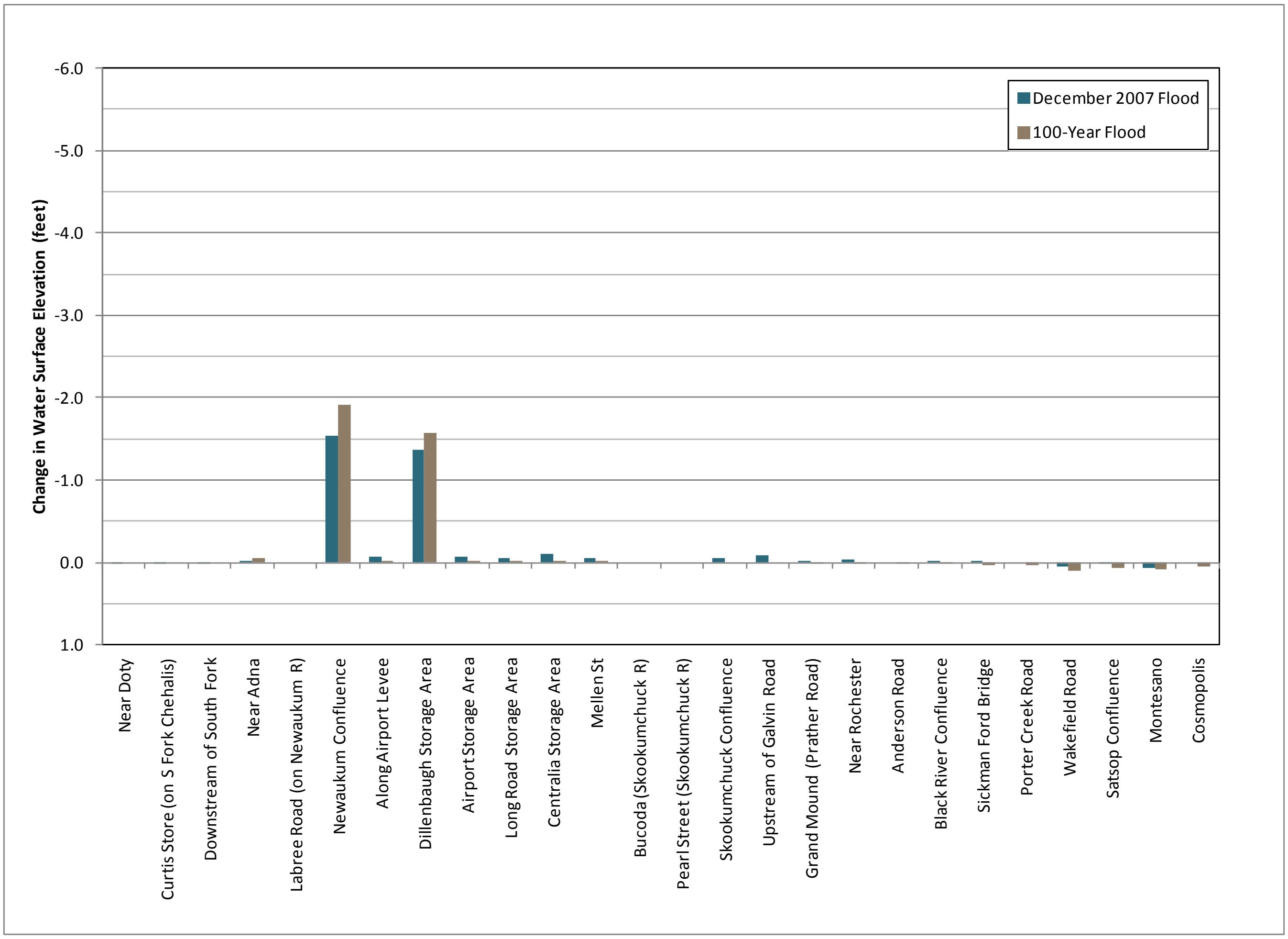


Table 9: Effect of Potential Scheuber Road Bypass Project Flood Relief Alternative



Programmatic Actions

The projects summarized here are non-structural or relatively smaller scale, less capital intensive projects and programmatic actions that provide more individual or localized flood protection benefits, for example, elevating homes in the flood plain or creating farm livestock evacuation areas (so called “critter pads”). Of course, when applied broadly even the smaller scale, more individual projects can have significant benefits and costs. They were selected based on the current focus of interested parties in the Basin.

For the most part, these projects would amplify or expand efforts already underway in the Basin to address flood impacts. Because they generally build on work already underway, they are presented slightly differently than the larger scale projects. Each project is described in terms of work underway, potential to expand this work, and potential costs. Information on potential benefits, concerns, and implementation issues is integrated in the project descriptions.

ADDITIONAL LAND USE AND LAND MANAGEMENT TO CONTROL BUILDING AND NEW FILL IN THE FLOODPLAIN

City and county governments in the Chehalis basin have a number of ongoing land use management policies and actions to mitigate the impacts of flooding.

Most local governments meet or exceed the FEMA and state minimum requirements for restricting development and fill within the floodplain and for ensuring that development which does take place is appropriately flood proofed or elevated. In general, counties prohibit new lots that are wholly in the floodplain; cities allow some infill in the floodplain but require flood proofing and new homes to be elevated. The requirements for elevation vary from one foot above the base flood elevations (100-year) to several feet above the flood of record (2007).

Chehalis, Centralia, Lewis County and Thurston County participate in the FEMA Community Benefit Rating System and Grays Harbor County is considering applying. This voluntary, incentive-based system gives jurisdictions recognition and encourages community floodplain management activities that exceed the minimum National Flood Insurance Program requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risks.

Additional land use management actions might build on ongoing work and could be based on the recommendations of the Chehalis Basin Comprehensive Flood Hazard Management Plan. These include:

- Ensure any new residential structures in the floodplain area elevated at least 2 feet above the base flood elevation, and all new commercial or industrial structures at least 1 foot.
- Establish a lower threshold for when flood proofing and/or home elevation would be required as part of improvements/additions to structures in the floodplain
- Limit critical facilities in the floodplain
- Adopt subdivision and development regulations that avoid or minimize development in floodplains
- Adopt low density zoning in the floodplain
- Encourage all jurisdictions in the Basin to participate in the NFIP CRS program and achieve at least a class 5 rating, which would result in a 25% decrease in NFIP premiums in Special Flood Hazard Areas.
- Require compensatory storage for fill in the floodplain 1:1 or 1.5:1 requirement for storage
- Adopt a zero-rise policy in the floodplain

While some local jurisdictions have expressed support of additional land use management actions, they recognize that it is not a panacea. Each jurisdiction has unique land use regulations, CAOs, building codes, and flood hazard mitigation objectives. Current land use requirements are summarized below in Figures 1 and 2.

Figure 1: Community Rating Service Scores for Chehalis Basin Communities

		LEWIS COUNTY		THURSTON COUNTY		CENTRALIA		CHEHALIS	
CRS CATEGORY	MAXIMUM POSSIBLE POINTS	POINTS EARNED	%	POINTS EARNED	%	POINTS EARNED	%	POINTS EARNED	%
310 (Elevation Certificates)	162	67	41%	147	91%	127	78%	122	75%
420 (Open Space Preservation)	900	328	36%	352	39%	160	18%	261	29%
430 (Higher Regulatory Standards)	2740	391	14%	856	31%	519	19%	402	15%
450 (Stormwater Management)	670	374	56%	531	79%	495	74%	495	74%
520 (Acquisition and Relocation)	3200	100	3%	100	3%	105	3%	264	8%
530 (Flood Protection)	2800	42	2%	84	3%	409	15%	44	2%

Figure 2: Land Use Regulations for Chehalis Basin Communities

		GRAYS HARBOR COUNTY	LEWIS COUNTY	THURSTON COUNTY	ABERDEEN	BUCODA	CENTRALIA	CHEHALIS	MONTESANO	CHEHALIS TRIBES	NAPAVINE
Code Citation		Grays Harbor County Code 18.06	Lewis County Code 15.35	Thurston County Code 14.38	Aberdeen Municipal Code 15.52	Bucoda Municipal Code 15.24	Centralia Municipal Code 16.12	Chehalis Municipal Code 17.21	Montesano Municipal Code 17.40 Article II	Flood Damage Prevention Ordinance, Comprehensive Plan and Zoning Code	Napavine Municipal Code 15.12
Is your community's **floodway boundary definition** more restrictive than FEMA's?		No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Do you use a more restrictive **floodway development** standard than FEMA's?		No. DRAFT CODE: Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	No.	No specification in code.	Yes.
Do you use a more restrictive elevation standard for **development within a floodplain** than the FEMA standard?	*Resi-dential*	No.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes. Shoreline Management Act.	Yes.	Yes.
	Non-resi-dential	No. DRAFT CODE: Yes.	Yes.	Yes.	Yes.	No.	Yes.	Yes.	No.	Yes.	Yes.
Do you require a **set-back** from the OHWM?		Yes. Setback is per CAO and SMP.	Yes. Setback is per CAO.	Yes. Setback is per CAO.	No specification in code.	No specification in code.	Yes. Setback is per CAO.	No specification in code.	Yes. Shoreline Management Act.	No specification in code.	No specificatio n in code.
Do you allow **critical facilities** within the 500-year floodplain?		No specification in code.	Yes.	Yes.	Yes.	Yes.	Yes	Yes.	No specification in code.	No specification in code.	Yes.
Do you require all new development in the floodplain to **determine the BFE** if one has not already been determined?		No specification in code.	Yes.	Yes.	No specification in code.	No specification in code.	Yes.	Yes.	Yes, Shoreline certificate required.	No specification in code.	No specificatio n in code.
Do you require new development to be elevated above the **flood of record?**		No.	Yes.	Yes.	No specification in code.	No specification in code.	No specification in code.	Yes. If higher than the BFE.	No specification in code.	No specification in code.	No specificatio n in code.
Do you require an **elevation certificate** for all new construction?		Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.
Do you use a more restrictive standard for "**substantial damage**" than the 50% required by FEMA?		Yes.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Are there provisions for **compensatory storage** beyond basic NFIP standards?		Yes.	Yes.	No.	No.	No.	Yes.	Yes.	No.	No.	Unsure.

ADDITIONAL FLOOD PROOFING, HOME ELEVATION, AND BUYOUT PROGRAMS FOR STRUCTURES ALREADY IN THE FLOODPLAIN

Many of the jurisdictions in the Basin already have programs that support flood proofing of businesses, home elevation, and buyouts of structures that are in the floodplain. Flood proofing involves changes to a structure or property using berms, flood walls, closures or sealants, which reduces or eliminates flood damage to buildings or property; it is used primarily for commercial structures and properties. Homes in the floodplain can be protected by home elevation, in which the structure is anchored against movement by floodwaters and the first floor of living space as well as all mechanical and services is at least one foot above the elevation of the adopted 100-year flood.

The City of Centralia has raised 173 homes inside the city limits and has approximately 1100 additional homes inside the city limits or the Urban Growth Area that might be eligible for raising. Centralia has acquired two houses inside the floodplain. There are approximately 340 commercial buildings developed within the Centralia city limits and UGA of which some have already been flood proofed. Centralia has acquired three properties in the flood plain.

Thurston County has approximately 947 structures in the floodplain, 924 of which are residential. Thurston County has raised 19 homes in the Chehalis Basin; there are approximately three remaining homes that have suffered repetitive flood loses and county staff believes there may be up to twelve additional homeowners who would be interested in home elevation if it were available. In Lewis County, they have a waiting list for elevation and buyout projects, but no budget to move forward. In Grays Harbor County, most of their prime agricultural land is located in the floodplain, so their need for buyouts, elevating, and flood proofing is more limited.

The cost of home elevation is approximately $30,000 - $50,000 per home. The cost of flood proofing varies depending on the size of the structure and the original construction techniques. The cost of acquisition varies greatly based on the properties involved.

Additional work in these areas would expand and accelerate projects by providing more funding for land owner assistance and buyouts.

ADDITIONAL LIVESTOCK AND FARM EVACUATION AREAS (“CRITTER PADS”)

The State Conservation Commission (SCC) is currently working on a Basin wide project to determine where livestock and farm evacuation areas (critter pads) could help to mitigate potential farm losses during floods. Working with farmers, they have identified potential critter pad sites in the upper basin, and are now looking into the permitting process at seven sites where there has been livestock mortality in the past due to flooding. One site in the upper basin has already been permitted. Work is also underway to evaluate potential sites in the lower basin.

Preliminary studies show a cost of approximately $1 million for the seven potential critter pads currently identified (or an average of approximately $142,000 per pad). If approved, these projects would likely use onsite material that has already been stockpiled, so no new material would be used as fill. The current projects are only for commercial farms with livestock, but the SCC also is looking into other project options that can benefit smaller vegetable farmers. The SCC is continuing to hold landowner meetings with individuals in the lower Chehalis Basin to document the potential need for critter pads in that reach of the Basin, and will have Basin wide details on potential critter/farm pad opportunities later in the summer.

Additional work in these areas would expand and accelerate permitting and construction for critter/farm pads by providing additional funding.

REFINEMENTS TO FOREST PRACTICES TO INCREASE WATER STORAGE CAPACITY PROVIDED BY MATURE FORESTS AND IMPROVE WATER QUALITY AND HABITAT FOR FISH

Forestland comprises approximately 84% of the land base in the Chehalis Basin. Of this land, approximately 91% is subject to the Washington Forest Practices Act (FPA); the remaining forestland is federal or tribal. Stakeholders in the basin have expressed concerns that timber practices may be causing more runoff and erosion and that harvest has removed the natural flood protection provided by mature forests. Certain forestlands in the Basin, like the area above Pe Ell, are in a rain on snow zone; in these zones, the greatest mitigating impact on storm events is provided when forests are over 10 to 15 years old.

Forest management has been criticized by some for encouraging short rotation of harvests, leading to an immature forest that contributes to flooding as well as harvest on steep slopes increasing the chance of landslides. There is little data on the status of forests in the upper watershed areas of the Basin and no definitive evidence that forest practices have contributed or not to flooding in the Basin.

The Washington State Department of Natural Resources (DNR) recently completed a draft report that proposed three projects that could provide tools and information to evaluate new forest practices protection options, and the effectiveness of existing protection in the Chehalis Basin. The full draft report and public comments are provided in Appendix D. The three priority projects, totaling $6.6 million, include:

- Geological mapping and updated LiDAR (Light Detection and Ranging) – estimated $4,274,600
- Evaluation of Hillslopes Regulated under Washington Forest Practices Rules – estimated $200,000
- Road prescription-scale effectiveness monitoring – estimated $2,200,000

LiDAR provides a base elevation model that is critical in developing better hydrogeologic models for flood evaluation; assists in location of wetlands and other critical habitat; and characterizes land cover. LiDAR data can be used to determine if potentially unstable landforms are correctly identified and evaluated for potential impact to public resources. This updated work would take some time to complete: LiDAR could be complete in one year; geologic mapping could take up to 5 years to complete and would need to be integrated into DNR's work plans; road prescription-scale effectiveness monitoring could take up to 10 years to complete.

IMPROVING RIPARIAN AREAS TO REDUCE FLOOD IMPACTS FROM DEBRIS AND INCREASE STORAGE AND IMPROVE HABITAT FOR FISH

The State Conservation Commission (SCC) is currently working on Basin wide project details for riparian improvements to reduce flood impacts from debris along stream banks, increase storage and improve habitat for fish. Riparian areas are land adjacent to streams where vegetation is influenced by the presence of water. Riparian vegetation can slow floodwaters, help maintain stable streambanks and protect downstream property, and improve habitat for fish. By slowing floodwaters and rainwater runoff, the riparian vegetation allows water to soak into the ground and recharge groundwater. Slowing floodwaters allows the riparian zone to function as a site of sediment deposition, trapping sediments that would otherwise degrade the river to build stream banks.

The SCC has estimated that approximately 7,079 acres in the Lewis County portion of the Basin could benefit from riparian improvement work, at an estimated cost of $14 million ($2000 / acre). Costs include site preparation, purchase and planting of trees, and protection of existing trees. The SCC generally provides up to five years of maintenance after a riparian improvement project; maintenance varies in costs depending on the site and would be an additional expense.

It is important to note that the forthcoming SCC project details will provide a sense of magnitude, need, cost, and specific priority areas that would benefit from riparian projects. Future, additional work could build on the work ongoing by the SCC and on riparian restoration and improvement work identified in other documents such as watershed plans.

ADDITIONAL BANK EROSION CONTROL TO REDUCE LOSS OF PROPERTY AND ADDRESS OTHER IMPACTS

Erosion control refers to controlling unnatural rates of silt and sediment movement by reducing the force of flowing water or increasing the resistance of the bank to erosion. Approaches include planting stream-side vegetation, and use of woody debris or other materials on the bank.

The State Conservation Commission (SCC) reports that after the 2007 and 2009 floods, erosion sites have increased dramatically in the Basin. They have identified 119 sites upstream of the confluence of the South Fork of the Chehalis River alone. SCC staff report that they receive frequent calls from landowners concerned with bank erosion, mainly on the main stem and South Fork of the Chehalis, and the main stem and South Fork of the Newaukum River.

Cost estimates for bank erosion control projects are not available at this time; the SCC is continuing to work with landowners to develop a project inventory and cost estimates.

Counties throughout the Basin have noted an interest in various specific bank erosion control projects. Grays Harbor County has expressed interest in a project along the Satsop River, where soil erosion has gone beyond the river bank, resulting in significant amounts of sediment and rock build up. Lewis County has expressed the need for bank erosion projects where roads are threatened. In addition to bank erosion due to flooding, some counties also noted the need to address erosion from farmland throughout the Basin.
A comprehensive strategy for erosion control approved by the state regulatory agencies would expedite action by local landowners.

FLOOD PROJECTS IN THE LOWER CHEHALIS BASIN

The Chehalis Basin Flood Authority has created a Potential Projects Matrix that lists flood hazard mitigation projects extracted from flood planning documents throughout the Chehalis River Basin. Within this matrix, potential projects have been identified in the lower Chehalis Basin/Aberdeen area, including: various floodplain projects involving filling, storm drain piping changes, and tide gates; reparation, maintenance, and potential new construction of levees and dikes in the Aberdeen area; and implementation of home elevation and buyout programs.

Additional meetings have been held recently throughout the lower Basin to discuss potential project needs and areas of concern. In Aberdeen, there is growing concern of the susceptibly to flooding if flows occur during high tides. In Montesano, the Chehalis River is anticipated to soon cut through an ox-bow and point towards Mary's River Lumber. Along the Satsop River, removing a portion of the levee could allow the River to meander into the historic channel migration zone, which is anticipated to reduce flooding and provide fish habitat. Others have highlighted the possibility of the Satsop River flooding areas upstream of Highway 12, but potential solutions have not been identified.

To better understand flow passage along South Elma Road, additional design and hydraulic modeling needs were identified. In the Cedarville/Sharon/Porter to Elma reach, some have identified the need for modeling of the Sickman-Ford Bridge/Harris Creek Culvert Replacement projects, to determine if additional work is needed to mitigate for potential downstream impacts. Finally, many in the lower Basin suggested the need for bank stabilization and sediment management to reduce the loss of land; this could be addressed through a coordinated effort of the Conservation Districts, landowners, Department of Ecology, and Department of Fish and Wildlife.

The projects documented are still preliminary and have not been prioritized. The projects are meant to serve as a potential baseline of projects to be considered for future funding, but additional details regarding project descriptions, flood benefits, and stages of readiness are still needed.

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Appendix B: Final Recommendations to the Governor

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NOVEMBER 9, 2012

Next Steps for Chehalis Basin Flood Damage Reduction

ACTIONS FOR THE NEXT BIENNIUM 2013-2015

Over the last century major floods in the Chehalis River Basin have occurred about twice per decade, causing loss of human life and livestock and damage to homes, businesses, farms, roads and railways. The worst floods on record have happened recently – in 1990, 1996, 2007 and 2009. The economic damages of the 2007 flood alone were estimated at over $900 million, with a third of that damage coming from disruption and damage to the transportation system, I-5, state highways, and rail lines. These recent floods prompted governments and residents of the Basin to re-commit to the task of flood damage reduction. There is broad agreement in the Basin that more should and can be done to reduce damages from large floods.

Since the 2007 flood there has been active engagement of leaders in the Basin to determine a program of flood damage reduction investments. Progress has been made in preparing for future floods, potential flood damage reduction projects have been scoped and evaluated, the flood warning system has been improved, and new tools, such as a hydrologic model, have been developed to better understand flooding in the Basin and the potential impacts of flood damage reduction projects. Decisions and actions are now needed to reduce flood risks for people that live along the Chehalis River.

The 2011 Legislature required the Office of Financial Management (OFM) to prepare a report addressing a series of technical questions and—in coordination with tribal governments, local governments, state and federal agencies—to recommend priority flood damage reduction projects for the Chehalis Basin. Based on the recommendations of Basin stakeholders, OFM asked the William D. Ruckelshaus Center at the University of Washington and Washington State University to coordinate development of the report, working with the entities mentioned above. A draft report – the *Chehalis Basin Flood Mitigation Alternatives Report* -- was made available for public review in July 2012.

In August 2012, as a follow up to the draft report, and in recognition that a time for decision making has come, the Governor tasked a small work group—David Burnett, Vickie Raines, Karen Valenzuela, J. Vander Stoep, Jay Gordon and Keith Phillips—to develop recommendations for flood damage reduction projects. The group was asked to develop recommendations that other Basin leaders and the Governor could consider for endorsement and action. Each member also was asked to interact with their respective constituents to inform the small group's discussions.

This document contains the group's final recommendations to the Governor. Draft recommendations were reviewed by the Chehalis Flood Authority and the Chehalis Tribe. Both broadly support the recommendations.

Objectives

Flooding from the mainstem of the Chehalis River and tributaries impacts people and communities throughout the Basin; accordingly a Basin-wide approach to reducing flood damages is needed.   A Basin-wide approach needs to significantly reduce flood damage for people and communities throughout the Basin by maximizing benefits and avoiding or minimizing adverse human and environmental impacts of flood damage reduction actions. It needs to ensure public safety and protect key community infrastructure and maintain public services during emergencies. A Basin-wide approach can't solve one community's flooding problems by making another community's problems worse.

A Basin-wide approach to flood damage reduction must go hand in hand with improvements in the environmental health and resiliency of the Basin. Flood damage reduction projects must avoid or fully mitigate environmental impacts. Floodplains, water, and shorelines should be managed in ways that reduce future flood damage and enhance overall environmental conditions and habitat for aquatic species. Fish mitigation and enhancement projects should be implemented in concert with flood damage reduction projects. It is critical that harvestable resources of the basin are increased as flood damage is reduced.

Even with efforts to reduce flood damages, flooding is a natural occurrence and will continue to occur. Communities need to be as prepared as possible with flood warning and emergency response systems. Future development in the Basin should not put more people or development in harm's way, and should not increase damages or costs to people already living in and using the floodplain.   By planning ahead, respecting what the river can do, and managing floodplains smartly, the Basin can reduce the risks from future floods.

Strategy

A great deal of research has been completed on flooding in the Chehalis Basin and options to reduce flood damages. Much has been learned since the 1996, 2007 and 2009 floods, and much work has already been accomplished to protect people and property in the Basin from potential future flood damages. These recommendations set forth a two-fold course of action over the next two years that promotes real improvements through implementation of a series of known smaller-scale projects and investments to reduce flood damage, and completes the analysis needed for decisions about the best mix of additional large and small-scale projects to significantly reduce flood damages in the future.

Based on current knowledge, the group believes a combination of actions is needed to <u>significantly</u> reduce damages from major floods. The emphasis is on substantial damage reduction from flood events like those in 1996, 2007 and 2009, although many of the projects contemplated also would reduce damages from more frequent, less severe flooding.   Actions needed include: (1) large-scale capital projects affecting a broad geographic area like a water retention, and/or improvements to protect Interstate 5; (2) smaller-scale capital projects with more localized benefits; (3) environmental projects to enhance overall conditions, aquatic habitat, and abundance of fish in the Basin; (4) land use management to help people already in the floodplain and reduce the potential that new development will increase flood damage; and, (5) an effective system of flood warning and emergency response.

No single project or set of projects will completely protect the Basin from all damage during major floods. There are significant differences amongst leaders in the Basin about the right balance for investment in each of the five categories of action, but there is broad agreement that some investment is needed in each category to substantially reduce flood damage. There also is agreement that we can act now with certainty to implement some actions; other actions, including large-scale capital projects, need more feasibility analysis before decisions about the best way to proceed can be made.

LARGE SCALE CAPITAL PROJECTS

A number of water retention alternatives have been investigated over the last two decades. Based on exploring large and small water retention options, the only known single water retention project that is potentially feasible and could <u>significantly</u> reduce peak flood elevations (and thereby reduce flood damages) for both upstream and downstream communities during major flooding is a large upstream water retention or storage facility on the mainstem of the Chehalis River. Such a structure could hold back storm flows when the mainstem of the Chehalis is the principal source of major flooding, and it could hold back mainstem flows when tributaries like the Skookumchuck and Newaukum are flooding.

Preliminary feasibility studies on a large upstream water retention structure have been done; however, at this time, it is not yet known whether this type of water retention structure is actually feasible. The next steps are to refine the engineering designs, further study dam safety, and identify more specifically the implications for water quality, quantity, and aquatic species. When this additional information is available, the assessment of the economic benefits weighed against its cost of large upstream water retention will need further refinement.

We know from the studies done over the last year that there will be environmental impacts, and there is the potential for environmental benefits, from a large upstream water retention structure. We need to know if the optimum structure is one that would remain open to the river (and to the passage of out migrating salmon) except during flooding, or if the optimum structure would be one holding a permanent reservoir allowing the release of water during summer months with the potential to improve water quality downstream. We need to better understand how and where fish currently use the river and to know what it will take to fully offset any risks to fish and water quality from water retention. In order to build the necessary coalition of support, we need to determine whether and how a large-scale water retention structure could be packaged with other investments to significantly improve the conditions for fish in the Basin.

Given the potential of large-scale water retention to significantly lower peak flood elevations during major floods and thereby provide Basin-wide flood damage reductions, answering these questions should be a primary task for the coming biennium. Many of the analyses contemplated also would support other work in the Basin including smaller-scale capital projects, fish and ecosystem enhancement efforts, and land-use management.

Even with an upstream water retention structure, Interstate 5 would still require major flood protection investments in Chehalis and Centralia, though the investments would be smaller than otherwise would be needed. As the evaluation of a large upstream water retention facility is completed, there also is a need to complete evaluation of I-5 protection alternatives.

SMALLER SCALE LOCAL PROJECTS

With or without large-scale water retention, local projects will be needed to protect key infrastructure, control shoreline erosion, and improve water conveyance and drainage at key points in the Basin. A program of smaller projects aimed at protecting key infrastructure and priority areas through the Basin may provide a measureable reduction in damages from major floods. As the evaluations of large-scale water retention and I-5 protection alternatives are completed, we also should explore the benefits from a combination of smaller projects across the Basin, and continue to construct projects that provide near-term local flood damage reduction benefits. Further analysis of such a program will help determine how much damage reduction is possible, and at what cost, and provide additional context for considering large-scale projects.

FISH AND ECOSYSTEM ENHANCEMENT PROJECTS

There should be a continued effort to explore options for a range of actions that can serve multiple benefits of flood damage reduction and environmental enhancement. There also is a need to develop a coordinated Basin-wide strategy with goals and objectives for enhancement of aquatic species and restoration of ecological functions in concert with flood damage reduction. At the same time there are a number of high priority actions that can be taken in the next biennium to improve conditions for aquatic species and floodplain function and improve understanding of how, when, and where fish use the Basin. These actions should be implemented.

LAND USE, FLOOD WARNING, AND EMERGENCY RESPONSE

The Basin has significantly improved its flood warning system, and individual Basin governments continue to improve their emergency preparedness efforts. Progress on floodplain management policies and programs also has been made, though additional improvements are both needed and possible. Further enhancements to state and local land use policies will help ensure new development and other land management activities do not increase the risk of additional flood-related damages and, to the extent possible, reduce damages and costs to existing development affected by flooding. It will also be important to continuously improve the information base and tools needed to understand flood impacts and to optimize actions to reduce flood damage while improving the environmental health of the Basin.

Workplan for the Next Two Years (2013-2015 State Biennium)

Determine the feasibility and, in consultation with Basin residents and leaders, select large-scale capital projects that will significantly reduce flood damage across a large geographic area, including upstream water retention and I-5 improvements.

- Determine the feasibility of upstream water retention. Determine the optimum water retention structure to meet the objectives of the goals of a Basin-wide solution, further define dam safety requirements and permitting feasibility, so that by December 2014 a policy decision can be made on whether to proceed to permitting a water retention facility as a preferred alternative. Determine the preferred water retention approach between a flood control only dam, multi-purpose dam or single-purpose dam that could be converted to multi-purpose in the future. **Biennium Budget Recommendation: Fund $5.6 M to determine the feasibility of water retention based on Chehalis River Flood Retention Structure 8 Year Project Planning Document (October 30, 2012)**
- Determine the best combination of walls, levees, pumps, bypasses and other structures needed to protect Interstate 5 traffic, the airport and key urban areas of Centralia and Chehalis, if a mainstem water retention facility is in place. Evaluate changes to the project that would be needed to secure comparable protection without a retention facility. **Biennium Budget Recommendation: Fund $3M to determine feasibility of I-5 protection options, and$230K to improve damage estimates to residential and commercial structures and improve the economic impact estimate from I-5 closures.** .

A. Continue to invest in smaller projects that provide local flood benefits where any adverse flooding or environmental impacts can be avoided or mitigated. This could include protecting water treatment facilities, protecting shorelines, improving existing local levees, and improving water conveyance at bridges.

Continue to explore smaller-scale projects that can provide flood damage reduction and environmental benefits, and, in consultation with Basin residents and leaders, identify and implement high priority projects. **Biennium Budget Recommendation: Fund $10M to design and construct high priority flood damage reduction projects. The Flood Authority recommended 18 critical projects costing $39.4M in the 2013-15 biennium (project list attached). Their highest priority projects would fund construction of nine projects in the 2013-2015 ($10 M). Design for these projects was initiated in this fiscal year with Jobs Act Now funds, as identified by the 2012 Legislature. The Governor's work group acknowledges and supports the priority projects recommended by the Flood Authority, with the exception of the Airport Levee Phase II ($2.6M), which will require additional evaluation. To ensure that available funds secure near-term benefits, we recommend a review of the preliminary design of each the Flood Authority's high priority projects early in 2013, where each project is evaluated to determine the best design for reducing flood damage. The recommended design and evaluation should be presented to the Flood Authority and the work group to determine if the project design achieves a high standard of benefit based on cost, potential flood damage reduction and other benefits, and potential to complete construction in the 2013-2015 biennium. If the projects are not determined to achieve the high benefit to cost then funding should be shifted to the next priority projects on the list. The group recommends the remaining projects on the Flood Authority list be further prioritized and any remaining funding within the $10 M budget for 2013-2015 be provided to the next highest priority projects.**

B. Evaluate the extent of flood damage reduction that could be possible through a Basin-wide program of smaller-scale projects. To the extent it is not already summarized in the Alternatives Report by the Ruckelshaus Center, summarize existing information (and any new information) on what is known about the relative contribution to reduction in peak flood level elevations (and concomitant flood damage reduction) from various floodplain management practices, including channel dredging, riparian wetland restoration, forest practices, flood easements on farm lands, road maintenance, removing bridges and constrictions, and removing, protecting, or avoiding floodplain development. **Biennium Budget Recommendation: Fund $250K to identify and evaluate Basin-wide program of smaller-scale projects.**

C. Develop and implement a coordinated strategy with goals and objectives for improving the conditions for fish and ecological function in the Basin in conjunction with flood damage reduction projects and implement known initial high priority projects. **Biennium Budget Recommendation: Fund $5M to develop the strategy and implement initial high priority projects (see attached project list).**

D. Implement a strategic program of buyouts and flood proofing for structures that have recurring damage requiring frequent public and private expenditures for repairs after flood events. **Biennium Budget Recommendation: Fund $2.25M to implement a strategic approach to reducing damage from repetitive losses.**

E. Continue to improve the Chehalis Basin hydrologic model and other data and analysis that support understanding of potential flood impacts and optimization of flood damage reduction actions. **Biennium Budget Recommendation: Fund high priority information gaps as part of the feasibility analysis for water retention, costs covered in A, above. In addition, fund $100K for a geomorphic analysis of the basin to determine potential migration zones of the river and potential impacts on flood damage reduction and ecosystem improvement projects.**

F. Ensure flood warning and flood preparedness systems are ready and effective for the public and emergency responders. **Biennium Budget Recommendation: Not eligible for state capital funding but local governments are encouraged to continue their support the following:**

- Coordinating Basin-wide flood awareness and provide opportunities for people living and working in the floodplain to be aware of risks, warning systems, and emergency preparedness and response.
- Ensuring emergency supplies and equipment are available and ready at the start of each flood season.
- Maintaining the flood warning system.
- Conducting training and drills.

In addition to these investments, we recognize that to realize this effort, additional and ongoing work will be required of the state agencies with relevant expertise and responsibilities, including the Departments of Fish and Wildlife, Ecology, Natural Resources, Commerce and Transportation. We understand that this requirement will be in the range of an additional 1M and we hope it can be advanced as vital to the success of the capital investments contemplated here.

Moving Forward

We believe implementation of these recommendations will involve an ongoing investment of time and expertise as well as the capital investments contemplated above. Through our work together and with the Flood Authority and the state team, we see the value of a policy-task force of Basin leaders with the Governor's Office working in concert with technical and other advisors. Although the work we were originally asked to do is complete with these recommendations, we respectfully offer that, if requested, we could continue to serve as a policy task force through this fiscal year, shepherding this effort through the Legislative process and its initial implementation. We see an ongoing role in this remainder of this fiscal year to:

- Communicate with the legislature and other opinion leaders as the legislature considers the Governor's recommendations.
- Oversee initiation of the critical path fish studies in a manner that is transparent, objective and trusted by the interested parties.
- Oversee development of the technical scopes of work and requests for proposals for the other dam feasibility studies and other programmatic recommendations so that the work can start immediately once the budget is approved.
- Assist with transition to whatever governance and management structure may be put in place for the 2013-2015 biennium.

Lead roles will need to be determined in this fiscal year so work elements of the framework are ready to go and can be accomplished in 2013-15 biennium. These include lead roles for:

- Dam scoping including engineering, geotech, fish studies, benefit cost, hydraulics/hydrology, permit scoping, and project management.
- Aquatic species and ecosystem enhancement strategy and projects.
- Identification and analysis of a suite of smaller scale capital projects.
- Implementing a comprehensive approach reducing repetitive loss and land use.

This effort will require robust ongoing management and governance to be successful, especially in the timelines contemplated.

In the short term, we recommend that, whether you choose to continue with a policy task force such as ours or not, you ensure a project manager to coordinate the work. We also recommend a team of technical experts be convened to develop scopes of work and requests for proposals for the work contemplated to start immediately at the beginning of the next biennium. This group should rely heavily on expertise from the current state team and the Chehalis Tribal staff and bring in other expertise as appropriate. There is a need to begin some of the fish studies in this fiscal year to have the data and analysis ready in time for key decisions in the next biennium. In addition, we recommend continued coordination and collaboration with the Flood Authority to serve as a broader sounding board for the work. This collaborative structure will ensure that work is transparent, broadly supported, and ready to go as soon as the new budget is available.

In the 2013-2015 biennium there is a need for both continued management and technical work and policy decisions to implement this framework.

We recommend that the next Governor appoint a policy task force in spring 2013 to oversee initial implementation of this framework and make the recommendation to the Governor and Legislature about the feasibility of the dam, preferred alternative for I-5, and next expenditures needed to continue implementation of the framework beyond 2015. We recommend the next Governor should consider the following factors in appointing this task force: skill and capacity to forge consensus amongst diverse interests in the Basin, broad geographic representation, and ability to create broad support for action across the Basin.

The Flood Authority should continue to serve as a sounding board, recommend local capital projects for the 2015-17 biennium, and oversee implementation of the local capital projects funded in the 2013-15 biennium. The Flood Authority also should oversee the strategy for reducing repetitive flood loss and land use management, evaluate a suite of local flood damage reduction projects, and implement and maintain the flood warning system.

The technical steering committee should continue to oversee the ecosystem enhancement and fish studies and dam scoping work, and make recommendations to the policy group as necessary.

A project manager/facilitator is needed support the policy group, Flood Authority, and technical steering committee in the short term and through the 2013-2015 biennium.

Summary of Recommended Expenditures for the 2013-2015 State Biennium Capital Budget

DAM SCOPING	**$5,600,000**
I-5 Alternatives	$3,350,000
Construct Local Projects	$10,000,000
Basin-wide Assessment of Local Projects	$250,000
Enhance Ecological Functions	$5,000,000
Reduction in repetitive loss to residential structures and improved land use management	$2,250,000
Flood Warning/Preparedness	0
Improve Basin Information	$100,000
State Agency Roles	$1,000,000
Project Management	$1,000,000
Total	$28,550,000

There are a number of areas where Federal funding could add to the proposed state funding and increase immediate efforts to reduce flood damage. These opportunities should be pursued aggressively.

Appendix C: Potential Capital and Construction Project Combinations

Appendix C: Potential Capital and Construction Project Combinations

Because of the complex hydrology and diverse geography and human communities in the Chehalis Basin, no single project can completely alleviate the adverse impacts of flooding. To spark conversation and illustrate some of the potential trade-offs between large capital projects, the draft report described three example project combinations.

- Combination 1 was made up of the WSDOT floodwalls and berms to protect Interstate 5, the Airport levee improvements, and the Mellen Street and Scheuber Road floodwater bypasses. It also included a modified concept for Skookumchuck Levees from the Corps' Twin Cities project, and modification of the Sickman-Ford and Wakefield Road (South Elma) bridges.
- Combination 2 included a dam on the Chehalis Mainstem, the Airport levee improvements, and a small floodwall along I-5 near Dillenbaugh Creek (instead of the I-5 floodwalls and berms). Like Combination 1 it also included improvements to the Skookumchuck Levees.
- Combination 3 was made up of a dam on the Chehalis Mainstem, the Airport levee improvements, and floodwalls and berms to provide additional certainty about protection of Interstate 5. As with the other two combinations, improvements to the Skookumchuck Levees, and modification of the Sickman-Ford and Wakefield Road (South Elma) bridges also were included. Combination 3 was essentially the same as Combination 1 except the dam on the Chehalis Mainstem was substituted for the Mellen Street and Scheuber Road floodwater bypasses.

The purpose of the project combinations was to show how potential flood hazard mitigation benefits might change if various projects were combined. Each provided a different mix of potential flood hazard mitigation benefits and potential natural resource risks and impacts, and costs. They were not presented as preferred or recommended options, only as examples. Comments on the project combinations were mixed, and none of the exact combinations described in the draft report are reflected in the recommendations forwarded to the Governor.

The potential project combinations included in the draft report are as follows.

COMBINATION 1 – LARGE CAPITAL FLOOD HAZARD MITIGATION PROJECTS WITHOUT A DAM

Combination 1 is made up of the WSDOT floodwalls and berms to protect Interstate 5, the Airport levee improvements, and the Mellen Street and Scheuber Road floodwater bypasses. It also includes a modified concept for Skookumchuck Levees from the Corps' Twin Cities project, and modification of the Sickman-Ford and Wakefield Road (South Elma) bridges.

Protection of Interstate 5 and the municipal airport with floodwalls, berms and levees provides collateral flood hazard mitigation for areas of the Twin Cities. It also raises flood elevations in some areas. Floodwater bypasses at Mellen Street and Scheuber Road increase flood hazard mitigation benefits in the Twin Cities and reduce the areas where flood elevations are increased in the Twin Cities. Based on predicted water level reductions, which are shown in Figure 3, in events such as the 2007 flood it is estimated that Combination 1 would completely dry 680 residences and 230 commercial structures and reduce flood elevations at 240 additional residences and 70 commercial structures in the Twin Cities area. Flood levels would be increased at 60 residences and 20 commercial structures, and these impacts would require mitigation. The hydraulic model predicts downstream increases of up to 0.5 feet (near Porter Creek Road in the 100-year event) and a range of smaller increases depending on which event and location are looked at. It also predicts reductions of 1 foot or more at some locations (near the downstream bridge replacement projects).

Figure 3: Combination 1 - Flood hazard mitigation in Twin Cities Area by Combination 1

	2007			100-YEAR		
CHANGE IN WSEL (FT)	RESIDENCE	COMMERCIAL	TOTAL	RESIDENCE	COMMERCIAL	TOTAL
<-2	330	200	530	210	150	360
-2 to -1	330	50	380	170	70	240
-1 to 0	260	50	310	210	30	240
Sum Decreased Flooding	**920**	**300**	**1220**	**590**	**250**	**840**
0 to 1	50	20	70	30	20	50
1 to 2	10	0	10	0	0	0
>2	0	0	0	0	0	0
Sum Increased Flooding	**60**	**20**	**80**	**30**	**20**	**50**

WETTED VS. DRIED	RESIDENCE	COMMERCIAL	TOTAL	RESIDENCE	COMMERCIAL	TOTAL
Wetted	10	0	10	10	0	10
Dried (Total)	680	230	910	340	170	510
Dried (by Wall Protection)	80	30	110	60	20	80

Notes: 1) Structures with less than 0.1 ft change are not tabulated 2) Structures assumed to be located at centroid of parcel 3) Each structure counted once, regardless of size 4) A single parcel may have multiple structures 5) Wetted vs. Dried structures are not "in addition to" the structures in the Change in WSE tables.

Protection of Interstate 5 with floodwalls would impact some wetland and stream courses, requiring mitigation; in addition residents of the Twin Cities have expressed concerns about floodwalls, both from an aesthetic and from an access point of view. It has an estimated cost of $80-100 million. The Mellen Street and Scheuber Road floodwater bypasses have not been thoroughly evaluated, they may present issues for fish by acting as potential fish "sinks" and issues associated with existing development in the bypass areas. Their costs have not been estimated.

Modifications to the Sickman-Ford and Wakefield Road bridges would address the potential for these structures to constrain floodwaters and provide localized flood hazard mitigation benefits. In past flood events, these bridges have been overtopped or access roads have been inundated. For purposes of this report the potential flood hazard mitigation benefits of bridge modifications were modeled by simply removing the entire bridge and bridge approach fills. This provides an estimate of the maximum possible benefits of bridge work. Creation of new bridges and approach roads, which likely will be desired, are not addressed. Removal of the Sickman-Ford Bridge is estimated to reduce flood elevations in the area immediately upstream of the bridge to the Black River confluence and possibly further. Water surface elevations in the vicinity of the bridge could be reduced by up to 1.4 feet with a complete bridge removal. These would taper out to zero approximately 6 miles upstream. The Chehalis Tribe has evaluated options for changes to the Sickman-Ford Bridge and developed a scope for additional engineering design that is moving forward to provide further evaluation of this project. Removal of the Wakefield Road bridge (South Elma) is estimated to reduce flood elevations by up to a foot or more in the area immediately upstream of the road fill on the right (north) bank floodplain. The road currently acts as a dam impeding flow in the floodplain and causing high upstream water levels. Expanding the size of the overflow bridge from 300 feet to 1,200 feet would offer localized benefits. The water surface reductions would be up to 0.6 feet at a distance of 4 miles upstream of the bridge in the 100-year event.

Improvements to the Skookumchuck River levees were originally evaluated as part of the Corps Twin Cities Project. A modified proposal might include only improvements to the levees along the lower 2 miles of the Skookumchuck River and the levee downstream of the Skookumchuck River confluence with the Chehalis. To be viable the alternative would need to ensure the levees were raised to a sufficient height to prevent overtopping in the 100-year and/or December 2007 flood events. This alternative project was evaluated using the hydraulic model and found to reduce flood elevations in the Ford Prairie area, Zenkner Valley, and the Edison District by several feet. In combination with the other project elements described above the Skookumchuck levee improvements could be a significant element in a Basin wide flood reduction alternative.

In summary, Combination 1 would reliably protect transportation infrastructure and provide some significant collateral flood hazard mitigation benefits in the Twin Cities -- completely drying 910 residences and commercial structures. The addition of targeted bridge modifications and Skookumchuck levee work would provide additional localized flood hazard mitigation benefits in those areas. Combination 1 does not provide flood hazard mitigation in the upper watershed or in the Newaukum, or in the lower watershed or Grays Harbor. It also does not provide flood hazard mitigation upstream in the Chehalis River tributaries such as Skookumchuck flooding in Bucoda. Flooding in those areas would need to be addressed through identification of local projects (such as the levee under discussion to protect the well field in Bucoda) and through programmatic approaches such as expanded flood proofing, home elevations and buyouts, livestock and farm pads, and riparian and other improvements that protect and restore natural floodplain function.

COMBINATION 2 – ADD A DAM ON THE CHEHALIS MAINSTEM AND REDUCE INTERSTATE 5 WALLS AND BERMS

Combination 2 includes a dam on the Chehalis Mainstem, the Airport levee improvements, and a small floodwall along I-5 near Dillenbaugh Creek (instead of the I-5 floodwalls and berms). Like Combination 1 it also includes improvements to the Skookumchuck Levees.

Addition of the Chehalis Mainstem dam increases flood hazard mitigation in the Twin Cities area and provides significant flood hazard mitigation in both the upper and lower watershed. It is predicted to reduce flood elevations in the upper watershed by up to 10 feet or more on the mainstem and by up to 6 feet on the South Fork. The flood elevation at the Curtis Store would be decreased by 6.1 feet. Based on predicted water level reductions, which are shown in Figure 4, in events such as the 2007 flood the combination of a Chehalis Mainstem dam and Airport Levee is predicted to completely dry 700 residences and 210 commercial structures and reduce flood elevations at an additional 270 residences and 120 commercial structures in the Twin Cities area. In a flood such as the December 2007 event, it is predicted to reduce flood levels from 2.7 to 3.4 feet at the Skookumchuck Confluence and upstream of Galvin Road, and from .7 to 3.4 feet from Anderson Road to Wakefield Road.

Figure 4: Combination 2 – Flood hazard mitigation in Twin Cities Area by Combination 2

	2007			100-YEAR		
CHANGE IN WSEL (FT)	RESIDENCE	COMMERCIAL	TOTAL	RESIDENCE	COMMERCIAL	TOTAL
<-2	370	230	600	100	120	220
-2 to -1	400	60	460	330	110	440
-1 to 0	200	40	240	190	40	230
Sum Decreased Flooding	**970**	**330**	**1300**	**620**	**270**	**890**
0 to 1	0	0	0	0	0	0
1 to 2	0	0	0	0	0	0
>2	0	0	0	0	0	0
Sum Increased Flooding	**0**	**0**	**0**	**0**	**0**	**0**

WETTED VS. DRIED	RESIDENCE	COMMERCIAL	TOTAL	RESIDENCE	COMMERCIAL	TOTAL
Wetted	0	0	0	0	0	0
Dried (Total)	700	210	910	270	140	410

Notes: 1) Structures with less than 0.1 ft change are not tabulated 2) Structures assumed to be located at centroid of parcel 3) Each structure counted once, regardless of size 4) A single parcel may have multiple structures 5) Wetted vs. Dried structures are not "in addition to" the structures in the Change in WSE tables.

According to the Anchor QEA Fish Impact Study, a dam on the Chehalis Mainstem could provide flow augmentation during summer months which may increase spring Chinook salmon populations by 122%-146%; however, there is not agreement about the certainty or extent of these potential benefits. The Anchor QEA Fish Impact Study predicts reductions in winter steelhead populations to be 32%-81% and reductions in coho salmon populations are predicted to be 28%-67%, due largely to a decreased quantity of habitat and increased percentage of fine sediments downstream of the dam. These impacts would need to be mitigated. EES Consulting estimates the cost of the dam at $245 million.

Combination 2 is predicted to protect Interstate 5; however, there is some uncertainty about the protection because water level predictions show water levels a few inches from the road surface in some areas. As in project Combination 1, targeted bridge modifications and Skookumchuck levee work would provide additional localized flood hazard mitigation benefits in those areas.

In summary, because of the dam, Combination 2 would provide significant flood hazard mitigation benefits in the South Fork Chehalis and throughout the mainstem Chehalis including in the Twin Cities where it is predicted to completely dry 910 residences and commercial structures. Like Combination 1 it does not provide flood hazard mitigation in the Newaukum, or upstream in the Chehalis River tributaries such as flooding from the Skookumchuck River in Bucoda. Flooding in those areas would need to be addressed through identification of local projects (such as the levee under discussion to protect the well field in Bucoda) and through programmatic approaches such as expanded flood proofing, home elevations and buyouts, livestock and farm pads, and riparian and other improvements that protect and restore natural floodplain function. Combination 2 is predicted to protect I-5, but this protection is less certain that that provided by Combination 1 or Combination 3 because floodwaters in a 2007-like event would be within several inches of the road surface.

COMBINATION 3 – A DAM ON THE CHEHALIS MAINSTEM AND INCREASE INTERSTATE 5 PROTECTION WITH WALLS AND BERMS

Combination 3 is made up of a dam on the Chehalis Mainstem, the Airport levee improvements, and floodwalls and berms to provide additional certainty about protection of Interstate 5. As with the other two combinations, improvements to the Skookumchuck Levees, and modification of the Sickman-Ford and Wakefield Road (South Elma) bridges are also included. Combination 3 is essentially the same as Combination 1 except the dam on the Chehalis Mainstem is substituted for the Mellen Street and Scheuber Road floodwater bypasses.

As in Combination 2, addition of the Chehalis Mainstem dam instead of the Mellen and Scheuber floodwater bypasses increases flood hazard mitigation in the Twin Cities area and provides significant flood hazard mitigation in both the upper and lower watershed. Outside of the Twin Cities area Combinations 2 and 3 would have very similar benefits to each other, with substantial water surface elevation reductions in most locations. Within the Twin Cities there would be some differences as the I-5 flood walls and levees would cut off some flow paths leaving areas downstream of these protected and areas upstream with slightly higher water levels then if the flood walls were not present.

In Combination 3 additional protection of Interstate 5 would be provided through floodwalls and levees. This increases the certainty of protection for transportation infrastructure and likely would provide some additional flood hazard mitigation benefits in the Twin Cities areas. These benefits have not yet been quantified. As in project combinations 1 and 2, targeted bridge modifications and Skookumchuck levee work would provide additional localized flood hazard mitigation benefits in those areas.

Natural resource impacts from the dam and from impacts to wetland and stream courses from I-5 floodwalls and berms would require mitigation. In addition there may be community concerns from Twin Cities residents associated with floodwalls.

In summary, Combination 3 would provide the most robust flood hazard mitigation of any of the project combinations – providing flood hazard mitigation throughout the mainstem Chehalis including in the Twin Cities from the dam and protecting Interstate 5 with floodwalls and berms. This would be the most costly of the project combinations if the bypasses cost less than the $245M estimate for the dam.

Like Combination 1 and 2, Combination 3 does not provide flood hazard mitigation in the Newaukum, or Bucoda. Flooding in those areas would need to be addressed through identification of local projects (such as the levee under discussion in Bucoda) and through programmatic approaches such as expanded flood proofing, home elevations and buyouts, livestock and farm pads, and riparian and other improvements that protect and restore natural floodplain function.

COMPARISON OF PROJECT COMBINATIONS

One of the purposes of the project combinations is to begin to illustrate where large construction projects have the potential to provide flood hazard mitigation benefits and where they, as currently framed, so far do not, and to spark conversation and comparison about “tradeoffs” between potential projects and combinations.

A dam on the Chehalis Mainstem provides the most flood hazard mitigation throughout the mainstem Chehalis; it also presents the most uncertainty and potential risk to natural resources particularly salmon and steelhead and has the highest cost of those projects that have been estimated. Floodwater bypasses such as at Mellen Street and Scheuber Road also could provide flood hazard mitigation in the Twin Cities; however they do not provide as much as a dam and they do not address flooding in other areas of the Chehalis mainstem.

Improvements to the Airport levee and at least some floodwalls will be needed to protect the airport and Interstate 5. This infrastructure is not completely protected by a dam on the Chehalis Mainstem in all storm events considered. Additional certainty for I-5 protection is provided by floodwalls and levees, however these structures raise aesthetic and natural resource concerns.

Figure 5: Flood hazard mitigation Project Combination Comparison Table

	COMBINATION 1	COMBINATION 2	COMBINATION 3
Upper Mainstem	No effect	Significantly more flood hazard mitigation than Combination 1	Significantly more flood hazard mitigation than Combination 1
Newaukum	No effect	No effect	No effect
Skookumchuck	Protected by levees	Protected by levees	Protected by levees
Twin Cities	Significant flood hazard mitigation	Relatively more flood hazard mitigation over Combination 1	Relatively more flood hazard mitigation over Combination 1
Lower Mainstem	No effect	Significantly more flood hazard mitigation than Combination 1	Significantly more flood hazard mitigation than Combination 1
Grays Harbor	No effect	Significantly more flood hazard mitigation than Combination 1	Significantly more flood hazard mitigation than Combination 1
I-5 and airport protection	Protected by walls and levees	Generally protected	Protected by walls and levees

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Appendix D: Individual Stories and Reflections on Flooding in the Chehalis Basin

Appendix D: Individual Stories and Reflections on Flooding in the Chehalis Basin

This appendix is a compilation of individual stories and reflections on flooding and flood impacts shared by residents of the Chehalis Basin.

Some individuals were provided the questions below, though most individuals chose to simply reflect on their communities and experiences of flooding in the Basin.

- What is special to you about the upper mainstem area (places, people and/or experiences)?
- If you were to describe this area to out of town friend or visitor, what you would highlight?
- What hopes do you have for the future of the area?
- When you think of the major floods over the past two decades, what are the strongest memories?

RON AVERILL, LEWIS COUNTY COMMISSIONER

Q - What is special to you about the upper mainstem area (places, people and/or experiences)?

A - The Twin Cities is the center of population with about 1/3rd of the residents. It is also the seat of government and the most urban area of the county with two ports, an industrial park, hospital and commercial areas. The I-5 corridor and the BNRSF/UP rail lines run through this corridor offering opportunities for jobs, commerce and recreation. Lewis was Washington's first county in 1843 and its infrastructure has been developing ever since.

Q - If you were to describe this area to out of town friend or visitor, what you would highlight?

A - The Twin Cities is nestled in an agricultural valley surrounded by forested hills and mountains. It has the first Community College in the State of Washington, operating continuously since 1925. The seat of Government is in Chehalis and both Centralia and Chehalis have industrial ports. While the major industry used to be the natural resource industries, the communities have slowly been diversifying. This is an area where you have urban services in an area which is still predominantly rural.

Q - What hopes do you have for the future of the area?

A - Persistent flooding has always been a problem in the Twin Cities area prompting hundreds of studies – but all without success. When a major flood arrives all commerce comes to a stop, homes, businesses and commercial establishments are inundated and there are major threats to life and property. My real hope is to someday implement a solution that will end the cycle of damage and recovery. In my estimation, the best way to accomplish mitigation is water retention

Q - When you think of the major floods over the past two decades, what are the strongest memories?

A - Lots of water, interdicted roads and bridges and major property damage. Not only is the freeway closed, but routes into and out of communities are blocked as well, and not infrequently access to the major hospital is blocked for four to five days. During a flood an estimated 450,000 acre feet of water accumulates along the I-5 corridor. The only solution that can provide relief is water retention.

JULIE BALMELLI-POWE, TWIN CITIES RESIDENT

Q - What is special to you about the upper mainstem area (places, people and/or experiences)?

A - The culture, the history and generations of family ties

Q - If you were to describe this area to an out of town friend or visitor, what would you highlight?

A - Breathtaking natural beauty; a step back in time; low keyed and slower paced; where your neighbors are there when you need them and not when you don't; a stone's throw from just about any activity you desire

Q - What hopes do you have for the future of the area?

A - An end to severe flooding which in turn would set the stage for a thriving economy – hopefully without a huge influx of people to spoil the essence of the area {one can wish, can't they? ;o) }

Q - When you think of the major floods over the last two decades, what are the strongest memories?

A - (After the 2007 flood, it's hard to remember the others, except for the fact that they were major.)

The longest night of one's life – working in the dark and the rain to save our animals, equipment and supplies while yelling "Get back in the house!!" to our three small children who 'wanted to help', standing knee deep in our carport, separated from us by 50 yds. of rapidly rising flood water; checking the water level every 20-30 minutes until it reached its peak around 3:00 a.m.

The pain and sorrow of friends and family – some who lost just a little, and some who lost almost everything, including the desire to go on

The disheartening sights and sounds – helicopters flying back and forth throughout the night rescuing those who were stranded on their rooftops; livestock and pets crying, frantically trying to escape the flood waters

The helplessness -- being cut off from everyone you care about – knowing that others are in need, but there is no way to reach them

The debris – everywhere – and I mean everywhere- dead things, yards and yards of plastic, jugs of oils and chemicals, fencing, haylage bales, commercial propane tanks, coolers, toys, wheels and tires, green house supplies, lumber, trees, piles of brush and dead grass, and lots and lots of garbage and mud -everywhere

The devastation – homes, farms, and businesses devastated; yards full of things that were once inside buildings – furniture, beds, fixtures, clothes, desks, papers, curtains, toys, carpet, sheetrock, livestock feed, all coated with 'flood mud'; flood mud, like pudding, was in and on everything – crawl spaces, mailboxes and inside homes and outbuildings – too soft to shovel, too thick to hose out

The horror stories – during the flood, one could only imagine the tragedies happening elsewhere, nothing you imagined was as bad as what really had – families, who the day before were secure in their homes, were now homeless with just the clothes on their backs; horses trying to swim to safety only to get caught in a fence under the water, unable to get free; having to listen to baby calves that were moved to a make-shift critter pad that never flooded before, crying in fear throughout the night, trying to escape the rising flood waters, but unable; the farmer who shot his whole bloodline of hand raised registered cattle, that after chasing them up on a hill, had followed him back to the barn where they had always felt safe - to him, shooting them was more merciful than watching them drown; sheep and cows stranded in barns, crawling on top of one another trying to stay above the water, some piles of dead animals reaching as high as the rafters, occasionally a bitter sweet ending with the animal on top surviving; and then there were the hundreds of cats, dogs, horses, sheep and cattle that were never found; the rescuers who dropped everything to help those in need, only to return to the fire station to find themselves victims of the flood as the cars were now submerged

The feeling of pride and thanksgiving – the resiliency of the communities, the generosity of friends, neighbors and total strangers willing to go miles and miles out of their way to bring food and supplies to those in need - everyone pitching in, helping out, rebuilding; FEMA employees thinking they were going to be swamped with people wanting their share of government handouts, surprised by how few showed up

The fear – the fear that comes back every time there is snow on Baw Faw; the fear that comes back every time the weather man mentions 'pineapple express'; the fear that comes back at the start of ***every*** flood season; the fear of not knowing if we will be as fortunate the next time it happens because it's not a matter of 'if', but 'when'; the fear that the next time it happens, people and businesses will just give up; the fear that the government will again build something in the floodway that gives them the 'biggest bang for the buck' to protect their infrastructure while again worsening the flooding for the people who live here; the fear that the Governor, like most politicians, will not keep her promise to protect the residents of the basin; and mostly the fear that a common sense solution like a dam, which our best science shows will protect I-5, reduce flooding for most with no negative impacts to others, will improve water quality and quantity, and will improve the economy of depressed communities that in turn will benefit the state and feds, will be passed up due to the unsubstantiated fear that it 'might' not, or passed over for a cheaper solution that values commerce more that human life or the environment

Q - Feel free to tell us more if you like.

A- Homesteaders and early settlers of the basin moved into the valley knowing that it flooded. They adjusted their home sites and their livelihoods to live with flooding – even welcomed it as it renewed the nutrients in the fields and gave them an unexpected 'vacation' from their everyday chores.
Starting in the 1940's and continuing still today, government (because it knows what's best) began making improvements at the expense of those who were already living here. In an attempt to protect and improve public interest, the following projects were completed that have substantially contributed to increased flooding in the upper basin…

** Building of the airport levee during WWII to protect the airport for national security – this flood protected area is now home to K Mart, Walmart, Home Depot, Applebee's, Walgreens and strip malls

** Construction of I-5 and State Hwys. 6 and 12 to improve transportation up and down the western U.S. and to the ports on the coast

** Removal of overflow bridges on State Hwy.6 creating a levee

** Resurfacing of roads and highways without first grinding them down because it's cheaper that way, thus creating higher levees

BRENDA BOARDMAN, DOTY/DRYAD

I was in the flood of 2007. I suffered all the anxieties and hard work that everyone else experienced at that time. I was out of my home for seven months and my vacation rental business was closed for one year. I did not have flood insurance as my home was not designated to be in a flood zone. I have taken $40,000 of my retirement money and have acquired an $87,000 loan to put my property back in order. If you include that landscaping and cleaning of my 25 acres that means about five years of my time, money and effort.

I oppose the building of the dam above PeEll for several reasons. I do not think it will solve the problem. The rains come to many places in the hills and to build a dam in only one place more that likely will not always be the solution. I also think that the proposed site of the dam, two miles above PeEll, would not give sufficient time for the town to be evacuated in a flood event. I feel that the study about the location should be completed before anything else in done concerning the dam.

It is my very strong feeling that the FLOOD PLAIN BELONGS TO THE RIVER. There should be NO building and NO filling in the flood plain! I think money should be spent to remove homes and business from harms way. This may take many years but it would solve the problem for good.

Equally important, I think every effort should be made to protect the river so it can help with flooding waters. I feel that logging practices need to be much more stringent when logging hills, riparian area and building logging roads. Though I know some of this has been done I do not feel it is enforced strictly enough nor is it strong enough. These improved practices would help the salmon and wildlife immensely as well as reduce flooding.

I think everything should be done to accomplish the above before anything is done to dam the rivers or build structures to redirect water. This will take time but I feel it will be a much better, safer, natural and long lasting solution to this difficult problem.

LYNN DAVIDSON, LEWIS COUNTY

It's so bitter sweet. I look around at what Jim and I fought so hard to rebuild after the December 3, 2007 flood. He's gone. Lost to cancer.

We moved to Lewis County in 2006, after Jim had been diagnosed with and had undergone treatment for cancer. We sold everything to buy our “home” free and clear. Then came the Dec. 2007 flood. We lost everything. We had one half hour to leave our home. We didn't know it at that time, but as we spent 12 hours on higher ground, waiting to be evacuated by the Coast Guard, we knew. We knew the river would take everything. And it did. The house, the car, the motorcycle, the RV, everything we had worked for was gone. Gone in 12 hours. A lifetime of hopes, dreams all gone in 12 short hours.

Why? Why did it happen? Why did what we had worked so hard for been lost so quickly? Was it clear cutting? Was it the “perfect storm” or was it because all these many years nobody had really addressed the “problem?” Not the “problem” of flooding I-5 and shutting off commerce but, the problem of saving homes and lives. Aren't those truly more important?

Jim's gone now. So is mom. Mom, who was 95 when she was air lifted out by the Coast Guard. Mom, who had to go live with relatives in Oregon while we tried to rebuild our lives. How can this be? We worked so hard to achieve some sort of life after retirement – and it's gone. Gone up in muddy river sediment. Jim died this last month from cancer. Mom died the prior year. Now I'm alone. What can I do? Declare bankruptcy and go into foreclosure. We took an SBA loan after the flood to rebuild. We owned the land. It seemed the right thing to do. After all, it had never flooded there before. Now the real estate market has bottomed out. I can't sell our home for what we owe and Jim is gone. I can't maintain it, either financially of physically. I have MS. We've lost everything to this damn flood. Am I bitter? Yes! Is there something that could have been done long ago to prevent this flood. YES!!! But it was ignored. The Corps of Engineers was handling everything with it's proposed levy solution – that's gone on for over 30 years!!! Why wasn't something done before 2007 – after the 1996 flood!! Am I mad? Yes! And what are you, the State of Washington, going to do about it? Just protect the commerce on I-5 – or maybe, just maybe protect the CITIZENS OF THE STATE OF WASHINGTON, instead of just the REVENUE for the State of Washington.

The retention dam needs building NOW! Lives need to be saved, not fish, not commerce, but people's lives. Now is the time to act – not 30 years from now.

STEVE EMRICH, CHEHALIS RESIDENT

I own roughly 30 acres along the Chehalis River and have lived on or near this street since 1958. Yes, I am an old timer around here at 55 years.

I am a firefighter for the city of Chehalis and also a member of the swiftwater team that is part of the fire department. When the flood started to rise in the early morning hours, I was called back to work with the swiftwater team and did so until 9 pm that night. During that time, my wife and 4 yr. old daugher were at home and watched and prepared for the flood and river rise. The water eventually came over our road, up to our house and eventually 8"in our house. When I got home at 9 pm, I arrived by boat onto our water covered back porch and our 4 yr. old riding her tricycle in the flood water in our house,(why not!) It is an eerie feeling hearing water running by outside your house during a flood, as we have had a few times in the past years, but to have it flowing through your house is another story altogether. Early the next morning, the water was receeding and we washed,swept the muddy silt out as best we could. A boat ride around the farm showed 5' of water in my farm shop, 2 other barns where equipment is wintered over under cover, 2 buildings with 3' of water in them which had the farm quads, motorcycles, tools and other personal storage items. It took another day for the water to receed sufficiently to get a look at the devistation in those buildings, barns etc. When we got to them, everything in those structures were in a state of complete devistation and full of mud and debris. All our tractors went 2/3 under, all quads and power tools were submerged, (and we had all these up on high ground, trailers and tables in prior preparation for this event) fuel containers were floating, one farm equipment shed washed away, 7 cords of firewood flowed downstream, all our fences for cattle around our section for cattle were bent, broken, covered with debris or just plain gone. We own the house next door as a rental and it suffered the same devistation as ours did. It was quite a chore hauling out all the insulation from under the house as well. We tore out 4'-9' of walls in our house such as sheetrock, insulation,etc. and re-did all the outlet wiring, tore out floors, sanitized and just plain worked day and nearly all night for 10 weeks to get our house back to liveable condition. The farm took 3 more years to get back in shape with equipment repairs, fence and building repairs, tool and equipment cleaning, etc. We had to do some downsizing of buildings and equipment as too costly to rebuild and replace some things that were lost or damaged.

The bummer of it is our flood insurance policy that we had written for the farm and rental as well as our property which was supposed to be the same as our home and farm owners policy was only written for our house! Not even covering our carport and outbuilding where 3 freezers full of home grown vegetables, beef and other items were floating in the flood water. 4 tons of pellets for our winter heat source was a pile of soggy sawdust. We used 2 kerosene heaters to dry out our house and to try to keep warm with for 10 weeks. Thank goodness we have a multi-level house where we lived upstairs with a shower, sink, bathroom and microwave and bedrooms for that 10 week time we did the downstairs repairs. Doing all the work ourselves in the repairs, we had just enough house insurance coverage for the new walls, flooring, appliances ansd electrical needs. The outbuildings, rental, and the farm were all out of pocket for all the needed repairs to farm eqiuipment and buildings, etc.

All in all, we got stronger from it, rolled up our sleeves and just did what was needed to get back on our feet. I sure do wish the folks at the Army Corps of Engineers would have listened to my dad's recommendations 40 years ago as well as my time talking with them 10 years ago about flood protection. 1 dam on the upper Chehalis and re-do the Scheuber road by-pass drainage ditch under highway 6 and along the Scheuber road to alleviate early rises of flood water. It is so easy to see and would protect I-5 as well as the people living in the valley. In regards to the diking projects suggested, I was told by a rep. of the Army Corps that I toured with that I lived close to the river, on the wrong side of the dikes and to keep paying my property taxes, but the flood waters would be worse than ever before and that it was just too bad for me and the good of the majority! Well, Thanks for your time and I hope a lot of folks take the time to write you their side of the flood story and their suggestions for prevention ideas. The 1 dam makes sense to me, keeps one tributary clear and provides better flows in the summer months, and hey, why not try to get the reservior to be a campground area for campers and tourists to stimulate some growth and business out in the PeEll area!

KEN ESTES, MAYOR, MONTESANO

Q - What is special to you about the lower main stem area (places, people and/or experiences)?

A - Established businesses, farming and produce, light industry, it is a transportation hub, with fishing, recreation and scenic views.

Q - If you were to describe this area to out of town friend or visitor, what you would highlight?

A - Shopping, viewing, recreation, fishing, a place you can find nearly every service-from lumber companies, parts stores, vehicle sales, butchering, flying, the Rail Road station and freeways, and especially tourism (like the Veterans Museum).

Q - What hopes do you have for the future of the area?

A - That their flooding issues were solved without causing additional flooding here in the lower basin; that for the both of us, the economy would improve and we continue to work together to solve both problems.

Q - When you think of the major floods over the past two decades, what are the strongest memories?

A - Water over roads and the freeway, pretty much isolating us from supplies and needs; loss of livestock and their feed; flooded homes; flooding made worse by incoming tides and a west wind.

Q - Feel free to tell us more if you like.

A - Here in the lower valley we appreciate the surrounding hills down to the valley floor; which blends into the perfect setting for industry, logging, farming, residential, fishing, hunting, recreation and our beautiful small cities and resourceful people. And all this is away from the hustle-bustle of the big city. Truly, this is what makes America.

BOBBI FENN (ON BEHALF OF GLADYS ORAVETZ)

I am submitting this story for my 85 year old Mother (Gladys Oravetz) who has lived in the same house since 1971. This is the first and only home she and my Dad ever owned. When the water started rising I called and told her I thought she needed to leave and her feisty response was that she would put her boots on and she would be fine. Needless to say, the fire chief evacuated her from her home and the water rose way above grandma's boots.

Mom lost everything in her home that was under four feet. Her house, was ripped apart all the way down to the studs, all the sheet rock, insulation, carpet, furniture, her appliances, bed, heating system, everything was gone. In addition, family pictures, books, music albums. The sewing machine my Dad bought for her, gone. The scrapbook of their life together all the way back to WWII, gone. Her car also was gone. But the worst thing that was taken from her was her sense of her own history, and her feeling of security. She still lives in fear when it rains hard.

I had only seen my mother cry one other time in my life, when my Dad passed. This was so traumatic for someone of her age to come back from. She has very limited income, and her physical ability to do things to put her home back together was limited as well. This resulted in some pretty traumatic times for all of us.

Kind neighbors loaned her a 5th wheel to live in while her home was repaired, it took three and a half months, but we moved her back in March.

The flood took a lot of things from my Mom, but it took part of her from me as she has never been the same since.

It is my hope that no one ever has to go through anything like this again. People should be able to feel secure in their homes and not be afraid when they hear the rain on their roof.

DAVE FENN, FARMER

Thanks, I think, for this "opportunity". I think you know how important this issue is to the area, so I feel pressure to make others recognize the effect 2007 and other floods has had on the area.

Q - What is special to you about the upper mainstem area (places, people and/or experiences)?

A - My experience is mainly in the Boistfort Valley, on the South Fork of the Chehalis. For me, the obvious is that I grew up here. My grandparents came here over 100-years ago, so the roots are pretty firm. In the south end of the valley where we live there was much turnover of settlers until after 1900. For whatever reason after that a group of families came here and most are still here.

Through the middle of the 1900s the valley, including the PeEll side on the mainstem, was an area of small farmers and loggers. In Boistfort my father was part of a group of people that started a volunteer fire department, a Lions club, a community water system and Little League. Weyerhaeuser was the main logging employer and was a wonderful partner in the community. I have come to realize that was a golden age in which to grow up. It was a good time for the whole of the United States and Boistfort was as good as anywhere. Life is never perfect, but our little school had some extraordinary teachers. Some were lifetime members of the community and did an extraordinary job. Another went on to become the dean of department of school administration for New York University on Long Island. Another ended his career as the superintendent of one of the Intermediate School Districts in the Seattle area.

My point is there was, and continues to this day, an extraordinary sense of community here. That was proven by the events following the flood and was true also in the PeEll, Doty area. By the way, "the flood " now means, 2007. There was a community plan in place to respond to an emergency and it worked. The mobilizing of people to help each other was amazing. And then the outside help that arrived kept the locals going through to the end. An example of spontaneous help involved my daughter's family. They live on Ceres Hill Rd. near the confluence of the two forks. I called at daylight to tell them it looked as though the River would be higher than it had ever been and they needed to take their cars and tractor to the hill. They only had time to get to the car, stop and get the 80 something neighbor lady and drive up the hill. A neighbor on the hill took them in for several days, until they were able to clean the house enough to move back in the upstairs.

Then the outside help started arriving. Through donations and locals that had not been flooded, the Grange fed helpers and affected people for months. The Mormon Church sent hundreds, if not thousands, to the area to do the initial cleanup. Then churches and other organizations came for months to assist. The Mennonites had members come from as far as Vanderhoff, B.C. and New York state There were donations from everywhere to help rebuild. As I told Jim, I had a church member from Tacoma tell of going to New Orleans to help rebuild and he was stunned by the difference between here and there. In New Orleans they were sitting and waiting for help. Here, everyone immediately had started helping each other begin the rebuilding process.

I have also told Jim of the aid from state and federal agencies to help landowners clean up and rebuild. Mark Clark, Valora Loveland and Doug Sutherland, working with the Legislature, the Governor and other agencies funded the Conservation District and DNR to allow aid to get the cleanup and repairs done. The FSA was also instrumental in that happening.

Even though there is a great sense of community and self reliance here and a heartwarming reaffirmation of the basic sense of human decency from the volunteer help., the flood has had serious consequences on the psyche and economics of the area. Several homes were removed, not to be rebuilt. Some good families moved away. There are potential serious restrictions on a number of homes and farms that may have long term effects on their use and value. Besides the money, people have spent untold hours dealing with cleanup and plans for the future. Flooding is a weight on the shoulders of the community.

I just reread question one and realized I had strayed from telling what is special to what the flood has done to us. Kind of proves that the flood has changed us.

Q -If you were to describe this area to out of town friend or visitor, what you would highlight?

A - The first two questions are really interrelated for me. First , our valley has a long history. The natives long used the area for hunting and gathering. The assumption is that the prairies here were the result of regular burning to keep open areas for hunting and gathering. Other than the Hudson's Bay Company, some of the first settlers north of the Columbia came to the valley. I am not a linguist, but my understanding is Boistfort is an Americanization of French words bois and faw (thus Baw Faw Grange and Peak) and means large or strong forest or a small park like valley surrounded by a large forest. The first settlers took out donation land claims, making for interesting property lines. Boistfort School District was the first in the territory and was No. 1 until consolidation of several districts made the current district. Somehow Steilacoom managed to take the No. 1 designation in that process. At one point the UW was proposed to be built here.

Weyerhaeuser and Long Bell were the main early logging companies in the area. Long Bell morphed to International Paper and that land has been sold several times. Weyerhaeuser had a logging camp and railroad that hauled logs to the water in Olympia to be towed to Everett. The current main fire station was built from salvaged lumber from the Weyerhaeuser logging camp. Weyerhaeuser is still a main player in the area.

In the early 1900's Herman Klaber developed what was reported to be the largest hop yard in the world. He went down on the Titanic on the return from Europe on a hop selling trip. The field north of the school is still known as the Hop Yard.

These bits of history show that the only constant in the world is change. The Valley today is a bit of a bedroom community with some commercial farms and a number of part time farms. These part time farms still produce a significant amount of revenue and maintain the valley floor as an ag area. One recent change is the development of specialty farms such as direct marketing and cheese producers.

Now I get back to the flood. The resiliency and determination of the community is there and important. Most folks love the beauty of the area and the people here and want to save it. A plan to reduce flooding is important to keep agriculture and forestry viable as well as protecting people’s homes and land values.

Q - What hopes do you have for the future of the area?

A - I think I am a pragmatist and a borrower of good ideas, but I can also dream big. In my dream I see using PL 566 and its Watershed Protection and Flood Prevention program to revitalize the area. As I said Wednesday evening, the program goals fit perfectly with the needs of the Chehalis basin. I envision several water retention structures of two types: smaller ones that only held water for a short period of time to take the top off any flood; larger structures that held water to the summer to also help fish, irrigation, recreation, small hydro production, cities and homes. Water for irrigation would make for a more certain crop production and enhance the prospect of people investing for the long term in ag production. The reduction in flood levels and danger would also make for a more certain economic future for the area.

I also see improvement of riparian habitat as part of the process, but not at the expense of severely restricting production agriculture or forestry. I see more committed and productive farms, large or small. I see more people taking pride in their community and home or farm. I see more people having appreciation for their streams and the wildlife that need them. In my big dream we find a way to extend the harvest interval on forest land. On steep slopes I feel that would have a significant conservation and water retention benefit. I know that is a very controversial issue, as certain regulations force timber owners to cut when they might not want to. They have also forced themselves into a corner economically by cutting to the point they must keep a short rotation just to have an income stream. I think the buffer issue needs to be modified in exchange for the issue of rotation length.

Our area suffers from a couple issues that plague many communities, especially rural ones. One is an aging population. Probably only time will take care of that. Any community needs young vibrant families to make it a thriving community; to get that you need good economic prospects. Our whole basin needs that without destroying our land base for farms and forestry that provides jobs and makes it a beautiful place to live. The growth management act and the counties have done a most uninspired job of that. In Lewis county we small parceled thousands of acres. We should have required clustering of home sites to save most of large parcels. Instead we have these 5 and 10 acre lots that are really blight on the land. This is really too long a discussion for here, but is a real issue.

The other rural problem is directly related to the flood for us. The flood lowered property values and drove some good people away. The result is cheaper homes and rentals, which may not bring your most sterling citizens to your area. Some people needing lower cost housing are great people getting started and working their way up. Others are people just trying to scrape by and are unwilling or unable to improve themselves. Many of them are not contributors, but takers. I am trying not to sound too negative, but there is a social cost to the nonproductive beyond just the public funds.

Maybe I could sum it up by saying I see a cleaner, more productive, more economically vibrant, more cohesive community for my family and neighbors. The history is here, the basis is here, we need a plan to carry us forward.

Q - When you think of the major floods over the past two decades, what are the strongest memories?

A - Should have quit after the last paragraph as I am not sure I can do better than that. I have covered a lot of this, but will see if I can list more. 2007 was by far the most significant for our area. One would be the effect on the outlook and response of people. It was varied. A very few cut and ran. Some people were almost frozen into inaction. Others took a deep breath and went to work. The extraordinary outpouring of money, time and support from total strangers still chokes me up. I think they and the community fed off each other. We kept working because they were helping and they kept coming because I think they knew they were making a real difference in helping people help themselves.

When government focuses on a problem with real determination to act, it really can work. Regulatory decisions were made quickly and in a relatively practical manner after the flood. After about a year things started to bog down to the usual pace. The frustration with the politics and pace of the Flood Authority became indescribable. But the determination of the One Voice group and some others is significant and different than the history in the basin. I want to put Mark Clark and the Conservation Commission and myself and the Conservation District in the determined category. I have spent a lot of time and become far more involved in the District than I ever intended. Part of my determination is I have people tell me nothing can be done. We will see about that.

MILES FOLKS, NC MACHINERY CO., CHEHALIS

NC Machinery has had a significant presence in the City of Chehalis at I-5 Exit 79 since the 1960"s as a significant employer and significant local tax payer in support of the construction, logging, and power generation industries. Our company's ownership has financially and materially supported community improvement efforts including, but not limited to, annual Scholarships to Centralia College students, major contributions for the Providence hospital expansion, and donations of equipment to local communities for the construction of youth ball fields.

Logically, floods and the associated losses have moved from the category "possibility of flooding,"' to "in the likely event of flooding". It is our sincere desire that the various governmental agencies responsible for protecting the people and business assets make the necessary physical improvement to mitigate the Chehalis River flood threat.

While the Management of NC Machinery makes no claim to have the answer to which project is the one that will be the "silver bullet," upon review of the many possible options it is our belief that a retention dam/generation dam provides the ability to retain a significant portion of flood waters where the waters begin while offering a method of recapturing some portion of construction through future sale of generated power via a reusable, green, fuel source, that being water.

Using the retention dam in conjunction with the expansion and raising the existing dike system, we believe, provides a significant bulwark against future flood events that would allow our ownership to enjoy an improved outlook of the safety of our significant Chehalis assets.

NC Machinery, Chehalis suffered fairly minor flood damage in 1990, significant damage in 1996, and catastrophic damage in 2007. As has been illustrated in Chehalis Draft Report 7-12-2012, the floods appear to be progressively more damaging with each event and be assured the insurance carriers for NC Machinery have taken note. In those events our company has rebuilt the facility twice, lost inventory, twice, had our business interrupted, and had to retool twice. But what about the other non-monetary costs of our employees?

From November to March, every single year, when it snows, then rains: rains heavily for extended periods: when the Willapa Hills carry a heavy snow load: or a Pineapple Express is forecasted, the personnel in our Chehalis facility become a little more tense because they know "this could be the year we get another flood, and if we get another one ……..?" Then, there are the personal tragedies of lost homes or belongings, friends and co-workers who need a refrigerator, bed, or sofa because theirs "got wet." These are the personal sides of the Flood Control Project and not quantifiable in a cost/benefit analysis, how do you put a value on the knowledge that your home will be where you left it when you return from work or a shelter. Those of us who were only inconvenienced open our wallets, homes, and cupboards all the while giving thanks that it isn't us needing assistance.

EDNA FUND, COUNCILMEMBER, CENTRALIA

Q - What is special to you about the upper mainstem area (places, people and/or experiences)?

A - When I read "The [Chronicle’s] Flood of 2007," on page 58, there is a picture of a woman wiping mud from a lady's face, who had several feet of water in her store. On page 22, is a picture of a volunteer rescuing a 4-year-old girl from the flood waters. Those pictures paint a picture of people helping people. Assistance provided without any remuneration. Our community pulls together in times like these.

Q - If you were to describe this area to out of town friend or visitor, what you would highlight?

A - Our area has high unemployment, has not solved the flood issue, yet the spirit of survival is here.

Q - What hopes do you have for the future of the area?

A - With flood mitigation, I am hopeful we can see the return of people and business to our area.

Q - When you think of the major floods over the past two decades, what are the strongest memories?

A - Some of my strongest memories are just arriving home in Centralia from my job in Olympia, before I-5 closed. I remember walking to Safeway and shelves being empty, since shipments could not arrive. I remember walking on the closed freeway, and it seemed almost like a ghost road.

I worked in The Chronicle Newsroom during the Flood of 2007, and it was a frenetic existence for many weeks. We then turned our work toward the book. Julie Zander and I co-authored the history chapter, and we found one of the earliest floods was in November 1887. If there was an easy solution, we would have solved it by now.

With our radio stations being off the air, I found most of my news on The Chronicle's blog. Folks were reporting all over Lewis County. The picture was changing hour by hour.

On page 108 of the [Chronicle] flood book is a picture of a farm which lost all of its livestock. On the front porch of the flooded home was a nativity scene, which normally was put up at Christmas. The family did not want to disappoint the community so they put it up. The picture brought tears to many people.

BILL GOERES, FARMER

Years blur together, but must have been fall of 2008. Dad had died 6 months previous and I had 24 hour care for Mom in her home. Rain cut loose, but it seems as if circumstances had me distracted and I was not paying attention to the Satsop River, which is incredibly fast in its rise. By the time I saw trouble, I had 30 minutes to get Mom, wheelchair, meds and helpers out. Luckily there was the disabled room available at the hotel. Then Satsop came up, Chehalis drowned us and I was stuck here with her care, which I am responsible for, going on 10 miles away. The next week was a blur, wet feed, dumped milk, wet barns, broken foot, workers ferried in and out. When it was done, I moved Mom to a nursing home, moved out Jenny's mother to a safer house. The flood zone is just too dangerous for them, and probably most senior citizens. Are the floods worse? I doubt it as the valley was not formed by gentle means. No place in the floodway is a safe place to live. Our grandfathers knew this, but the next generations slowly drifted into the floodway and now we cry because we have put ourselves in harm’s way.

Hopes for the area: Ag has a bright future, especially here as water is plentiful, land inexpensive and markets close. Climate is great for cattle and many crops. This is probably as good as it gets for farm land.

We need to respect the flood zone. Over the years there have been many abuses to the zone that have led us partially to the place we are today. We have put farms, fill, houses, roads, stores, highways, gravel pits, construction overburden smack in the floodway and then we get the results that we do not like.

Look at the river. It wants to meander, fill a surge area. Fill to the extent of the need and not be stopped by dikes, freeways or fills.

We want 24 hour, 365 day north south traffic on I-5, but the pass has to close sometimes for avalanche, snow and water. Why not I-5?

Mitigation for fill put in the floodway does not work. It does not act the same. My opinion is that we have to start a removal process of obstructions starting west and working east. If my farm is named as a problem, so be it. We need a 100% stop to building in the flood way. No building permits issued for new, remodel or home raising. No new fills, no road lifts. No exceptions.

Surge zones need to be re-established. Maybe highway 12 needs to be lowered in places. Maybe I-5. Cross roads need to be lowered.

So....sorry, more than you asked for and down my old rabbit trail. It scares me more every year. Maybe it is time to get out.

Summary:

- A no BS study of real obstructions done yesterday
- Incentive for removal. Added incentive for voluntary removal
- Designated receiving area for removed material with expedited permitting
- Moratorium on any type of construction and fill Private, county , state, fed all included
- Authority for imminent domain to take, condemn, remove obstructions as needed

I understand that this looks crazy to you. Hey, it even looks crazy to me, but the insults to the flood zone are too many and have been in place too long for us to be gentle.

JAY GORDON, FARMER, EXECUTIVE DIRECTOR WASHINGTON STATE DIARY FEDERATION

Q - What is special to you about the lower mainstem area (places, people and/or experiences)?

A - The lower Chehalis Valley is a place where most folks still know their neighbors; the valley floor is kept, tilled, tended and occupied by a small community of farmers, with a few fishermen, loggers and avid hunters. The area has had its share of economic struggles, but most farming and logging communities have, so our challenges are not all that different than other communities. The land has been in agriculture, relatively unchanged the past fifty or sixty years.

Q- If you were to describe this area to out of town friend or visitor, what you would highlight?

A - Our valley is a quiet place; trees growing on the hills and cows grazing in the valley, early on Sunday mornings make the loudest noises. It rains, a lot in the winter, much less in the summer. On summer Saturday nights you can hear, for miles, the sound of the cars racing at the fairground. It's an hour to the beaches, two to the Ski lift. If you want to meet most of the citizens of Elma and Montesano, you need only come to the High school football game between them in the fall. There are two stoplights in the lower 40 miles of the valley, if you don't count Aberdeen as lower valley (which it's not, really!)

Q - What hopes do you have for the future of the area?
A - A bit more prosperity, it's hard to sustain a community when our kids must leave to find work. Oh and a little lower flood levels.

Q - When you think of the major floods over the past two decades, what are the strongest memories?

A - They keep getting bigger, higher and more frequent, creating a question in the mind of how high will the next one be?

STEVE HALLSTROM, FARMER

Q - What is special to you about the lower mainstem area (places, people and/or experiences)?

A - Special for me is the natural environment, the forested hills, the wildlife all surrounding and comingling with a very fertile river valley. I have found the people mostly caring and friendly and have enjoyed being accepted as an oddity, an organic direct market farmer in a more traditional livestock based area.

Q - If you were to describe this area to out of town friend or visitor, what you would highlight?

A - The beauty of the natural setting, the abundance of wildlife, and the tranquil atmosphere as well as the closeness of the community.

Q - What hopes do you have for the future of the area?

A - That is remain natural, and not be over developed, that there be a return to profitable small farms, that local community groups become more active and involved in local service.

Q - When you think of the major floods over the past two decades, what are the strongest memories?

A - I've only been here one decade. On arriving it was interesting to see the COE tags on the Cedar tree in the yard designating the heights of the previous floods. Then the floods came. Being in the lower stem we get the high water a day or more later than upstream. Unusual though it may seem, it is often sunny when the waters rise, the storm having passed the previous day. So there is time to prepare, to get the equipment on high ground, to move animals etc. Probably the most vivid memory is working to move some hay stacked in an area that gets water in a flood. A nice sunny day, the neighbor came to help. At 3 pm she remarked that there was no hurry, the fields were not filling with water, the usual occurrence before a flood. At 5 pm we were isolated, the road to the farm inundated, and standing waves 2 feet high in the field next to the house. In both the high floods the water level was about the same as the 1996 flood marked on the cedar tree, even though the flow rates were much greater.

MARLENE HAMPTON, ROCHESTER

I have lived in Rochester Washington since 1980. I can in no way describe to you what it is like to be flooded to make you understand the trauma a person goes through. It is one of those experiences you have to experience to fully understand. I was very disillusioned when I heard awhile back that our governor was more interested in the commerce of out state than she was the flood victims. I went to a meeting last week hosted by WSDOT which reiterated the states goal not to interrupt commerce at the expense of the people. From what I understand the walls they plan to construct will make flooding on the west side of I-5 worse! What kind of a solution is this? Wouldn't it be great to have a advocate to expedite the Dams process. This would benefit EVERYONE and the money spent on the walls could be put towards the Dam project. The craziest aspect of the whole idea of the walls is that some tax payers will be helping to fund a project that will causing them to be flooded more!!! I honestly don't know how the folks that make these decisions can sleep at night. This is like throwing a drowning victim an anchor!

HELGI HEIDAR M.D., CENTRALIA

I have lived in Centralia for 38 years. During those years I have been through 3 major flooding events and sustained significant losses to property and equipment. With a hanger and an aircraft at the Chehalis airport I have repeatedly had major repairs to the hanger structure. In 2007 my aircraft was damaged to the tune of 70.000 dollars.

But more importantly I have seen first hand scores of friends, family and neighbors been virtually devastated by these flooding events. My brother in law, a dentist had a loss of $600.000 to his dental office and loss of income for many months of repair. Due to the flooding history, he is unable to get tenants to occupy the building. This area is economically depressed due to the ongoing threat of flooding.

I am strongly in favor of a water retention dam on the Chehalis river west of Pe Ell.

Please consider the welfare of the citizens of this community as you propose your budget for this next biennium.

People who do not live here and do not have to experience these horrific events, should not be allowed to hold us hostage via their ideological opinions.

HELEN HOLLOWAY, CENTRALIA

I had been asked to write about our experiences during the 1996 flood. My typewriter drowned and I have switched (sp?) to longhand since then.

My name is Helen Holloway… and I am 87 years old.

The weather was horrible for days – cold, windy and very heavy rain. We awakened on Feb. 8 1996 to very high winds and heavy rain and I noticed the ceiling was leaking just above the dinette windows. I called the roofer who would come the next day. The rain was unrelenting.

Just after lunch I called the fire department to inquire about the condition of the Skookumchuck and Chehalis rivers, just blocks away from our house. I was told to leave immediately and go to the shelters at Edison School two blocks from our home. The dike – four blocks north of us on the Skookumchuck River was giving way.

That night about 7PM the dike broke and the water washed out the ground under the railroad tracks two blocks north of us and we flooded. The tracks saved us our [illegible text] from possible flooding.

We spent Feb. 8 and 9 at the shelter and decided to check on our house. Our house was a half block from our Pastor's which was higher and only had his basement flood and the sump pump took care of that.

Our house was at the lowest section of "J" street and had a foot of water, sewage, petroleum products, garbage, and who knows what else. The smell was awful!

Our garage and a small storage building out back each had 2 ½ feet of water. We could not get to our house on the 10th and just stood and looked on in horror. We were invited to stay with the Pastor and his family the 10th and 11th. Our cars were safe packed at the center so they were saved.

Our grandson-in-law came out on the 11th and took out all the carpet and it was taken to the space between the sidewalk and the street. The pile of debris got about five feet tall. We had just had insulation installed under our house we had to tear it out so we could have the floor start drying. It joined the carpet. Later that pile was about six feet high with all that flooded along with appliances. Later the city came with dump trucks and removed all the trash.

It took about six weeks before the water went down in the backyard. Only then could we begin to clean the garbage and the storage shed which had several generations of treasures and pictures.

On the 12th we decided to go home. We were able to turn on the furnace and start drying out the house. Our furnace ran day and night for three months. Then the nightmare of clean-up started in earnest (sp?). The dump truck would remove piles of debris and we would continue to make piles – it was endless.

Unless you have lived through a flood you can't imagine what it does to your home, health, mental and physical and your live savings. The cost to us was over $50,000 plus the funds we received from FEMA. We had NO FLOOD INSURANCE. We bought insurance once in July of '96. We have been insured since then – I have been paying premiums that went from $300 per year to over $1550 for the past 10 years. My husband died three years ago and those premiums are harder and harder to pay.

We worked for 13 months – cleaning, sanitizing, replacing, and repairing. All our floors were replaced. Our first job was to put in all new windows as only two could be opened. Wallpaper paste became moldy and the paper fell off the walls. Our floors never got dry enough until [illegible text] to start replacing the floors.

My husband and I lost weight – there were days that we couldn't eat because we both cried over all the irreplaceable keepsakes we had to take to the pile. For months we started our day by not even knowing what to do next. Family helped carry out garbage to the pile, Church helped clear out and sanitize garage floor. We finally decided to work alone. It was easier than directing help who didn't know where to start or what to do.

We dried furniture and though it didn't look as nice as before we had to make do. We used gallons of Purel (sp?). Everything had to be sanitized. Every room – nook and cranny had to be cleaned, sanitized, and repaired.

After months of just plain back breaking work and sadness – come the workmen (sp?) who replaced floors – walls and began the actual putting the house back together. There was endless furniture moving from one room to another. Each room had to be absolutely empty as we [illegible text] painted the cleared and returned furniture.

After 13 months we began to see some return to normalcy. I was in my 70s and my husband was in his 80s when we flooded. We only had a foot of water in the house – and I know that doesn't sound like much! One cannot believe what damage a foot of water did and cost us.

Why can't the river be dredged and retention dams be built? They did it in Oregon – it worked! We live in the same country. Let's keep spending years and millions for studies, planning and arguing while the flooding increases and the damage is astronomical. Please somebody help!!!

I left my home 3 times in the past 7 years fearing flooding. Thank God when I got back all was well – others weren't that lucky.

WILLIAM G. P. HUNTER, PE ELL

I was a resident of the Boistfort Valley in a home that was flooded to a height of nine (9) feet. The second floor of the home was okay, but the first floor was entirely under water. With the rising water, I was "trapped" in my bedroom on the second floor with the family dog. The dog and I were rescued by boat, the boat owned by a local resident who, on his own initiative, was getting people out of their flooded homes, with help from emergency personnel.

We were taken to a building on the east side of the Chehalis River south fork bridge, where it was reasonably dry. There we waited until we were again rescued by Navy helicopters and flown to the Chehalis airport, then from there, taken to a Red Cross shelter set up at W. F. West High School in Chehalis.

What is clear from the experience is that nothing quite this devastating had ever happened before and, more to the point, no one who suffered through the experience wants it to happen again, ever.

I have attended Flood Authority meetings and have on occasion registered comment with that group. I have relocated from the Boistfort Valley to Pe Ell, where I am just as concerned about the possibility of another flood – perhaps even more concerned.

But, whatever my personal concerns or insights, the main issue for everyone is that something tangible be done about flooding. The issue does not need to be talked to death – it needs to be dealt with directly and expeditiously.

Unfortunately, there are some who, for political or ideological reasons, have absolutely no interest in solving the problem. We have seen this in the "battles" among Flood Authority members and the comments of un-elected bureaucrats who, because they are accountable to no one, can say whatever they like.

Let me state clearly that, so far as I can determine, the only workable, reasonable plan that has been put forth to deal with flooding is the proposal for water-retention facilities near the headwaters of the Chehalis River. The Corps of Engineers plan initially put forth is essentially useless; other plans to build levies that would only protect I-5 and nothing else are also essentially useless. There has been a great clamor that we need more plans. But, where are they? So far, five years after the flood, THERE ARE NO OTHER PLANS.

GARY AND KIRSTEN KLEIN, CHEHALIS

My wife and I would like to comment on the Flood Mitigation Alternatives Report. We have been residents of Lewis County since 1980 and have lived in the West Side of Chehalis at 675 NW Saint Helens Avenue since 1992. The floods that we have seen have been devastating to our friends, neighbors and the community.

In 1996 and 2007 the Dillenbaugh Creek rose above the level of the Chehalis River, and came through the culvert under Main Street and also over Main street to flood the residences on Prindle, our back yard, the residences on Oregon, and then work its way down to the residences and businesses along Saint Helens and Maryland. The water subsequently rose until it could flow over the top of the center barriers of I-5. This was significantly higher than the maximum height that the Chehalis River reached.

The Chehalis River did not flow over the freeway and into this part of town. The water flowed in the other direction.

I believe that our back yard used to be a drainage to the Chehalis River for the local area, but since I-5 was built, that drainage is effectively dammed by I-5.

Obviously, any dikes added to protect I-5 between 13th Street and Chamber of Commerce Way, higher than the existing center barriers, will cause the flooding in this part of town to increase substantially. Our house, which has not been flooded in 128 years, would be susceptible to flooding.

For this part of town, it is imperative that measures to protect us from Dillenbaugh Creek are implemented. The most obvious would be to reduce the restriction of Dillenbaugh where it passes under I-5, and to provide dikes and flood gates to keep it from flowing north across Main Street. If anything could be done to improve the drainage of the West Side area underneath I-5, that could also help.

We would also like to comment on the proposed alternative express lanes or emergency bypass lanes. We highly object to these proposals. They would put a berlin wall through the center of our town. The lanes would not be attractive. They would add noise. We would be living underneath trucks looking down on us. Privacy and enjoyment of our houses and yards would be substantially reduced.

We are in favor of the upper Chehalis Dam proposal. It would be able to moderate the peak flows and reduce damage for the whole basin.

BEN M. KOSTICK, C.P.A., CHEHALIS

My wife and I responded to the call for firewood for flood victims of the 2007 Chehalis River flood. We hauled two trailer loads of alder donated by a local mill, Cascade Hardwood to the Adna high school. Then we decided to drive with the trailer over the hill to Boistfort to see if we could help somebody there. What we saw was sobering. Flood water had receded by then but most houses were filled by two to three feet of mud. There were tractors inside houses hauling out mud and we asked if we could help haul it away. House after house was filled with mud from Boistfort to State Highway 6. But they were also filled with volunteers shoveling, hauling and cleaning.

The one sight that still sticks with me was that of a man who must have been in his eighties walking through his field pulling fence posts upright and removing debris by hand. He looked so helpless which all the people in that valley wee against the force of the flood.

We need to minimize the damage before the next big flood. Levees along I-5 won't do anything to protect those people we helped that day. Water retention will do that and It needs to happen soon.

MERLIN MACREYNOLD, CITY MANAGER, CHEHALIS

Q - What is special to you about the upper mainstem area (places, people and/or experiences)?

- Recreational opportunities
- Rural lifestyle
- Pristine forestland, wildlife
- Timber harvest (employment) / sustainable forest opportunities
- Agricultural opportunities (farmland)

Q - If you were to describe this area to out of town friend or visitor, what you would highlight?

- Beauty of the area
- A community that gets things done (e.g., Chehalis Foundation projects, Library)
- Perfect location – within a couple hours drive to mountains, ocean, two major cities
- Great school district
- Friendly, close-knit community
- Responsive government
- Pride of our local history

Q - What hopes do you have for the future of the area?

- Family wage jobs
- Deal with flooding issues
- Growth, but still maintain small-town feel
- Geographical planning (unique opportunities and challenges)
- Economic development

Q - When you think of the major floods over the past two decades, what are the strongest memories?

- The devastation
- The shut down of I-5
- The quick and organized response of emergency management
- The can-do attitude of the people
- Neighbors helping neighbors
- The speed at which things get back to "normal" – people back in their homes, businesses reopening
- The increased awareness of the public of where (in a floodplain) they live
- Transportation challenges – 'can't get there from here'
- Lack of funding for localized flood damage reduction (home elevation / buyout programs)

DAN AND LARISSA MAUGHAN, ADNA

We live close to Adna WA and were greatly impacted by the Dec. 2007 Chehalis River flood. It is impossible to describe the prolonged stress and difficulties that this brought. Our major clean-up and repairs took six months and $70,000 to complete. We are in the cattle buying business and due to destruction of our fences and damage to our corrals we were unable to operate for those six months. The financial burdens are going to be long-standing. Emotionally the experience was crushing. A flood control plan that merely includes dikes to protect I-5 will put us at greater risk. There should not be a few winners and many losers in the end result of a movement started to protect the entire Chehalis River basin. We encourage those considering the different options available for flood control to work towards the combination of solutions that will help as much of the basin as possible.

BARRY PANUSH, CURTIS

At the time of the flood, I was the Fire Chief for Fire Dist. 13. At about 2:30 AM, the morning of the flood, I got a phone call from Central Dispatch saying that PE Ell was getting a lot of water. We had not had that much rain in our valley and I was at a loss as to what to do with that information as it was still dark. I went on line to see what the river gauges were at that time. I was unable to get on line and chose to wait until daylight. Just before 7:00 AM we were toned out for a water rescue. As the Crews left for the call, I called my cousin at the upper end of the valley for a visual check of the river. He stated that they had not had that much rain but would check and call back. We returned to say the river was up higher than he had ever seen it and may loose his bridge. He did. I then called Emergency services and reported and told him to expect at least 2 feet more than they had ever seen. Just happened to be right on. Then I called KITI radio and told a friend there the same information. Since I was not an expert, he could not use my information. Now I am an expert because I have a county sponsored Noa radio. Go figure.

I put things up on the table and bed and left the house to report to the Emergency center. That is the procedure we teach out firemen. Get your family safe first so you can concentrate on the needs of the Department.

My house was built in the early 1930’s and had never been flooded. We were 4 inches short of having 8 feet of water in the house. After the flood we removed over 50 yards of mud from in and under the house. It is a two story house of just under 2,000 square feet. We had no flood insurance because it had never flooded before.

We now know how high the river can get and can better prepare. We now have a new Doplar Radar system on the coast that can tell us of impending weather. We hope the river gauges continue to operate but with advanced notice of bad weather and internet viewing of the river gauges, we can get out safely. From my training and knowledge of the valley, I can safely say that if this event had happened in the dark, lives would have been lost. I don’t think that is near the issue with current updates.

The problem as I see it on the Chehalis River is too much water in the winter, at times, and not enough in the summer. The only thing that seems to address this is “Water Retention”.
That is a Dam on the upper Chehalis.

In past years, I have along with others, followed the crest of the river as it flows to the Pacific. Knowing what and when is not the issue. It is the amount of water and what it does.

The Chehalis has more rock and dirt in it as a result of the floods and is being choked by the invasive grasses. It does not handle as much flow as it use to. They were grasses introduced years ago the grew much faster than native grasses and they grow very well near water. These are facts that must be taken into account if we are to stop erosion and property loss.

I have moves 6 miles, up stream, from where I was before the flood. I am on Stillman/Mill Creek. Any of the Dams proposed will not help me where I live but they are the right thing to do.

My history is as follows: My grandparents (Mothers side) homesteaded on the upper end of the South Fork of the Chehalis. On my father's side, they did the same in the Adna area. My parents purchased the Curtis Store in 1948 when I was one year old. Other than three years in Portland and one in Vietnam, I have been there my entire life.

LIONEL PINN, COUNCILMEMBER, NAPAVINE

Q - What is special to you about the upper mainstem area (places, people and/or experiences)?

A - The historic value of the people and properties. Napavine is the third largest city in Lewis County, it can actually be impacted by both rivers (Newuakum and Chehalis). # 1 is the Newuakum River: three main stems on the 56 + mile long river runs strong during the flood season and has changed the lives of many as they rise through our community during past flood events. The Exit 72 region of I-5 is the most sensitive region and, without fail, is hit the hardest by flood events. This area is the key tax based for the city and livelihood for the businesses who have built there. # 2 is the Chehalis. When it reaches capacity it has to start pushing back on its creeks, stream and the mighty Newaukum. Eventually, in the right conditions, the water will start to run back up river, from north back to the south.

Q - If you were to describe this area to out of town friend or visitor, what you would highlight?

A - We are the third largest city in Lewis County but number one as it pertains to new home construction and fast growing economic structures. Love's Truck Stop and the Richie Brother Auction house are two examples. The main part of the city is well above the flood plain and it stays high and dry in all events, however the lower and northeast end of the city is well within the flood plain of the Newaukum River. People are good, the city is well run and it's a hometown kind of place that people love. Great school system, an in-town fire department, convenience store, barber, hair dresser, many upper end restaurants, gas stations, with a brand new hotel being built with a small conference room attached as well as additional retail space. You are never far away from a good conversation and good friends. Of special note is the one and only city owned outdoor amphitheater which has drawn many big name artist and shows.

Q - What hopes do you have for the future of the area?

A - More retail space at Exit 72 and on top of the hill in downtown Napavine; expansion of the UGA; more concerts and shows at the Amphitheater; also a possible location for a full on NASCAR racing facility.

Q - When you think of the major floods over the past two decades, what are the strongest memories?

A - Water covering the interchange at Exit 72; the closure of the entire I-5 freeway from Exit 71 to north of Centralia; the lifelong damage to homes, business and lives; the loss of livestock, damage to farmland and lack of preparation by the government.

Q - Feel free to tell us more if you like.
The other aspect of planning and concern is the Dike project in the Adna region. From what I have been told there we may be creating more of a problem with the diking than helping. Apparently the waters that would be roaring down the Chehalis River would eventually start backing into the Newaukum and thus back impact an

already pressured river. I am in favor of building the Damn in Pe Ell. That is the best solution for a difficult challenge. Mitigating how that impacts others downstream is important too but the good of the all must outweigh the good of a few. I am also in favor of some, carefully conducted dredging, if done the correct way it would have little to no impact on the fish habitats. The fish are important; they will always be important to a variety of people and groups, and they must be a part of the conversation knowing that they are a resilient species and will survive no matter what we do with the river.

VICKI RAINES, MAYOR, COSMOPOLIS

Q - What is special to you about the upper mainstem area (places, people and/or experiences)?

A - The upper main stem area of the Chehalis Basin is important to residents of the entire Chehalis Basin as land use, storm water runoff, and growth can affect everyone in lower reaches of the basin. This is an extremely important area to the economy of the State of Washington with I-5 being the main North South Corridor for our state; were you actually wanting our view regarding the lower basin?

Q - If you were to describe this area to out of town friend or visitor, what you would highlight?

A - The Grays Harbor Cities area is a nice place to live and is the most populated area in Grays Harbor County. We have a diversified economy of industrial, retail, tourism, transportation, and marine related jobs that support our economy. There are numerous recreational opportunities in our area with fishing, hunting, sports facilities, hiking, water sports etc. The City of Cosmopolis has two of the largest employers in Grays Harbor County in Weyerhaeuser and Cosmo Specialty Fibers. The Port of Grays Harbor is growing with new industries and shipping that are no longer timber dependant. The City of Hoquiam recently welcomed the re-opening of Hoquiam Plywood Company and are getting ready to reopen the Grays Harbor Paper Company. There are new housing developments in all three of the cities, and we have excellent school systems and available medical care.

Q - What hopes do you have for the future of the area?

A - We hope to see a continued diversification in our economy in the future with the development of the waterfront in Cosmopolis and Aberdeen. Numerous economic opportunities exist along the waterfront with the existing South Side Flood Control Dike in place that protects this area from flooding. In Cosmopolis we are working on gathering funding for the removal of the breached Mill Creek Dam so we can create a natural area for use in flood control and for educational programs. Another infrastructure item we have prioritized is a new Police Station, Court, Council Chambers, Admin Building that can replace facilities that are undersized and insufficient for our needs.

Q - When you think of the major floods over the past two decades, what are the strongest memories?

A - A couple of floods in the past two decades have had an economic impact on the City of Cosmopolis. In November 1990, the City of Cosmopolis received nearly six inches of rainfall in a 48 hour period combined with the flow in the Chehalis River from the upper reaches of the basin that cause US 101 to be under two feet of water closing off the northern entrance to the city. This flood event closed off rail service and the trucking of materials for the Weyerhaeuser Company for a couple of days costing them thousands of dollars.

The second flood event that had and still does have an effect on Cosmopolis is the November 2008 flood that caused a breach in the Mill Creek Dam. Mill Creek is the main drainage for the entire City of Cosmopolis that flows into the Chehalis River. The breaching of this Dam cost an estimated $700,000 damage to the Dam and properties downstream. The City of Cosmopolis is still seeking funding to remove the Dam and restore the sight back to a natural area that could enhance flood control and be available for educational opportunities.

SUSAN AND RENE REMUND, CURTIS

It is probably difficult for people who have not experienced a devastating flood to understand the enormity of the losses.

While we work in Chehalis and Centralia, we live west of Chehalis on a small farm at Curtis.

All but one of our pigs, two steers and a pet goat drowned in the December 2007 flood. How the one pig survived, we don't know. She not only survived but farrowed three months later.

Our 130 year old home was inundated to the top of the first floor, destroying everything not impervious to water and mud.

Our house guest, who has limited mobility, was alone in the home and feared the home would wash away or he would be trapped and drowned before he was rescued by boat from a porch roof.

We learned later that one of our older neighbors was trapped in her manufactured home. The water pressure sealed her door and she could not get out. She was standing on her kitchen table putting farewell notes on the ceiling when her neighbor came in a boat, broke out a window, and rescued her.

The flood deposited approximately eight inches of clay and wood debris onto our property. Over 500 cubic yards of mud and debris were eventually removed from around our home, garage, and barn.

Within two days our neighbors and friends who were not flooded arrived to push the mud out of the house, haul away all the furnishings and appliances from the first floor and then strip the home to the studs. That work was followed by church groups, a local restaurant delivering soup at noon and the local Grange feeding flood victims and volunteer workers for many months.

After nearly five years the physical signs of the 2007 flood have been largely removed, but the fear of repeated flooding returns during every serious winter storm.

The only solution to catastrophic flooding is water retention. Everything else is either impractical, a half measure, or a means of pushing floodwaters onto someone else.

Immediately following the flood there was little political support for anything other than the Corps proposal to build levees to protect portions of Chehalis and Centralia. Through the concerted effort of flood survivors and a group called One Voice, the legislators of our area and Governor Gregoire have committed themselves to finding a basin wide solution to our recurring problem.
For this we are thankful.

The leaders of the water retention effort recognized from the beginning that the environmental effects and specifically the effects on fish would have to be satisfactorily addressed for this single most effective flood prevention measure to be built.

Of the measures included in the report, some, such as the WSDOT flood walls for I5, should be rejected other than to the extent minor installations are required to supplement the benefit of the upper river dam. The conservation projects likely have marginal benefit during major storm events.

For the Chehalis River valley to be economically productive and physically safe for residents, control of devastating flooding is necessary. Construction of a dam near Pe Ell would provide sufficient storage to reduce flooding within the entire basin. It is the only proposal that removes the source of our problem-too much water. The 2007 flood cost nearly a billion dollars in damage. The impact on people was incalculable.
Future losses of life, property, and security can be prevented.

The answer is containing flood water in the upper river and then using that water for electric generation and increased water flow in late summer.

Water retention is best answer.

People in the Chehalis River basin should regain their security. Falling rain should not be a terror.

SUE AND JOE ROSBACH, CHEHALIS

Our names are Joe and Sue Rosbach and we live on my family's farm located at 128 Christin Rd., Chehalis and this is our story. My family purchased this farm in 1902 and have lived and worked here ever since. I am the third generation to live on this farm. We gave our two daughters each some land to build a home, just as my parents did for me and my Dad's parents did for him. This farm has NEVER flooded, some of the fields get standing water in the winter, but NEVER has it EVER flooded the homes or barns. In fact, even with the close proximity to the Chehalis River, this land was never in a Flood Zone. We were on the high bank of the river, so flooding was never a real concern.

The morning of December 3, 2007 about 6 am, my nephew called and asked if he, his wife and 10-month old baby could come over. They live about ¼ mile from us. When I asked why, he stated that the water from the creek was really high, in fact it was at the bottom step of his house. He was worried. We said yes, come over. He then called back and said he could not get his car out of the driveway and could Uncle Joe please come and get them. Joe immediately took off in his pickup to get them; it was still dark outside. To his surprise, he could not get to the end of our road, so he came back and got a tractor – went to their house, picked them up and brought them to our house on the tractor. When the sun came up, we could see how high the water had gotten. At that time, we still were not real worried – it had never flooded before – and in 1996, which was the worst flood to date, the water was close to the river bank but did not overflow and we did not encounter anything more than water in some of the fields, of course many of the surrounding roads closed due to water over the roadway, but that is common during a flooding event. As the day progressed, we knew this was different. By 10 am the stop-sign at the end of the road was covered by water; by 10:30 am my nephew's house was jarred loose and started floating down the road. Do you have any idea how profoundly sad it is to watch a young couple lose everything they own AND watch the home float down the road, breaking apart along the way? It is NOT something I ever want to encounter again – there are no words that can console them, there are not enough hugs that can take away their pain. It was simply awful.

Still, the water wasn't close to our house and I had been calling both daughters, who live closer to the river, and they were watching the river rise but not overflow. We were trapped, as all access to our house was shut off with flooding and the roads were not drivable. I kept in touch with my daughters and brother with cell phones (thank God). As the day progressed, the flood waters creped closer and closer to the house and barns. Joe was busy moving cars, trucks, cattle and as much equipment as possible to higher ground, just in case. I moved things in and around the yard and garage, walking in waist deep water – watching rats and mice float by. You do what you have to do. My brother wanted to come get us by boat, but the water was too swift to attempt it. It was about 3 pm that something significant happened and we surmised this is when the Chandler Bridge broke, sending the water down Leudinghaus Road; the water was coming at us very quickly and starting to come up the steps to the house; it is at least 4 feet above ground. I got as much stuff upstairs that I could before the flood waters entered the house. We got nearly 2 feet inside the house, 6 feet in the garage. Just before this happened, my brother (who also lives on a portion of the farm) stopped by my daughter's house to tell her to evacuate and get to his house (he lives on a hill). Her husband was at work. She went back in the house to get the dog and keys, dropped the keys in the water, so she jumped in the truck with my brother. He then went to my other daughter's house and told them to evacuate. My son-in-law was home and was going to start moving things, so my daughter and 3 kids, and neighbor Nikki and 2 kids went with my brother to his house. Troy, my son-in-law and neighbor Bill started to load stuff into vehicles and drive to my brother's house. On the way, another neighbor was trying to move horses and one was hung-up on barbed wire with the owner slipping under water so they stopped to help. They got the horses and the neighbors to my brother's house, but in the meantime, the floodwaters came quickly. The boys were lucky they left when they did; their vehicles were flooded. They all knew that their homes were flooded, but they were safe at my brother's house. There was nothing we could do – we were isolated in a flooded house. About 7 pm my nephew, wife and baby were picked up my helicopter and taken to town. We had no provisions for a 10-month old baby and her family wanted her closer to them. It was a sad goodbye; we had just been through something traumatic together. We stayed at the house. The waters then quickly receded; at least it was out of the house, leaving a wet, silt-y mess. We went to bed, not knowing what we would find in the morning, and cried. We heard helicopters all night.

The roads were passable by the next morning and we went directly to my brother's house; at the bottom of his driveway we had to walk in about 2 feet of mud/muck, a residual of the floodwater, to get to the house where not only our girls & families were staying but many of the neighbors too. I can't remember the count, but I think there were 20+ people there. It was a VERY emotional reunion; they were worried about us because we were trapped and we were worried about them, because we knew if we had that much water, they had to have more…..

The adults went to their homes, I stayed with the grandkids. It was HORRIBLE. My oldest daughter's house had about 5 feet of water in it, with about 2 feet of mud. Everything was ruined, everything was lost. My other daughter's house had about 6 feet of water in it, with about 3 feet of mud. Everything was ruined, everything was lost. All of their vehicles were flooded and lost. The neighbor's house (that we lived in for 33 years and sold to them a couple of years before) had 8 feet of water in it, with about 3 feet of mud. Everything was ruined, everything was lost. They all came back to the house in shock – they had lost everything…..and they had no home to go home to. Thinking back, I think all of us were in shock during those first few days – not really comprehending what had happened, but knowing what needed to be done.

We talked with our daughters, husbands and grandkids to figure out what we were going to do; we all had our own problems. Our younger daughter, husband and dog lived with us for the next 6 months. Our older daughter, husband and 3 kids (the baby was only 3 months old) lived with his parent's during the week and with us on the weekends. We got busy tearing out the flooring and sheetrock of our house. They got busy first swamping out the mud, then tearing out virtually everything in their houses and started over. I could not bring myself to go see their houses for about a week; I knew that it would not be good, but I had NO IDEA how bad it was. We have a video that my son-in-law took those first few days, that I still have trouble watching. Their Christmas tree and ornaments were strewn, shoes, clothes and furniture were floating, appliances were tipped over and mud was everywhere. It was a long road to clean up and recovery. Since none of us were in a Flood Zone, none of us had Flood Insurance. FEMA gave each of us a little money, but it wasn't close to what we all had to spend to replace all that was lost. Financially, it was another hardship that none of us needed at that terrible time.

When I think about that terrible day, my first thought is about that 3 month-old baby. She slept in a cradle on the floor – if the flood had happened during the night, she would have surely drown. My next thought is I'm glad that my parents and grandparents did NOT live to see this terrible tragedy – it would have killed them. This farm was their pride and joy, to see it not only flooded, but strewn with garbage and debris; equipment ruined, fences gone, feed/hay lost. Really, for all the damage that this flood did to houses, barns, animals and equipment – we were lucky that no one died. The emotional toll is an unmeasured part of the flood. The kids' homes were completely destroyed – they lost EVERYTHING. I still cry when I think of what my daughters and their young families had to endure – it is not fair; I am so proud of them for the strength they have shown in rebuilding their homes and their lives.

Next, not only did my home, both daughter's homes and neighbor's homes flood, but I am a Vice President at Security State Bank and the Gold Street Branch and Administrative Building also flooded – but that is another story. The water had no mercy. So, when I finally got back to work after dealing with my home flooding, there was more to deal with at work.

In conclusion, I know the only reason we flooded was because the Chandler Road and Leudinghaus Road bridges were dammed up with logs and mud that come from the hills. They finally broke, sending the water down the road at amazing speed and reckless abandon. <u>The only logical solution to prevent another tragedy like this would be for water retention. It just makes sense to STOP the water BEFORE it comes down to destroy everything in its path.</u>

MICHELLE SCHILTER, SUN-TON FARMS, ADNA

I write to you today regarding the flooding that affected my family in December 2007. We were woken up very early in the morning from a friend of ours that lived on Ceres Hill in Boistfort asking if they could come to our home with their children to escape the water approaching their house. It was quite a startling phone call but it did nothing to prepare us for the nightmare that would descend upon our life approximately 6 hours later. In between that phone call and 2:00 p.m., we managed to evacuate our dairy calves from their hutches (they would have all perished), disconnect and move milk pumps to "higher ground" (not high enough), chain our propane tank to concrete posts, and evacuate our 3 children to a different location. We watched as the water entered our home at about 4:00 p.m. and the water leave our home at 7:45 p.m. My husband, hired hand, and myself slept in the attic of our residence, listening to the evacuation helicopters fly the valley all night. We woke up to a nightmare, a nightmare I never want to repeat. Through the generosity of family, friends, and strangers we were able to rebuild our home and dairy.

I share this story because flood mitigation is crucial to the survival our our dairy, our family, and our community. We need action now and we need to look at all options. We live in the Upper Chehalis River Basin. The most logical flood mitigation solution for our area in Adna is the water retention project above Pe Ell. Any of the other levy solutions proposed so far will do nothing to help our area. In fact, it will probably make our flooding worse. I understand this will not help in the lower part of the basin, that is why I ask the Governor to embrace the plans that includes several different components. I come from an area that has used several different options together to solve flooding (Napa, California). I know by now the Governor must understand there is not a "Silver" Bullet that will solve every issue and area of flooding in the Chehalis Valley. Please include the Water Retention Project above Pe Ell as a critical component of the flood mitigation project. My family, my 3 children, my dairy, and my community can not live through another catastrophic flood like December 2007.

MICHAEL SMELL, CHEHALIS

Q - What is special about the Newaukum River?

A - Our section of the Newaukum River is close to I-5 and Chehalis but still rural in nature.

Q- What would I highlight to an out-of-town visitor?

A - This is the place to be if you like a rural setting. It is complete with a dairy farm, a beef cow ranch and a meandering river with fish in it. Bald Eagles nest in the area while Blue Heron, doves, killdeer, rabbits, coyotes, songbirds, and other wildlife honor us with their presence. Hay fields dot the roadsides. It is peaceful and quiet at night. Vegetables and fruit trees are easily grown. It is a natural country setting.

Q - What do I see as the future of the area?

A - The major commercial development will continue to be along I-5. We should be left alone since we are not in the UGA but are in the floodplain.

Q - What are the strongest memories of the major floods over the past two decades?

A - Being prepared every year for a flood lessens the consequences. Seeing a 20 foot long 2 foot diameter log float along Hamilton Rd 20 feet from our house. Using water to clean out the silt left from the flood waters from all the out buildings. Keeping the two submersible pumps in our basement running continuously for 35 hours to keep the water level to 1 foot in our daylight basement when the flood waters outside were at eye level on the basement windows. We have never lost electrical power or telephone service. Using our rowboat to take tons of grass and weed debris off the New Zealand fencing around the pasture. Having to journey to the carport to feed horses standing knee deep in flood waters for two days. Discovering that the fast flowing flood water current picked up part of the asphalt roadway by our house and deposited it ten feet inside our pasture. Being able to share the experience with each other.

Q - Tell us more

A - My wife and I have lived here for 26 years. We have had a flood on the Newaukum River by our location every year. Some are minor Phase I and Phase II while 1990, 1996, 2007, and 2009 were major. All are still minor inconveniences when compared to the beauty and peacefulness of the area at other times. Come by in the spring, summer, or fall and see what the area looks like and everything that is growing. We are prepared every year for flooding. This minimizes the effects. We are able to have farm animals and tend to our vegetable garden and fruit trees. It is still country living.

KRISTIE SWANSON, BOISTFORT VALLEY

I've put a lot of thought into how I want to share my flood story. It's tempting to emphasize only the emotional difficulty we've all faced, but I also think it is important to stress the value of water retention in mitigating future disasters.

I grew up in the Boistfort Valley along the south fork of the Chehalis. I am a landowner in the Valley, with plans to return there to raise my children. At the end of 2007, my husband deployed to the Persian gulf, and I returned to the valley to stay with my family during that time. I flew back to Washington the evening of

December 3rd. I woke up early on the4th and looked out the window onto a completely different place from where I grew up. Despite the alien appearance of my childhood home, I soon realized that my parents received only a glancing blow from the flood at their house. That first day was spent restoring the destroyed water supply for the house and farm animals and clearing the "back road". This was necessary because my parents' driveway crosses a bridge, which had been washed out by the flood. (Ironically, mu parents would have been granted FEMA funds to replace the access to their house, but my father is a farmer, and so there is a business at the same address, precluding them from receiving FEMA funding. In case you wondered, bridges aren't cheap.) The next day we headed down the valley to check on my sister's family. Suffice to say, aerial pictures do not do justice to the horrible scene we saw. They simply don't provide enough vertical scale for the destruction. Landslides, ruined homes, wasted fields full of logs, dead animals in power lines, you name it, we saw it. And mud. Mud everywhere. It has taken years to repair the damage done to the land and homes, and we are still pulling sticks out of fields and finding deposits of flood mud.

As bad as the destruction was, over time I've come to realize that the human toll is far worse. I watched as strong, capable people were immobilized by fear and shock. That might have been the greatest gift brought by all the volunteers: action. We're the kind of people who will wake up and pitch in to help those who want to help us. My sister is still scarred, and scared every winter when the rains come. But she is still in the valley, carrying on the family's farming tradition. Perhaps most difficult for me is watching my father tell his flood story. It took me a couple years to realize that for him, the pain was in hindsight. We lost my brother when I was young. For my father, realizing how easy it would have been for him to also lose his oldest daughter and grandchildren still terrifies him.

This brings me back to the most important part of all this: action. While 2007 and 2009 brought unimaginable, record floods, it is conceivable that these events will become more commonplace. With climate change bringing wilder weather and irresponsible logging practices reducing nature's ability to mitigate these events (I have a degree in forestry, don't even get me started on how inappropriately the Willipa Hills are being managed), we have a responsibility to enact basin-wide relief. The only feasible solution is water retention. It is the only option that, quite frankly, has science on its side. It will reduce high water flow, improve fish habitat, and even more importantly, improve things for the entire basin. It is unbelievable to me that any solution that makes flooding worse for half the basin would be considered, which is what the other options would do. That is tantamount to placing a monetary value on human life, and then deciding a road is more valuable. Mind-blowing.

I urge you to remember that while economic impacts are significant, without the amazing, industrious, hardworking people of this state, those impacts are simply numbers. It is our citizens that make Washington worth living in, and water retention facilities will protect those citizens, their livelihoods and the basin.

DAN THOMPSON, PUBLIC WORKS DIRECTOR, OAKVILLE

I live near Oakville now but have lived up and down the river over the past 38 years. In the upper area my thoughts and experiences are around the recreational aspects of the river. I raised three children in Chehalis and most of our summers were spent camping, swimming and fishing in the rivers and lakes surrounding the Chehalis River. The area is diverse economically and developmentally. Due to the interstate and central location of Centralia/Chehalis it is the retail hub of Lewis and Clark Counties. Manufacturing, natural resource harvesting and farming also play a huge role due to the forests and infrastructure available. Rail, trucking, airport's and state highways crossing the Cascade range to the eastern parts of the state make this area a great place to live. The people in the upper river basin are from all backgrounds and live different lifestyles from rural to urban or following college pursuits at the Centralia Community College.

If I was describing this area to a friend or acquaintance I would highlight the fact that you are 50 miles from the mountains. It's 60 miles to the Pacific Ocean and 85 miles in either direction to a huge metropolitan city. You can chose your lifestyle and be within an hour and a half to any one of them. My hopes for the future locally are to continue the emphasis on responsible land management and develop strategies to live with the river but remain driven to not make the mistakes of the past and mitigate flood caused suffering and economic loss with the best science available. My strongest memories are the floods of the 80's and 90's because my family lived thru the suffering and economic losses personally. As the Public Works superintendent for Oakville I have put the City back together after each flood and learned the mistakes of the past all too well. The present leaders of our state and local activists are on the right track with a basin wide solution led by local residents of the valley. I want to thank you for allowing me to express my own experiences of why I love this area so much.

J. VANDER STOEP, CHEHALIS

After the December 2007 flood my wife and our three girls began helping people in the upper basin muck out their flooded homes and farms. Our girls were between 10-16 at the time. We would take one of them with us each day as much for them to understand how destitute the poor families were who were flooded and how lucky they were to have a home that does not flood. The first couple of homes where we helped were owned by friends but by the third or fourth home we were mucking out the homes of strangers. Some people may think that a flooded home just means that things get wet. Its much more significant than that. The flood water was filled with dirt and the dirt went everywhere the water went. What it left was a substance like grainy chocolate pudding in every drawer, every appliance in every wall. It was a horror to see a home hit by the 2007. At every home the drill was the same, the volunteer would be assigned a room and our job was to make two piles, the first pile was things we thought could be saved and the other was things to throw away. The most searing memory for me was at about the fourth home. This was the home of an Hispanic couple with two young kids. They had just built a modest home on land they had purchased that had been part of a very old dairy farm west of Adna. The land had never flooded but in 2007 their new home had 3 feet of water. I was assigned to go through the belongings in the bedroom to make the two piles.   Imagine how exhausted and desperate you would have to be to invite a stranger into your bedroom and ask him to go through your belonging to make these two piles. It was at that moment that I dedicated myself to finding a solution so that this kind of terrible event would not occur again.

The floods of 1990, 1996 and especially 2007 were of such enormous magnitude and so devastating to so many families and communities in the Chehalis basin that it is really impossible to fully describe the impact then and still today.

Appendix E: Comments and Responses on the Draft Chehalis Basin Flood Mitigation Alternatives and Draft WSDOT I-5 Flood Report

Appendix E: Comments on the Draft Chehalis Basin Flood Mitigation Alternatives and Draft WSDOT I-5 Flood Report

This appendix includes comments and responses on the draft Chehalis Basin Flood Hazard Mitigation Alternatives Report and draft WSDOT I-5 Protection from 13th Street to Mellen Street near Centralia and Chehalis Report. A draft Alternatives report was made available for public review and comment from July 16– August 31, 2012. A separate report, The Washington State Department of Transportation (WSDOT) draft I-5 Protection from 13th Street to Mellen Street near Centralia and Chehalis report describes I-5 protection options in more detail and was available for public comment from August 17–31, 2012. Forty-nine comment letters or emails were received on the two reports; thirty-six on the Alternatives report and thirteen on the WSDOT report.

Steve Emrich 7/23/12

Hi; I hope you are having a great day and things are going well for you.

I received an e-mail stating that your organization would like to hear from some flood affected individuals back in 2007.

To start with, I reside at 1358 NW River street (correctly named) , Chehalis WA. 98532. My personal cell is 360-880-8905. and My name is Steve Emrich.

I own roughly 30 acres along the Chehalis River and have lived on or near this street since 1958. Yes, I am an old timer around here at 55 years.

I am a firefighter for the city of Chehalis and also a member of the swiftwater team that is part of the fire department. When the flood started to rise in the early morning hours, I was called back to work with the swiftwater team and did so until 9 pm that night. During that time, my wife and 4 yr. old daughter were at home and watched and prepared for the flood and river rise. The water eventually came over our road, up to our house and eventually 8"in our house. When I got home at 9 pm, I arrived by boat onto our water covered back porch and our 4 yr. old riding her tricycle in the flood water in our house,(why not!) It is an eerie feeling hearing water running by outside your house during a flood, as we have had a few times in the past years, but to have it flowing through your house is another story altogether. Early the next morning, the water was receding and we washed, swept the muddy silt out as best we could. A boat ride around the farm showed 5' of water in my farm shop, 2 other barns where equipment is wintered over under cover, 2 buildings with 3' of water in them which had the farm quads, motorcycles, tools and other personal storage items. It took another day for the water to recede sufficiently to get a look at the devastation in those buildings, barns etc. When we got to them, everything in those structures were in a state of complete devastation and full of mud and debris. All our tractors went 2/3 under, all quads and power tools were submerged, (and we had all these up on high ground, trailers and tables in prior preparation for this event) fuel containers were floating, one farm equipment shed washed away, 7 cords of firewood flowed downstream, all our fences for cattle around our section for cattle were bent, broken, covered with debris or just plain gone. We own the house next door as a rental and it suffered the same devastation as ours did. It was quite a chore hauling out all the insulation from under the house as well. We tore out 4'-9' of walls in our house such as sheetrock, insulation,etc. and re-did all the outlet wiring, tore out floors, sanitized and just plain worked day and nearly all night for 10 weeks to get our house back to livable condition. The farm took 3 more years to get back in shape with equipment repairs, fence and building repairs, tool and equipment cleaning, etc. We had to do some downsizing of buildings and equipment as too costly to rebuild and replace some things that were lost or damaged.

The bummer of it is our flood insurance policy that we had written for the farm and rental as well as our property which was supposed to be the same as our home and farm owners policy was only written for our house! Not even covering our carport and outbuilding where 3 freezers full of home grown vegetables, beef and other items were floating in the flood water. 4 tons of pellets for our winter heat source was a pile of soggy sawdust. We used 2 kerosene heaters to dry out our house and to try to keep warm with for 10 weeks. Thank goodness we have a multi-level house where we lived upstairs with a shower, sink, bathroom and microwave and bedrooms for that 10 week time we did the downstairs repairs. Doing all the work ourselves in the repairs, we had just enough house insurance coverage for the new walls, flooring, appliances and electrical needs. The outbuildings, rental, and the farm were all out of pocket for all the needed repairs to farm equipment and buildings, etc.

All in all, we got stronger from it, rolled up our sleeves and just did what was needed to get back on our feet.

I sure do wish the folks at the Army Corps of Engineers would have listened to my dad's recommendations 40 years ago as well as my time talking with them 10 years ago about flood protection. 1 dam on the upper Chehalis and re-do the Scheuber road by-pass drainage ditch under highway 6 and along the Scheuber road to alleviate early rises of flood water. It is so easy to see and would protect I-5 as well as the people living in the valley. In regards to the diking projects suggested, I was told by a rep. of the Army Corps that I toured with that I lived close to the river, on the wrong side of the dikes and to keep paying my property taxes , but the flood waters would be worse than ever before and that it was just too bad for me and the good of the majority!

Well, Thanks for your time and I hope a lot of folks take the time to write you their side of the flood story and their suggestions for prevention ideas. The 1 dam makes sense to me, keeps one tributary clear and provides better flows in the summer months, and hey, why not try to get the reservoir to be a campground area for campers and tourists to stimulate some growth and business out in the PeEll area!

Thanks again for listening;

Sincerely, Steve Emrich

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. We acknowledge your support for water retention as the solution to mitigate the potential for future flood damages. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller, more localized projects, and programmatic actions.

Helgi Heldar 7/24/12

Greetings,

I have lived in Centralia for 38 years. During those years I have been through 3 major flooding events and sustained significant losses to property and equipment. With a hanger and an aircraft at the Chehalis airport I have repeatedly had major repairs to the hanger structure. In 2007 my aircraft was damaged to the tune of 70.000 dollars.

But more importantly I have seen first hand scores of friends, family and neighbors been virtually devastated by these flooding events. My brother in law, a dentist had a loss of $600.000 to his dental office and loss of income for many months of repair. Due to the flooding history, he is unable to get tenants to occupy the building. This area is economically depressed due to the ongoing threat of flooding.

I am strongly in favor of a water retention dam on the Chehalis river west of Pe Ell.

Please consider the welfare of the citizens of this community as you propose your budget for this next biennium. People who do not live here and do not have to experience these horrific events, should not be allowed to hold us hostage via their ideological opinions.

Respectfully

Helgi Heidar MD

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. We acknowledge your support for water retention as the solution to mitigate the potential for future flood damages was acknowledged. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions.

Daniel Thorson 7/24/12

Melissa,

None of the five points listed below even mentions dredging. Levees, flood walls and dams are not serious solutions. They always have and always will fail. They are a waste of major waste of money in Washington State. Dredge the rivers and be done with it. No serious discussion on this topic can be accomplished while ignoring this important fact.

Daniel Thorson

Are you concerned about flooding issues in the Chehalis Basin and potential solutions? If so then your input is needed by Friday, August 10, 2012.

At the direction of the Governor and Washington State Legislature, the William D. Ruckelshaus Center has prepared a draft report on alternative flood damage reduction projects for the Chehalis Basin. The purpose of the report is to provide decision-makers with key information on projects to reduce flood damage in the Basin. Projects covered in the draft report include:

- Water retention project (multi-purpose dam) on the mainstem Chehalis River upstream of Pe Ell.
- Improvements to the levee around the Chehalis-Centralia Airport.
- Flood walls to protect Interstate 5 in the Chehalis / Centralia Area.
- Raising/improving the US Army Corps of Engineers levee system around Centralia and Chehalis (the “Twin Cities Project”).

Other potential construction projects and programmatic approaches, such as land use planning, flood proofing, home elevations and buyouts, and livestock evacuation and sanctuary areas.

The final report is intended to be available in late August/early September.

Written comments are due Friday August 10, 2012 and should be sent to Melissa Kuehne at eithermelissa.kuehne@wsu.edu or by U.S. mail to Melissa Kuehne, Ruckelshaus Center (WSU West), 520 Pike Street (Suite 1101), Seattle, WA 98101.

Response to Comment

Thank you for your comment. We acknowledge your support for river dredging as a way to mitigate future flood damages. Specific dredging and sediment management options are described in the Additional Potential Flood Mitigation Projects and Appendix A sections of the report.

Lynn Davidson 7/25/12

Melissa, I wrote this last evening after I had walked around the yard enjoying the beauty. The roses are gorgeous this year. It's a beautiful place to be. But, not much longer for me. I'll move within the year. Will I stay in Lewis County. At this time, I have to say, "no." Though I've friends here, I'm afraid. Afraid of another flood and facing another loss. No. I'll move somewhere else. Jim was 71 and I was 64 when we rebuilt after the flood. We lost our home, completely.

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It's so bitter sweet. I look around at what Jim and I fought so hard to rebuild after the December 3, 2007 flood. He's gone. Lost to cancer.

We moved to Lewis County in 2006, after Jim had been diagnosed with and had undergone treatment for cancer We sold everything to buy our "home" free and clear. Then came the Dec. 2007 flood. We lost everything. We had one half hour to leave our home. We didn't know it at that time, but as we spent 12 hours on higher ground, waiting to be evacuated by the Coast Guard, we knew. We knew the river would take everything. And it did. The house, the car, the motorcycle, the RV, everything we had worked for was gone. Gone in 12 hours. A lifetime of hopes, dreams all gone in 12 short hours.

Why? Why did it happen? Why did what we had worked so hard for been lost so quickly? Was it clear cutting? Was it the "perfect storm" or was it because all these many years nobody had really addressed the "problem?" Not the "problem" of flooding I-5 and shutting off commerce but, the problem of saving homes and lives. Aren't those truly more important?

Jim's gone now. So is mom. Mom, who was 95 when she was air lifted out by the Coast Guard. Mom, who had to go live with relatives in Oregon while we tried to rebuild our lives. How can this be? We worked so hard to achieve some sort of life after retirement – and it's gone. Gone up in muddy river sediment. Jim died this last month from cancer. Mom died the prior year. Now I'm alone. What can I do? Declare bankruptcy and go into foreclosure. We took an SBA loan after the flood to rebuild. We owned the land. It seemed the right thing to do. After all, it had never flooded there before. Now the real estate market has bottomed out. I can't sell our home for what we owe and Jim is gone. I can't maintain it, either financially of physically. I have MS. We've lost everything to this damn flood. Am I bitter? Yes! Is there something that could have been done long ago to prevent this flood. YES!!! But it was ignored. The Corps of Engineers was handling everything with it's proposed levy solution – that's gone on for over 30 years!!! Why wasn't something done before 2007 – after the 1996 flood!! Am I mad? Yes! And what are you, the State of Washington, going to do about it? Just protect the commerce on I-5 – or maybe, just maybe protect the CITIZENS OF THE STATE OF WASHINGTON, instead of just the REVENUE for the State of Washington.

The retention dam needs building NOW! Lives need to be saved, not fish, not commerce, but people's lives. Now is the time to act – not 30 years from now.

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. We acknowledge your support for water retention as the solution to mitigate the potential for future flood damages. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions.

Carol Seaman 7/30/12

To: The Citizens of Grays Harbor County

This letter comes in response to a recent article entitled, "Study suggests multi-pronged flood solutions," by Steven Friederich, dated 7/25/2012.

First, I applaud Steven Friederich for sitting through, and reporting on, the often times laborious, sometimes tedious, meetings, of the Chehalis Basin Flood Authority.

However, one has to wonder, with the millions of dollars already spent on consultants & studies, why there is still no apparent progress, solution or answer to this group's attempt at preventing flooding on the beautiful, natural Chehalis River. I wonder, has The Flood Authority ever stopped to think that perhaps doing nothing at this time might be the best way to proceed. It would appear to me, and many citizens of Grays Harbor County, that the Flood Authority has been spinning its wheels for years, while spending a great deal of money in the process.

What is the answer?

For those of us who live on the river--especially downstream from the proposed earthen dam and levees--we would say, DO NOTHING! That is correct--DO NOTHING because there are no answers to the questions regarding dangerous effects the "proposed" projects would most likely have on people and properties downstream. It would also be prudent to look at the devastation caused by earthen dams over the years in Washingston State, as well as elsewhere throughout the world. This is an unequivocally dangerous proposal and should not be considered. Period. This stance is validated by the most recent 282 page report presented by the Ruckelshaus Center and certainly questions the policy makers in this county.

Not even the latest "new report" required by the state Office of Financial Management, was effective in offering any kind of quantifiable activity or project that hasn't been considered previously, as well as the mitigation questions. This report is nothing more than a weak attempt to keep the Flood Authority rolling along and justify more millions being spent for what? Honestly, this entire endeavor is absolutely pointless without the completion of mitigation studies--that means "what happens downriver when you start changing upriver" whether it be earthen dams, levees or any number of projects sighted in the "many pronged attack." There are too many variables, tidal flow, high winds, heavy rains and this question cannot effectively be answered--no matter the money spent. Even with these suggestions offered by the Ruckelshaus/Jim Kramer report--the Flood Authority has no more answers than it had several years ago! To many of us, it is beginning to look like an unending lesson in futility!

Why doesn't the Federal Government step up to the plate...build an overpass to eliminate the flooding issues on I-5 in the Centralia/Chehalis area. All of the building there was done with full knowledge that it was in a flood plain. Why doesn't the Chehalis River Authority disband and stop acting like they are accomplishing something? They aren't. Stop spinning your wheels with useless studies, and certainly some amount of bickering reported to the citizens of Grays Harbor over the years. Divert the 5 million dollars you are posed to receive, already alloted--to a fund which would help flood victims in the case of a flood.

Five million dollars would be a start. Then, take a serious look at the logging industry for the large part they have played, and continue to play, in the flooding on the Chehalis and many other rivers in this state. Work with Mr. Peter Goldmark, our Public Lands Commissioner for some answers and hopefully some assistance and solutions. Perhaps DNR would be willing to contribute to my proposed "Flood Victim Fund."

As for Mr. Kramer signing a recent $91,200 contract to "provide facilitation services" to the Flood Authority--nonsense. If he is unable to offer opinions or direction to the Flood Authority, it is a complete waste of more money. Put that money also in the fund to help flood victims in the event it is needed! There, now you already have $5,091,200. That's a good start. Leave the river alone--no good comes from trying to control natural habitat. I wonder if the Chehalis Flood Authority knows that a DNR driven, 5000 acre Natural Area Preserve and a one of a kind estuary system, which contributes natural flood control, currently exist at the mouth of our precious Chehalis River? Please, let us not jeopardize what we have with more relentless studies and inept attempts to control yet another natural river!

Sincerely,

Carol Seaman
2001 Mallard Lane
Aberdeen, WA 98520

Response to Comment

Thank you for your comments. We acknowledge your perspective that river should be left alone to flood as naturally as possible, and mitigation actions should focus on raising I-5 in the floodplain and on forest practices. The potential flood hazard mitigation projects summarized in this report were included based on the Legislative requirements and the current focus of interested parties in the Basin. Raising 1-5 on a viaduct was one of the alternatives evaluated and is described in the WSDOT I-5 protection from 13th Street to Mellen Street near Centralia and Chehalis report. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. It also calls for evaluation of how much flood hazard mitigation floodplain improvement and wetland projects could offer the Basin.

Rob Worrell 8/2/12

Hello. On our DNR website was an “Ear to the Ground” article suggesting a request for flood mitigation ideas. I grew up in that area and still live close by and have seen this flooding since the 60’s. I have always wondered if a flood channel could be cut on the west side of the valley along Schuber Rd, west of the hospital, and ending somewhere around the Galvin area where it would rejoin the river. A project of this nature would be Army Corps of Engineers size, and some of what was dug could be used to bolster the levees. Seems that a shallow angled flood channel (like I’ve seen in the Midwest) could still be used for some agriculture and the route would displace a minimum number of residence. That is my 2 cents worth. Have a good day.

Ronald T. Worrell
Aviation Maintenance - Resource Protection
State of Wash. - Dept. of Natural Resources
Voice 360-664-8602 Fax 360-586-5546

Response to Comment

Thank you for your comment. We acknowledge your support for a flood water bypass as a solution to mitigate potential future flood damages. A potential flood water bypass along Scheuber Road is described in the Additional Potential Flood Mitigation Projects and Appendix A sections of the report.

Miles Folks 8/2/12

Sir,

NC Machinery has had a significant presence in the City of Chehalis at I-5 Exit 79 since the 1960"s as a significant employer and significant local tax payer in support of the construction, logging, and power generation industries. Our company's ownership has financially and materially supported community improvement efforts including, but not limited to, annual Scholarships to Centralia College students, major contributions for the Providence hospital expansion, and donations of equipment to local communities for the construction of youth ball fields.

Logically, floods and the associated losses have moved from the category "possibility of flooding,"' to "in the likely event of flooding". It is our sincere desire that the various governmental agencies responsible for protecting the people and business assets make the necessary physical improvement to mitigate the Chehalis River flood threat.

While the Management of NC Machinery makes no claim to have the answer to which project is the one that will be the "silver bullet," upon review of the many possible options it is our belief that a retention dam/generation dam provides the ability to retain a significant portion of flood waters where the waters begin while offering a method of recapturing some portion of construction through future sale of generated power via a reusable, green, fuel source, that being water.

Using the retention dam in conjunction with the expansion and raising the existing dike system, we believe, provides a significant bulwark against future flood events that would allow our ownership to enjoy an improved outlook of the safety of our significant Chehalis assets.

NC Machinery, Chehalis suffered fairly minor flood damage in 1990, significant damage in 1996, and catastrophic damage in 2007. As has been illustrated in Chehalis Draft Report 7-12-2012, the floods appear to be progressively more damaging with each event and be assured the insurance carriers for NC Machinery have taken note. In those events our company has rebuilt the facility twice, lost inventory, twice, had our business interrupted, and had to retool twice. But what about the other non-monetary costs of our employees?

From November to March, every single year, when it snows, then rains: rains heavily for extended periods: when the Willapa Hills carry a heavy snow load: or a Pineapple Express is forecasted, the personnel in our Chehalis facility become a little more tense because they know "this could be the year we get another flood, and if we get another one ……..?" Then, there are the personal tragedies of lost homes or belongings, friends and co-workers who need a refrigerator, bed, or sofa because theirs "got wet." These are the personal sides of the Flood Control Project and not quantifiable in a cost/benefit analysis, how do you put a value on the knowledge that your home will be where you left it when you return from work or a shelter. Those of us who were only inconvenienced open our wallets, homes, and cupboards all the while giving thanks that it isn't us needing assistance.

Respectfully,
Miles Folks
Branch Manager
NC Machinery Co., Chehalis, WA

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. We acknowledge your support for water retention as the solution to mitigate the potential for future flood damages. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions.

Richard Tardiff 8/3/12

Melissa,

Good morning to you, I would like to comment on all the fill material they have been placing in an around all the commercial sites around I-5 & Chehalis area, under Home Depot, and opposite the Wal-Mart store on the south side shopping strip in Chehalis, all that import material came from the Clay deposit on the hillside across the Freeway, it seems to me because of a water issue and flooding problems, they would want to import more of fracture rock and design drain fields and pervious paving which would allow for displacement of water and not effect the buildings and roads above, instead they just fill them with clay dirt period. Seems like they always want to use the cheapest material they can find for there applications, it's like there building dikes all around the freeway and gives the water no place to go. Also on the freeway expansion were there going to raise I-5 down to exit 72 with fill dirt, why don't they just build the freeway like a concrete bridge north and south from I-5 Mellon St in Centralia down to the Wal-Mart I-5 Exit 79, that would allow all the water if it floods just to run under the bridge. They build them in Louisiana and there miles long and still standing over the swamps. Just a thought, makes sense to me. You look at the millions it cost daily when they close down the freeway do to flooding. I think they need to re design that part of the freeway, pretty simple math; you keep filling in these areas with cheap fill dirt you just create more flooding. That's pretty much the end result. You don't have to be an engineer to figure that one out. With all the ideas and plans in motion they all need to fit like a puzzle or this flooding issue will never go away. Just wanted to share my thoughts. Regards Richard Tardiff

Melissa,

One more thought if they built it that way, they could actually leave the existing road under the bridge to use them as feeder roads north and south that would allow traffic to travel from Mellon Street to Chambers Way Exit 79, prevent traffic from getting on an off the freeway which in turns reduces accidents and it also saves on tearing out the sections that need to be raised up with millions of tons of fill dirt. That cost would be applied to the overhead bridge. Have a good day, Richard

Response to Comment

Thank you for your comment. We acknowledge your concern about the composition of the fill in the floodplain and your perspectives about protection of I-5 in the Chehalis / Centralia area. Please refer to Appendix J, a report recently prepared by WSDOT on protection of I-5 from 13th Street to Mellen Street that explores specific alternatives to protect this stretch of the highway, including the option to put I-5 on a viaduct as described here.

J. Vander Stoep 8/7/12

After the December 2007 flood my wife and our three girls began helping people in the upper basin muck out their flooded homes and farms. Our girls were between 10-16 at the time. We would take one of them with us each day as much for them to understand how destitute the poor families were who were flooded and how lucky they were to have a home that does not flood. The first couple of homes where we helped were owned by friends but by the third or fourth home we were mucking out the homes of strangers. Some people may think that a flooded home just means that things get wet. Its much more significant than that. The flood water was filled with dirt and the dirt went everywhere the water went. What it left was a substance like grainy chocolate pudding in every drawer, every appliance in every wall. It was a horror to see a home hit by the 2007. At every home the drill was the same, the volunteer would be assigned a room and our job was to make two piles, the first pile was things we thought could be saved and the other was things to throw away. The most searing memory for me was at about the fourth home. This was the home of an Hispanic couple with two young kids. They had just built a modest home on land they had purchased that had been part of a very old dairy farm west of Adna. The land had never flooded but in 2007 their new home had 3 feet of water. I was assigned to go through the belongings in the bedroom to make the two piles. Imagine how exhausted and desperate you would have to be to invite a stranger into your bedroom and ask him to go through your belonging to make these two piles. It was at that moment that I dedicated myself to finding a solution so that this kind of terrible event would not occur again.

The floods of 1990, 1996 and especially 2007 were of such enormous magnitude and so devastating to so many families and communities in the Chehalis basin that it is really impossible to fully describe the impact then and still today.

I am grateful to the Ruckelshaus foundation for the time and effort spent putting together its report on the Chehalis basin flooding. It is a very valuable contribution to understanding the issue. My comments on the report principally focus on page 4 in the description of the impact of the dam on the fishery. The Anchor report did not, as the report suggests, predict a 22-44% increase in Chinook spawners in the upper basin. Anchor predicted a 120-140% increase from a current number of approximately 300 upper basin spawners to almost 800 with an optimized multi-purpose dam. The Anchor report opines that with increases in Chinook and decreases in Steelhead and coho in the main river channel, taken together, there will be an increase in spawning salmon of 50 fish. Anchor estimates that late summer flows in the upper basin would increase from 30 cfs to 170 cfs. State and federal fishery and environmental agencies have, for decades, been concerned with the negative impact on fish from low flows in the upper Chehalis. I believe that the report should include some of this context and explain how flows can be improved and temperatures can be lowered by a multi purpose dam.

Also, the report gives data from WSDOT estimating the number of homes and businesses that would be protected and those that would be further harmed by building the I-5 flood wall. If that is worthy of note then an estimate as to the numbers of homes and businesses that would be subject to less flooding with upper basin water retention should also be included – and that number will be in the thousands. – J. Vander Stoep

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. We acknowledge your support for water retention as the solution to mitigate the potential for future flood damages. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions.

The reference to an increase in Chinook populations as a result of the dam was corrected for the final report and additional information about the potential for natural resource benefits from a dam was added.

Pamela Hopwood 8/8/12

Instead of being short sighted and putting a bandaid on the flooding problem down here, I am in favor of solution 3 (Combination 3) is made up of a dam on the Chehalis Mainstem, the Airport levee improvements, and flood walls and berms to provide additional certainty about protection of Interstate 5. As with the other example project combinations, improvements to the Skookumchuck Levees, and modification of the Sickman-Ford and Wakefield Road (South Elma) bridges are also included. Combination 3 would provide the most robust flood mitigation of any of the project combinations – providing flood mitigation throughout the mainstem Chehalis including in the Twin Cities from the dam and protecting Interstate 5 with floodwalls and berms. It also is expected to be one of the most costly of the project combinations if the bypasses cost less than the $245 million estimate for the dam. Outside of the Twin Cities area Combinations 2 and 3 would have very similar benefits to each other, with substantial water surface elevation reductions in most locations. Within the Twin Cities there would be some differences as the I-5 flood walls and levees would cut off some flow paths leaving areas downstream of these protected and areas upstream with slightly higher water levels then if the flood walls were not present. This increases the certainty of protection for I-5 and likely would provide some additional flood mitigation benefits in the Twin Cities areas. These benefits have not yet been quantified. As in project combinations 1 and 2, targeted bridge modifications and Skookumchuck levee work would provide additional localized flood mitigation benefits in those areas. Which promises to give the most protection to the most people, infrastructure and businesses in this area. This problem has been studied to death and it is way past time for concrete action to be taken.

Pamela Hopwood
2565 Kristine Ct.
Centralia, WA 98531
Pam@CompPrime.com
360-520-2980

Response to Comment

Thank you for your comments and for expressing your preference for how best to move forward to address flooding in the Chehalis. The final report recommends moving forward with the additional work needed to determine if it is feasible to put a water retention (dam) project into permitting and to support decision making about a dam, as well as I-5 protection projects, as part of a suite of actions that are recommended to reduce the potential for future flood damages.

Michael Smell 8/9/12

9 August 2012

Our Story for your Draft Report dated 16 July 2012

What is special about the Newaukum River?

Our section of the Newaukum River is close to I-5 and Chehalis but still rural in nature.

What would I highlight to an out-of-town visitor?

This is the place to be if you like a rural setting. It is complete with a dairy farm, a beef cow ranch and a meandering river with fish in it. Bald Eagles nest in the area while Blue Heron, doves, killdeer, rabbits, coyotes, songbirds, and other wildlife honor us with their presence. Hay fields dot the roadsides. It is peaceful and quiet at night. Vegetables and fruit trees are easily grown. It is a natural country setting.

What do I see as the future of the area?

The major commercial development will continue to be along I-5. We should be left alone since we are not in the UGA but are in the floodplain.

What are the strongest memories of the major floods over the past two decades?

Being prepared every year for a flood lessens the consequences. Seeing a 20 foot long 2 foot diameter log float along Hamilton Rd 20 feet from our house. Using water to clean out the silt left from the flood waters from all the out buildings. Keeping the two submersible pumps in our basement running continuously for 35 hours to keep the water level to 1 foot in our daylight basement when the flood waters outside were at eye level on the basement windows. We have never lost electrical power or telephone service. Using our rowboat to take tons of grass and weed debris off the New Zealand fencing around the pasture. Having to journey to the carport to feed horses standing knee deep in flood waters for two days. Discovering that the fast flowing flood water current picked up part of the asphalt roadway by our house and deposited it ten feet inside our pasture. Being able to share the experience with each other.

Tell us more

My wife and I have lived here for 26 years. We have had a flood on the Newaukum River by our location every year. Some are minor Phase I and Phase II while 1990, 1996, 2007, and 2009 were major. All are still minor inconveniences when compared to the beauty and peacefulness of the area at other times. Come by in the spring, summer, or fall and see what the area looks like and everything that is growing. We are prepared every year for flooding. This minimizes the effects. We are able to have farm animals and tend to our vegetable garden and fruit trees. It is still country living. I would like to make some observations:

As I have stated at meetings and in writing before, I feel a dam on the Upper Chehalis River is not the correct choice because it would be stationary on the Upper Chehalis River. You own draft lists 3 examples and Larry Karpack’s presentation at your meeting on 14-15 June 2012 showed 10 examples of major rain events. They show that major rain events are scattered all over the Chehalis River Basin. Dam proponents have not addressed this issue. Even if the majority of the rain event occurred behind the dam site, the dam would be less effective the higher the retained water level was at the beginning of the rain event. The dam would be useless if the rain event was below the location. This is my major objection. The cost is very high with or without hydro and as stated above; it may or may not have any effect on flooding downstream. You must also add to the cost any mitigation projects that would have to be accomplished such as for fish habitat as a dam would permanently alter the land and river downstream. Now add the fact that the town of PeEll is only 2 miles downriver which means any breach on the dam would give the town no time to evacuate. The Chehalis River Basin Flood Authority has over a hundred varied projects on their list that are scattered throughout the Basin. I would rather see ALL of them completed FIRST. Natural projects like the Horseshoe Bend (Oxbow) that the Chehalis Tribe funded on the Newaukum River in 2000 to temporarily store flood water would be my first choice. Another natural project not even listed but that used to be the pet project for the Lewis County Government when the COE Twin Cities Project was proposed is the Hamilton Meadows Project. Unlike the Scheuber Road Bypass, this project would temporarily store flood water next to State Route 6 and then release it after the river level went back down. I would like to see any project that works with Nature instead of trying to conquer it. Anyone can look at our land at 470 Hamilton Rd, Chehalis, WA to see natural ways to temporarily store flood waters. I also hope that more wetlands will be established throughout the Basin as another natural way to absorb the flood waters.

-Glenda Smell

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. We acknowledge your concerns about the potential for a dam on the upper Chehalis. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller, more localized projects, and programmatic actions.

Jarred Filgar-Barnes 8/9/12

Alternatives Draft Report.

So now what do we do about this flooding problem. Sounds to us like this problem has been getting worse and worse. Should we continue with practices that contribute to the problem or start fixing some of them???

After reading your report we have come to some conclusions.

First a “Basin Wide” solution does not nor will ever mean focusing on the twin cities area. Though this area has its fair share of problems they are only part of the solution.

Second, a dam, really??? We are in an era of dam removal not dam creation. Plus in “potential concerns associated with the water retention facility” you don’t list certain problems such as:

- Large amounts of mass wasting deposits from the 2007 floods still exist upstream and the sediment and gravels associated with those deposits are slowly being carried down stream. Eventually, a facility will fill up with sediments (like Mt. St. Helens first diversion dam).
- Dams prevent sediment transport which can have dire effects on downstream habitat (see first bullet).
- Dams reduce flows and limit downstream transport of sediments, which effects a rivers carrying capacity for flood waters. For example, the North Fork Cushman dams effect on the Skokomish River contributed to the build up of gravels downstream, gravel bars are higher than the river’s flood plain and aggradations of sediment and gravels cause the river to go sub-surface during summer low flows which reduces fishery potential. The Skokomish River is the most flooded river in the state (dams where the problem—not the solution).
- What about an earthquake? A recent report suggests that we are overdue for a 8.0-9.0 magnitude earthquake by about 500 years. A dam is defiantly not worth the benefits of flood relief if it bursts and a 30ft wall of water heads down the valley. Does your cost/benefit analysis factor that in???

You state, a large amount of mitigation will be required for a dam. Why not mitigate without making the dam! Why don’t you get rid of fish barriers that restrict the flood plain and increase the potential of flooding. Set back levees allowing a large flood plain in the twin-cities area might help!

Still, why build more levees at all? There are plenty of examples that show how levees fail in their initial purpose, flood control. Often, gravel will fill the stream or river channel between the levees. So, many times a river will be dredged causing additional sediment to fill the channel after dredging (a continual process which ultimately cost thousands upon thousand’s of dollars). Or conversely—no dredging occurs and the river elevates itself above the flood plain which causes the need for a higher levee to keep the river within it’s channel. We have seen how well that works in the massive flooding in the Dakotas where levees elevated above agricultural land and cities broke causing massive damage to crops and entire cities. In our area, the Skokomish River has had flooding problems for many years. The Skokomish Tribe believed the best way to reduce flooding was to remove existing dikes in the estuary, removing confining bridges and connecting wetlands which would allow flood waters to spread out and move faster out of the system. It seems to be working! So, how about letting the flood plain be a flood plain, move the people out the best you can and remove blockages and other impediments to the river, like the Skokomish Tribe has done, except they didn’t have a Flood Authority. The Skokomish River has a committed Skokomish Watershed Action Team made up from the local community, Tribal, and county members, working on programmatic solutions for the whole basin (without taxes).

Basically what we are saying is "Local Projects and Programmatic Approaches: Another Way" is the way to go for the whole basin. It adds up,! Doing the right thing for the watershed is not constricting and damming.

Last, but not least, we need better forest practices. Remember what caused the massive landslides in the upper Chehalis? Rain of course--but specifically in the Chehalis headwaters, 1,614 landslides were considered to initiate off of managed forest lands: 547 in clear-cut's (0–5 years), 104 in young stands (5–15 years), 403 in sub-mature timber (15–50 years), 0 in mature timber (50+ years), and 560 near forest roads (DNR OPEN FILE REPORT 2008-5).

Thank you for the opportunity to comment. Please include this in the final Basin Flood Mitigation Alternatives Report.

Sincerely,
-Jarred, Kim and Ron Figlar-Barnes

Response to Comment

Thank you for taking the time to respond. All your comments were taken into consideration. We acknowledge your concerns about a potential dam on the upper Chehalis. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. The recommendations in the final report include an effort to better understand how much flood hazard mitigation a suite of smaller, more local projects, and projects aimed at improving restoring natural floodplain function could offer. Please refer to Appendix C for a Washington Department of Natural Resources report on improving forest practices in the Chehalis basin.

Michelle Schilter 8/10/12

I write to you today regarding the flooding that affected my family in December 2007. We were woken up very early in the morning from a friend of ours that lived on Ceres Hill in Boistfort asking if they could come to our home with their children to escape the water approaching their house. It was quite a startling phone call but it did nothing to prepare us for the nightmare that would descend upon our life approximately 6 hours later. In between that phone call and 2:00 p.m., we managed to evacuate our dairy calves from their hutches (they would have all perished), disconnect and move milk pumps to "higher ground" (not high enough), chain our propane tank to concrete posts, and evacuate our 3 children to a different location. We watched as the water entered our home at about 4:00 p.m. and the water leave our home at 7:45 p.m. My husband, hired hand, and myself slept in the attic of our residence, listening to the evacuation helicopters fly the valley all night. We woke up to a nightmare, a nightmare I never want to repeat. Through the generosity of family, friends, and strangers we were able to rebuild our home and dairy.

I share this story because flood mitigation is crucial to the survival our our dairy, our family, and our community. We need action now and we need to look at all options. We live in the Upper Chehalis River Basin. The most logical flood mitigation solution for our area in Adna is the water retention project above Pe Ell. Any of the other levy solutions proposed so far will do nothing to help our area. In fact, it will probably make our flooding worse. I understand this will not help in the lower part of the basin, that is why I ask the Governor to embrace the plans that includes several different components. I come from an area that has used several different options together to solve flooding (Napa, California). I know by now the Governor must understand there is not a "Silver" Bullet that will solve every issue and area of flooding in the Chehalis Valley. Please include the Water Retention Project above Pe Ell as a critical component of the flood mitigation project. My family, my 3 children, my dairy, and my community can not live through another catastrophic flood like December 2007. I thank you for your time and look forward to hearing from you. If you have any questions, please do not hesitate to contact me. I can be reached at 360-748-7011.

Michelle Schilter
Sun-Ton Farms
Adna, Washington

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. The recommendations included as part of the final report acknowledge that no single project will be enough and call for moving forward on a variety of efforts including the additional work needed to determine if water retention is feasible.

Christine Hempleman 8/14/12

Chehalis Basin Flood Mitigation Alternatives Report, draft July 16, 2012

Ecology comments 8/14/12

Priority flood hazard mitigation projects

The Chehalis basin will continue to flood on the mainstem and tributaries and, as the report states, it appears that frequency and magnitude of floods are increasing. Current floodplain management science prioritizes methods that are generally non-structural and have multiple benefits to the watershed. Ecology favors this approach along with small capital projects targeted at localized problem areas.

The report uses the terms “flood mitigation” and “flood hazard mitigation” but the distinction and meanings need clarification. “Flood mitigation” may suggest that we could make flooding “go away.” However, there are no projects that exempt areas from flooding. For example, some proposed projects focused on the mainstem may reduce impacts to some areas, in some situations, while providing no or minimal benefits to other areas of the basin - notably tributaries, including most of the South Fork, Newaukum, and major rivers in the lower basin.

“Flood hazard mitigation” recognizes natural watershed processes; it is based on the premise that it is most beneficial in some situations to move the water away from people, in others to move people away from water.

To move water away from people, current floodplain and watershed management science prioritizes methods that enhance natural functions such as:

- programmatic and regulatory measures
- restoring watershed functions, including wetlands and upland tributaries
- restoration of riparian zones and reconnecting flood plains
- improved forest management, especially forest road restoration.

To move people away from water, it may be most cost-effective to use early warning systems, buy-outs, flood easements, and raising houses.

The modern floodplain management, watershed-wide methods we prefer:

- offer a reduction of flood impacts to critical areas on the mainstem and on tributaries
- are more sustainable, providing a better cost/benefit ratio up-front as well as in long-term maintenance costs
- are adaptable to changing needs and conditions
- can be funded over time and distributed throughout the basin
- have multiple benefits to overall watershed function including improved groundwater recharge, more stable and predictable geomorphologic processes (e.g., erosion, aggradation, and impacts to Grays Harbor) and proven benefits to fish and aquatic ecosystems.

Information contained in the report

General comments:

- Characterization of the 2007 flood and storm: The report should note that there is disagreement about the 100-year design flood used in the analysis. Ecology's analysis shows that floods at Grand Mound are associated with high flows both at Doty and from the Newaukum River. The methodology used for the current 100-year flood biases flow to the mainstem above Doty. The report should clearly explain the differences between calibration storm events and the design storms, and limitations and biases of each.

Ecology recommends that a second design flood should be developed for a storm focused predominantly on the Cascade foothills rather than the Coast Range. Otherwise designs of downstream projects could be missing the potential impacts of a storm that is not consistent with the current design storm.

- Retention project compliance with the Clean Water Act and State Water Quality Standards: The report makes no mention of these requirements. There are separate concerns for upstream impacts (the reservoir) and downstream impacts (below the dam).

Above the reservoir are areas that have been designated for salmon spawning in the State Water Quality Standards. From a regulatory perspective, how to remove existing uses (including salmon spawning) from a waterbody is unclear and a regulatory pathway may not exist. Normally, to meet Clean Water Act requirements a project would have to show that it would not impact the current designated uses of the waterbody. Off-site fishery enhancements cannot be used as mitigation for loss of an existing use. How the proposed Chehalis River dam project would address this issue is uncertain.

Below the dam, Ecology's analysis shows that water quality standards for dissolved oxygen and temperature are likely not to be met. The timing and severity of the impacts would depend on the final design of the reservoir, especially the depth of the outlet, and how the dam was operated. The design and operation of the dam will have to ensure that standards are met downstream. How this would be accomplished has not been determined, although it will likely add to the costs of the dam.

One key limitation is the need for a numeric model of basin hydrology to support the hydraulic model, identify gaps in the understanding of basin hydrology, and aid in future decision-making.

1. Cost/benefit of the dam: The disparity of opinions and need for better information regarding the projected cost of the dam is not adequately characterized in the report. A number of potentially significant cost considerations have been raised in response to the Phase 2B report (Economic Feasibility), in subsequent studies, and in public comments. These considerations regarding the existing, conceptual cost estimates for the dam should be acknowledged in the report:

    - Water quality and Clean Water Act compliance
    - Additional construction and operation costs for dam hazard mitigation due to proximity of Pe Ell
    - Lack of detailed assessment of the dam site including key factors such as stability and haul distance to suitable construction material
    - The "life cycle costs" of a dam including refined operation and maintenance (with fish mitigation and sediment management), as well as decommissioning of the structure at the end of its useful life. (This life-cycle consideration should be factored into cost analyses of all capital projects.)
    - Updated fish mitigation construction and operating costs

In general, the report seems to overemphasize the possible benefits of the proposed dam and underestimate the possible costs in dollars as well as impacts to watershed functions. There remains a great deal of uncertainty about both.

1. Limitations to the modeling approaches: During review of the hydraulic modeling, Ecology identified a variety of limitations and concerns with the modeling. We recognize that this hydraulic model is a definite improvement over past efforts. However, the report should recognize that the model still has large areas of uncertainty and inaccuracy and that additional improvements should be considered for the future.
2. The report could better acknowledge the fact that the problems in the lower basin are less well defined than in the upper basin. Without this, the need for a solution doesn't seem well supported.

Specific comments:

(*underlined language is suggested add)

1. Page 4: In introducing the Fish Impact Study, take a more even-handed approach. Along the lines of: "According to (the study),* a dam may have mixed results for salmon species in the basin. A dam could provide..."
2. Page 4: Add available cost information, to make the section on the water retention project parallel with the others in this section – such as: "Conceptual cost estimate for construction of a multi-purpose dam is $245 million. This estimate is based on preliminary information. Potentially significant cost considerations have been raised during studies conducted after the preliminary cost estimates, and in public comment."
3. On page 49, please include a summary of factors that could increase cost of the dam project as we have outlined above under "cost/benefit of the dam" in General Comments above.
4. Page 5, bottom of page: Bullet list of Corps options uses a set of terms that are meaningless to the average reader. It would be helpful to briefly describe what these are (i.e. General Investigation, General Reevaluation Report, etc.)
5. Page 7 Combo 2: "Because of the dam, Combination 2 would provide significant flood mitigation benefits in the *lower South Fork Chehalis and throughout the mainstem Chehalis….." There is emphasis in the report on the importance of the Boistfort Valley as an agricultural area – for example, page 32 – but our understanding is that the dam does not protect all these areas.
6. Page 7 Combo 3: Suggest this be revised to ensure clarity: "Outside of the Twin Cities area Combinations 2 and 3 would have very similar benefits to each other, with substantial water surface elevation reductions in most locations *in the upper and middle mainstem."
7. Page 8 and page 60 "Local Programs and Programmatic Approaches: There seems to be an erroneous distinction being made between structural options and programmatic approaches: "This kind of approach would be the less expensive to implement; *however the risk of flood damage to existing development in the floodplain would remain*." No project can eliminate the "risk of flood damage to existing development in the floodplain." And programmatic actions such as elevating houses and building critter pads can directly reduce the risk of flood damage to existing development. A more accurate statement would be, "This kind of approach would be implemented and funded over time throughout the basin. The scope of such an approach, as well as the associated flood hazard reduction benefits and costs, have not been evaluated."
8. The summary of hydrology on page 21 creates a somewhat inaccurate impression about how floods can occur in the basin. A large flow at Grand Mound can be predominantly from the Cascade foothills (Skookumchuck and Newaukum) or from the Coast Range (above Doty and S. Fork). Flood events have occurred that were predominantly from either of these two areas. (The percent of flow from Doty for all

Grand Mound floods ranges from 17% to 40%, with 2007 as an outlier at 88%.) To focus solely on flood events focused on the headwaters above Doty introduces a bias that may neglect the impact of the significant flood events that focus on the Cascade foothills. The basin is large and complex enough to need multiple design storm events.

Here is some suggested revised language:

- Flood events at Grand Mound are generally a combination of high flows from the Coast Range (mainstem above Doty and the South Fork) and the Cascade Foothills (Newaukum and Skookumchuck Rivers). Floods generally vary from being roughly two-thirds from the Coast Range to two-thirds from the Cascade Foothills, including any proportion in between.
- The 2007 flood event was an extremely unusual event with unprecedented flows concentrated to an extreme amount over the Coast Range.
- A large flow at Doty or a large flow in the Newaukum River are reliable (although not perfect) indicators of a large flow downstream at Grand Mound.

9. Pages 42 and 89 conflict in reference to which communities are considering applying for the FIRM Community Rating System. Page 42 says Grays Harbor is considering applying, 89 says Grays Harbor and Napavine. Napavine does not participate in the NFIP at this time so cannot apply for the CRS.
10. The “Potential Programmatic actions” on page 47 and the discussion of Riparian restroration on pages 93-94 should also refer to the restoration of wetlands and floodplain storage and connectivity that can provide floodwater storage and habitat benefits.
11. The analysis of the dam on pages 48-49 should also mention uncertainty regarding Clean Water Act compliance and the adequacy of the design to protect Pe Ell.
12. Figure 5 on page 59 - Are combination A and combination 1 the same thing? It would be useful to understand the difference between ‘significant’ flood mitigation, ‘some’ flood mitigation and ‘generally’ protected, etc.
13. The summary on page 72 is misleading.

    a. The last sentence of the first paragraph under “Water Retention Project On The Mainstem Chehalis River” states:

    “A single-purpose flood storage structure has also been examined, but does not have the added benefit to fish and wildlife of providing additional water flow and cooler instream temperatures from water pulled from deeper parts of the reservoir during the summer months, to mitigate environmental impacts.”

    We suggest:

    “A single-purpose flood storage structure has also been examined. While a single-purpose structure may not have the potential environmental benefits of the proposed multipurpose structure, it may help reduce some of the potential impact.”

    b. Under the fourth bullet, releases from the dam can result in lower oxygen levels. Therefore this statement should say: “The Anchor QEA model predicts flow augmentation in the summer months can enable higher concentrations of dissolved oxygen at times, depending on how the dam is constructed and operated.”

    c. Under the fifth bullet also is inaccurate. This statement should say: “The Anchor QEA model predicts the additional 65,000 acre-feet of storage can be used for controlled release in the summer, which may reduce water temperatures at times, depending on how the dam is constructed and operated."

14. The "potential concerns" on page 73 are incomplete. The following should be included:

    a. The inundated area of the reservoir will eliminate salmonid spawning areas, which creates challenges both directly on the fishery and also for Clean Water Act Compliance.
    b. The Anchor QEA model predicts that dam releases at times may reduce concentrations of dissolved oxygen, depending on how the dam is constructed and operated. These reduced oxygen levels may not be incompliance with the State's Water Quality Standards.
    c. The Anchor QEA model predicts higher water temperatures at times, depending on how the dam is constructed and operated. These elevated temperatures may not be incompliance with the State's Water Quality Standards.
    d. Construction and operation of the dam to protect high hazard conditions because of the downstream proximity of Pe Ell may significantly increase the costs of the dam.

15. The last sentence on page 73 is unclear. Should the reference to the airport area be to I-5? In other words, would additional localized improvements be needed along I-5 to protect I-5, not to protect the airport area?
16. Page 96 - third sentence in the first paragraph. It is the Chehalis River, not the Mary River, that will cut through the oxbow and head directly at Mary's River Lumber in Montesano. In the fourth sentence (1st paragraph), it is unclear and counterintuitive how removing levees could <u>prevent</u> a river from moving. Should it state that removal of the levee would <u>allow</u> the river to meander? In the last sentence of the second paragraph, the Department of Ecology also needs to be involved in bank stabilization proposals.

Response to Comment

Thank you for your comments. Numerous technical improvement and clarifications were made to the report as a result of this review and subsequent conversations with Ecology and the rest of the State technical Team.

With respect to the comments on hydraulic modeling, WSE, the technical consultant performing the modeling prepared the following response.

"Ecology's comment seems to consider the 100-year design flood and the 2007 flood as if they are the same. The hydraulic modeling and analysis conducted for the OFM Report used both the December 2007 flood and a 100-year design flood and these are quite different from each other. The hydrologic data was developed by WEST Consultants for the Corps of Engineers as part of the Chehalis River Basin Ecosystem Restoration Study. A detailed discussion of the hydrology, including the long-term statistical basis for the 100-year design event, is provided in WEST's report (June 2012). The hydraulic evaluations described in the OFM report were based on modeling of four flood events including the two largest "basin wide" floods observed in the past 82 years (December 2007 and February 1996), the recent January 2009 flood event, and a theoretical 100-year design flood event. The staff to the Ruckelshaus Center for the OFM report and technical team agreed that modeling and analysis of basin wide flood relief projects using these four floods provided a robust analysis of the alternatives.

Modeling additional theoretical floods could be done. However, to be useful for evaluation of alternatives a theoretical design flood would need to be reasonably possible in addition to simply being big. The overwhelming evidence in the 82-year record at the Grand Mound gage is that extreme floods (i.e. a 100-year type flood) simply cannot come primarily from the Cascade foothills. Considering WEST's hydrologic analysis, the sum of the 100-year flood on the Skookumchuck River (13,200 cfs) plus the 100-year flood on the Newaukum River (14,995 cfs) is 28,195 cfs or 36% of the 100-year flow at Grand Mound. While it would be possible to create a 100-year flood at Ground Mound that gets most of its flow from the Skookumchuck and Newaukum Rivers, the magnitude of flows from those tributaries would need to far exceed their 100-year values making the event so rare that it could not be considered a 100-year event.

The 100-year design flood used in the latest hydraulic modeling (distributed by WSE in June 2012) has contributions from the Newaukum of 14,500 cfs (97% of the 100-year flood) and from the Skookumchuck of 13,070 cfs (99% of the 100-year flood). Since the contributions to the theoretical 100-year event from the Cascade foothills basins are on par with the overall event recurrence interval, as are the contributions from the upper mainstem, there is no apparent bias towards flows from any particular portion of the basin."

With respect to the other comments submitted, the report added language regarding the water retention project and compliance with the Clean Water Act and State Water Quality Standards.

Your considerations regarding the existing, conceptual cost estimates for the dam are acknowledged in Appendix A of the report.

Most, if not all, of the limitations and concerns that Ecology previously raised with the model have been addressed with model changes, were shown to be of no consequence, or were acknowledged as issues for future work. A summary of the WSE team's responses addressing Ecology's earlier comments was included as an Appendix to the WSE report, which was included as an Appendix to the OFM Report. The WSE team is currently scheduled to meet with the State technical team in September to discuss possible steps that can be taken to improve the modeling further.

The final report better acknowledges the fact that the problems in the lower basin are less well defined than in the upper basin.

Specific edits to the text have all been incorporated except for comment 8, for which WSE prepared the following response:

"Review of the USGS gage data shows that the ratio of peak flow at Doty to peak flow at Grand Mound ranges from 22% to 80% with an average of 41%. December 2007 is the highest value (80%) but there are similar ratios seen in other historical events so it is not clear to us that this event can be discarded as an "outlier". Ecology's suggestion to use multiple design storm events is what was done by modeling four floods instead of only one and reporting the results from all of these in the hydraulic modeling report. As described in our response to general comment 1, Ecology's assertion that the hydraulic analysis of flood relief alternatives focused "solely on flood events focused on the headwaters above Doty" is not true. The analysis looked at the three largest storms observed at the Grand Mound gage in the last 20 years and that these included a mixture of storm centerings and distributions, including the January 2009 event which was largely focused in the Newaukum watershed. It is not possible to create a 100-year design event that gets two thirds of its flow from the Cascade foothills without an unreasonable contribution from the Skookumchuck and Newaukum basins and a runoff distribution that has never been observed during an extreme event.

Reviewing the USGS gage records for the Chehalis basin it can be shown that for the top 10 historical floods at Grand Mound (ignoring WY 1933 and 1937 for which data are not available for other basin gages) the average contribution from the Doty, Newaukum, and Skookumchuck basins for the remaining 8 events are 45%, 19%, and 14% respectively while the 100-yeardesign flood model has contributions of 45%, 18%, and 16% respectively.

We also believe that Ecology's suggested revised language to describe the flood data is misleading or inaccurate as follows:

Flood events at Grand Mound are generally a combination of high flows from the Coast Range (mainstem above Doty and the South Fork) and the Cascade Foothills (Newaukum and Skookumchuck Rivers). Floods generally vary from being roughly two-thirds from the Coast Range to two-thirds from the Cascade Foothills, including any proportion in between.

Based on the top 10 largest peak floods on the Chehalis River at Grand Mound it is not correct to suggest that either two-thirds of the observed flow at Grand Mound or two-thirds of the combined flow from the four major upstream basins can come from the Skookumchuck and Newaukum Rivers. In fact, review of the observed data shows that on average 64% of the flow from the four upstream basins comes from the upper Chehalis and South Fork (max 84% min 57%) while on average 36% comes from the Newaukum and Skookumchuck (max 43% min 16%). The 100-year design storm has 65% of the total contribution coming from the upper Chehalis and South Fork, approximately the same as the average of the observed large flood events.

The observed data also shows that when compared to the flow at Grand Mound the concurrent summed peaks at the Doty and South Fork gages average 62% (max 105% min 47%) while the sum of concurrent Skookumchuck and Newaukum peak flows averages 33% of the Grand Mound peak (max 46% min 21%). For the 100-year design flood, the sum of peak flows at Doty and on the South Fork is 65% of the Grand Mound peak while the sum of Newaukum and Skookumchuck peaks is 35% of the Grand Mound peak.

A large flow at Doty or a large flow in the Newaukum River are reliable (although not perfect) indicators of a large flow downstream at Grand Mound.

The proposed rewritten statement is not an improvement over the current statement. Looking at the largest three floods in the observed record at Grand Mound (Dec 2007, Feb 1996, Nov 1990), we see that these events in this same order are the top three events at the Doty gage. This stands in contrast to the Newaukum gage for which these events rank third, first, and sixth, respectively. Considering these three events (and noting that the fourth largest flood at Grand Mound is significantly smaller than these three), the correlation with the Doty gage is much stronger than at other basin gages and therefore noteworthy. While other gages, such as the South Fork Chehalis and Newaukum River, are also somewhat correlated with Grand Mound we believe that the concise statement included in the OFM Report is the most supportable based on the observed data."

John Donahue 8/15/12

PAGE	LINE, PARAGRAPH #, AND/OR OTHER REFERENCE	CHECKER/REVIEWER COMMENT
5	fourth bullet bottom of page 5	Replace with "Conduct a limited Post Authorization Change Report as in bullet three, and concurrently proceed forward with a basin wide flood risk management study under the Chehalis Basin GI."
	References to "Corps levee project"	The "Corps levee" project is an inaccurate description. The project authorized in 2007 also included improvements to the Skookumchuck Dam. Suggest replacing this phrase with "the Corps of Engineers Centralia Flood Damage Reduction Project (aka the "Twin Cities Project")" initially, and as the "Corps Twin Cities Project" in succeeding occurances.
52	Other Alternatives that Could Provide Flood Relief and Protection in the Basin, first sentence	Same comment as page 6.
47	fourth bullet from the top	Replace "Raising/improving the" with "Constructing new levees and raising and improving the existing"
49	First paragraph in the section titled " The Current Alignment and Design . . . "	The timeline from 1980 up to now is complex. The plan referred to in the text presented in 1980 was indeed a levee plan, but that was revised following further study at the request of the city. The revised plan presented in 1982 and authorized by Congress in 1986 was only to add flood control to the Skookumchuck Dam. That plan was was later found to be uneconomic following further study, and terminated in 1992. See chronology Table 1-1 and Section 1.6 in the Corps of Engineers General Re-Evaluation (2003): http://www.nws.usace.army.mil/Portals/27/docs/civilworks/projects/Centralia%20GRR%202003.pdf
26	Second paragraph, second sentence.	change ". . . total cost of the delays . . . " to "total cost of freight delays".
26	Second paragraph, third sentence.	change to "This figure includes estimates of freight-related business losses and associated reductions in economic output, as well as an estimate of statewide economic impact, such as employment, personal income, sales tax receipts. It does not include local economic impacts, impacts due to passenger vehicle delay, or roadway maintenance and repair.
77	Same comment as Page 49.	
78	Bullet 2 at the top of the page	Suggest deleting reference to 100 year level of protection. That was true at the time, but the 100 year level has changed since then, so the reference is ambiguous.
78	Bullet 4 at the top of the page, first sentence	Add "with an option to increase capacity to 20,000 acre-feet upon further investigation and at the sponsor's option."
78	Bullet 5 at the top of the page	Suggest adding date of the estimate (January 2012).

PAGE	LINE, PARAGRAPH #, AND/OR OTHER REFERENCE	CHECKER/REVIEWER COMMENT
78	First bullet under "What are the potential benefits of the Corps levees project?", last sentence	Suggest removing or clarifying this sentence. It seems the benefits of a flood protection measure would normally be stated in the case in which its assumed to not fail. Otherwise, you would have to add this kind of disclaimer to the statement of benefits for other project too. In the case where we know the analysis is showing the levees are operating outside design limits, which may be the case here, then suggest stating that the protection is contigent on this condition.
78	Second bullet under "What are the potential benefits of the Corps levees project?", last sentence	This statement is imprecise - no project protects all storm events. Suggest adding more context like "but not in all storm events examined."
79	third bullet under "What are some of the major implementation issues of the Corps Levee project?"	Suggest adding another sentence: "Eventually, the dam would need to be in public ownership to allow for the Corps to invest in flood control improvements, so a public agency would have to be identified who would be willing to own and operate the dam."
231	Corps Twin Citiy Levee Project section	Title should be consistent - "Corps Twin Cities Project" is the most accurate. See other comments about improving the project description elsewhere.

Response to Comment

Thank you for your comments. Your proposed edits are incorporated in the final report along with numerous other technical clarifications and refinements made as result of comments from and conversations with the state technical team.

Bruce Treichler and James Wilcox 8/20/12

Mr. Kramer.

As you're aware, Wild Game Fish Conservation International (WGFCI) is the only non-governmental organization to actively participate in the ongoing efforts of the Chehalis River Basin Flood Authority.

As such, we've expressed several concerns and clarifications during flood authority meetings, flood authority-sponsored public meetings, meeting with our elected representatives, and via local press. In 2010, WGFCI submitted two resolutions to the Flood Authority:

1. Immediate and permanent moratorium of steep slope clear cut logging and an immediate and permanent moratorium on floodplain development
2. Flood Authority-sponsored studies to be peer-reviewed by University of Washington/Washington State University

After considerable participation with the Flood Authority and review of countless Flood Authority- sponsored studies and reports, it is our opinion that the proposed multi-purpose dam (water retention and hydropower) to be sited in the headwaters of the Chehalis River near Pe Ell would not provide basin-wide flood damage reduction, nor would it keep interstate 5 passable. This multi-purpose dam would be extremely expensive, would require decades to construct given the need for additional studies, lengthy permitting processes, expected litigation, would irresponsibly place residents and businesses in harm's way and would devastate many Chehalis River basin fish and wildlife populations and their habitats.

Our concerns regarding the proposed multi-purpose dam in the headwaters of the Chehalis River are reinforced in the recently completed "Chehalis Basin Flood Mitigation Alternatives Report":

- "Major flood events can be isolated on a single tributary or set of tributaries, and not affect the whole Basin" - Throughout the Flood Authority meetings and processes it's been documented that the proposed multi-purpose dam would capture approximately five percent of the basin's storm water thus leaving ninety five percent in a 2007 type storm to impact downstream residents and businesses.
- "A dam on the Chehalis main stem provides the most flood mitigation throughout the main stem Chehalis; it also presents the most uncertainty and potential risk to natural resources particularly salmon and steelhead and has the highest cost of those projects that have been estimated." – Residents and businesses in the Chehalis River basin deserve and expect flood damage protection via one or more effective projects that also protect the region's highly-prized natural resources not a project that is the least likely to protect them while risking natural resources.
- "A very different approach than reliance on major construction projects such as in the three project combinations described above would be to leverage local projects to remove key obstructions in the floodplain and use programmatic changes to address the flood damage. Such an approach could include widening of culverts, bridges, and dikes and levees that cause localized flooding, prohibiting any new development in the flood plain, raising or buying out structures already in the flood plain, improving other land use management practices, and improving forest practices to incentivize longer logging rotations, completing smaller construction projects in localized areas such as the Bucoda levee, and the Centralia-Chehalis airport levee, protecting livestock and farm investment with farm/critter pads, and ensuring effective detour routes around Interstate 5 to accommodate periodic closures during flooding."

On page 3 is the statement that a dam would lower flood elevations by " almost 2 feet at Montesano." This statement is unclear as different modeling assumptions produce different estimates of the flood elevations throughout the basin. In reviewing Appendix F, we could find only one instance where the flood elevation would be reduced by this amount. This is in Table 8 in which a comparison is made between a 100-year flood and the 2007 flood. Given the challenges of understanding the 2007 flood, i.e. gages disappearing and the impact of down timber, we suggest that this estimate may well have a large error factor. We suggest that this statement needs to be highly qualified.

On page 3, reference is made to the Anchor QEA fish study. This study is problematic. There is barely a year's worth of data. Based on conversations with fish biologists our conclusion that this amount of data is not nearly sufficient. It does not take into account different water quality, water quantity, different return rates for salmon and other anadromous species over several years, nor does it include the wide range of salmon and other species that are in the Chehalis. The juvenile fish assessment project in Grays Harbor demonstrates the need for several years worth of data. This study, done by the Wild Fish Conservancy, is beginning its third year. When asked how many years worth of data were essential to reaching reasonable conclusions, the answer was a minimum of three years with the possibility that a fourth or even a fifth year was necessary.

During the workshop, three options were presented to the Flood Authority. It is not clear where these came from and we have heard Flood Authority members make the same comment.

On page 7 the reference to the cost of a dam states there is a $245 dollar estimate for the dam. This significantly underestimates the cost of a dam given the need for additional studies, lengthy permitting processes, likely litigation, and features such as fish ladders that are not included in the design to this point.

Again, on page 7, the statement is made that a dam would provide significant mitigation benefits in the South Ford Chehalis. There maybe some benefits to those living and farming on the south fork, but some specificity about those benefits would be beneficial.

On Page 8, there is a section entitled "Local Projects & Programmatic approaches: Another Way". At the end of this section this statement is made "This kind of approach would be less expensive to implement; however the risk of flood damage to existing development in the floodplain would remain." This statement, to a greater or lessor extent, can be made about any single project or any combination of projects that have been or could be proposed. It seems to us that this point should be made clear at the beginning of the report; there is no silver bullet.

On page 9, there is a bullet list that defines a Basin-wide approach to flooding. The first two bullets are the same. For comparison, on page 52, where they are part of the same paragraph.

On page 23, the 2007 flood is characterized. We suggest something that is sometimes glossed over. Namely, this is the amount of debris and logged timber that came down from both the main stem and the south fork of the Chehalis. This should be discussed. From our perspective, this is one aspect of the 2007 flood that is difficult to estimate and model.

On page 52, at the end of the second to the bottom paragraph, you say the following "some participants, while understanding and supportive of the need to find effective solutions to the damage flood causes to human communities, were very skeptical of a dam and concerned about the potential for it to adversely affect fish and other natural resources."

We are aware, that some refer to us as being more concerned about fish than people. This is exactly what this statement implies, thereby simplifying our (and others) motives and concerns. We do not pretend that we are not concerned about ecological damage, including to fish. However, we have stated any number of times that we are indeed concerned first about the residents of this Basin. There are a number of reasons to be skeptical about a dam. These range from the cost to the length of time it would take to build it and have it operational to the degree of effectiveness it would have in protecting people and reducing flood damage.

Thank you for the opportunity to comment on this report.

Sincerely,
Bruce Treichler James Wilcox, Wild Game Fish Conservation International

Response to Comment

Thank you for your comments. We acknowledge your perspective that a potential dam on the upper Chehalis would not provide appropriate flood damage mitigation for Basin communities and your other concerns about a potential dam. Specific responses are below.

p. 3 - the report qualified the reduction at Montesano as during an "event like December 2007". Since the December 2007 flood was the largest seen in the lower watershed the report discusses benefits in that event to a greater extent than in other floods.

p. 3 - The Fish Study analysis was based on the best available information gathered through data compilation and collection efforts. Significant efforts were made to compile available data and collect data to address those data gaps that could be filled in the timeframe of the project. In applying these data, the analysis of potential impacts to the species studied was based on scientific literature and well documented. Each of the contributing models in the Fish Study is well recognized in the discipline of analysis. . As noted, in the comments, the limited time frame of the study precluded additional data collection, and the collection of additional data could be used to further inform baseline conditions.

p. 7 - Appendix A contains more detailed information on the potential projects identified in the report, including the dam, and acknowledges that project design is still in an early phase and cost estimates may change significantly.

p. 7- text was edited to clarify that flood mitigation benefits are in the lower South Fork Chehalis.

p. 8 - the notion that there is no silver bullet is communicated in the discussion of the components of a Basin wide approach: "Include a combination and sequence of projects in different places to address different aspects of the flooding; there are different perspectives on what combinations and sequences of projects are most appropriate." This concept is amplified in the final report and the recommendations call for moving forward with a variety of actions to mitigate the potential for future flood damages.

p. 9 – the bullet was deleted.

p. 23 – language on the impact of flood debris was added.

Ben Kostick 8/20/12

My wife and I responded to the call for firewood for flood victims of the 2007 Chehalis River flood. We hauled two trailer loads of alder donated by a local mill, Cascade Hardwood to the Adna high school. Then we decided to drive with the trailer over the hill to Boistfort to see if we could help somebody there. What we saw was sobering. Flood water had receded by then but most houses were filled by two to three feet of mud. There were tractors inside houses hauling out mud and we asked if we could help haul it away. House after house was filled with mud from Boistfort to State Highway 6. But they were also filled with volunteers shoveling, hauling and cleaning.

The one sight that still sticks with me was that of a man who must have been in his eighties walking through his field pulling fence posts upright and removing debris by hand. He looked so helpless which all the people in that valley wee against the force of the flood.

We need to minimize the damage before the next big flood. Levees along I-5 won't do anything to protect those people we helped that day. Water retention will do that and It needs to happen soon.

Ben M. Kostick, CPA
176 N.E. School St.
P.O. Box 721
Chehalis, WA 98532
360 748-7101 Phone
360 748-7861 Fax

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. We acknowledge your support for water retention as the solution to future flooding. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions.

Bobbi Fenn 8/20/12

I am submitting this story for my 85 year old Mother (Gladys Oravetz) who has lived in the same house since 1971. This is the first and only home she and my Dad ever owned. When the water started rising I called and told her I thought she needed to leave and her feisty response was that she would put her boots on and she would be fine. Needless to say, the fire chief evacuated her from her home and the water rose way above grandma's boots.

Mom lost everything in her home that was under four feet. Her house, was ripped apart all the way down to the studs, all the sheet rock, insulation, carpet, furniture, her appliances, bed, heating system, everything was gone. In addition, family pictures, books, music albums. The sewing machine my Dad bought for her, gone. The scrapbook of their life together all the way back to WWII, gone. Her car also was gone. But the worst thing that was taken from her was her sense of her own history, and her feeling of security. She still lives in fear when it rains hard.

I had only seen my mother cry one other time in my life, when my Dad passed. This was so traumatic for someone of her age to come back from. She has very limited income, and her physical ability to do things to put her home back together was limited as well. This resulted in some pretty traumatic times for all of us.

Kind neighbors loaned her a 5th wheel to live in while her home was repaired, it took three and a half months, but we moved her back in March.

The flood took a lot of things from my Mom, but it took part of her from me as she has never been the same since.

It is my hope that no one ever has to go through anything like this again. People should be able to feel secure in their homes and not be afraid when they hear the rain on their roof.

Sincerely,
Bobbi Fenn
1366 Wildwood Road
Curtis, WA 98538

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin.

Sue Rosbach 8/22/12

To Whom It May Concern:

Our names are Joe and Sue Rosbach and we live on my family's farm located at 128 Christin Rd., Chehalis and this is our story. My family purchased this farm in 1902 and have lived and worked here ever since. I am the third generation to live on this farm. We gave our two daughters each some land to build a home, just as my parents did for me and my Dad's parents did for him. This farm has NEVER flooded, some of the fields get standing water in the winter, but NEVER has it EVER flooded the homes or barns. In fact, even with the close proximity to the Chehalis River, this land was never in a Flood Zone. We were on the high bank of the river, so flooding was never a real concern.

The morning of December 3, 2007 about 6 am, my nephew called and asked if he, his wife and 10-month old baby could come over. They live about ¼ mile from us. When I asked why, he stated that the water from the creek was really high, in fact it was at the bottom step of his house. He was worried. We said yes, come over. He then called back and said he could not get his car out of the driveway and could Uncle Joe please come and get them. Joe immediately took off in his pickup to get them; it was still dark outside. To his surprise, he could not get to the end of our road, so he came back and got a tractor – went to their house, picked them up and brought them to our house on the tractor. When the sun came up, we could see how high the water had gotten. At that time, we still were not real worried – it had never flooded before – and in 1996, which was the worst flood to date, the water was close to the river bank but did not overflow and we did not encounter anything more than water in some of the fields, of course many of the surrounding roads closed due to water over the roadway, but that is common during a flooding event. As the day progressed, we knew this was different. By 10 am the stop-sign at the end of the road was covered by water; by 10:30 am my nephew's house was jarred loose and started floating down the road. Do you have any idea how profoundly sad it is to watch a young couple lose everything they own AND watch the home float down the road, breaking apart along the way? It is NOT something I ever want to encounter again – there are no words that can console them, there are not enough hugs that can take away their pain. It was simply awful.

Still, the water wasn't close to our house and I had been calling both daughters, who live closer to the river, and they were watching the river rise but not overflow. We were trapped, as all access to our house was shut off with flooding and the roads were not drivable. I kept in touch with my daughters and brother with cell phones (thank God). As the day progressed, the flood waters creped closer and closer to the house and barns. Joe was busy moving cars, trucks, cattle and as much equipment as possible to higher ground, just in case. I moved things in and around the yard and garage, walking in waist deep water – watching rats and mice float by. You do what you have to do. My brother wanted to come get us by boat, but the water was too swift to attempt it.

It was about 3 pm that something significant happened and we surmised this is when the Chandler Bridge broke, sending the water down Leudinghaus Road; the water was coming at us very quickly and starting to come up the steps to the house; it is at least 4 feet above ground. I got as much stuff upstairs that I could before the flood waters entered the house. We got nearly 2 feet inside the house, 6 feet in the garage. Just before this happened, my brother (who also lives on a portion of the farm) stopped by my daughter's house to tell her to evacuate and get to his house (he lives on a hill). Her husband was at work. She went back in the house to get the dog and keys, dropped the keys in the water, so she jumped in the truck with my brother. He then went to my other daughter's house and told them to evacuate. My son-in-law was home and was going to start moving things, so my daughter and 3 kids, and neighbor Nikki and 2 kids went with my brother to his house. Troy, my son-in-law and neighbor Bill started to load stuff into vehicles and drive to my brother's house. On the way, another neighbor was trying to move horses and one was hung-up on barbed wire with the owner slipping under water so they stopped to help. They got the horses and the neighbors to my brother's house, but in the meantime, the floodwaters came quickly. The boys were lucky they left when they did; their vehicles were flooded. They all knew that their homes were flooded, but they were safe at my brother's house. There was nothing we could do – we were isolated in a flooded house. About 7 pm my nephew, wife and baby were picked up my helicopter and taken to town. We had no provisions for a 10-month old baby and her family wanted her closer to them. It was a sad goodbye; we had just been through something traumatic together. We stayed at the house. The waters then quickly receded; at least it was out of the house, leaving a wet, silt-y mess. We went to bed, not knowing what we would find in the morning, and cried. We heard helicopters all night.

The roads were passable by the next morning and we went directly to my brother's house; at the bottom of his driveway we had to walk in about 2 feet of mud/muck, a residual of the floodwater, to get to the house where not only our girls & families were staying but many of the neighbors too. I can't remember the count, but I think there were 20+ people there. It was a VERY emotional reunion; they were worried about us because we were trapped and we were worried about them, because we knew if we had that much water, they had to have more…..

The adults went to their homes, I stayed with the grandkids. It was HORRIBLE. My oldest daughter's house had about 5 feet of water in it, with about 2 feet of mud. Everything was ruined, everything was lost. My other daughter's house had about 6 feet of water in it, with about 3 feet of mud. Everything was ruined, everything was lost. All of their vehicles were flooded and lost. The neighbor's house (that we lived in for 33 years and sold to them a couple of years before) had 8 feet of water in it, with about 3 feet of mud. Everything was ruined, everything was lost. They all came back to the house in shock – they had lost everything…..and they had no home to go home to. Thinking back, I think all of us were in shock during those first few days – not really comprehending what had happened, but knowing what needed to be done.

We talked with our daughters, husbands and grandkids to figure out what we were going to do; we all had our own problems. Our younger daughter, husband and dog lived with us for the next 6 months. Our older daughter, husband and 3 kids (the baby was only 3 months old) lived with his parent's during the week and with us on the weekends. We got busy tearing out the flooring and sheetrock of our house. They got busy first swamping out the mud, then tearing out virtually everything in their houses and started over. I could not bring myself to go see their houses for about a week; I knew that it would not be good, but I had NO IDEA how bad it was. We have a video that my son-in-law took those first few days, that I still have trouble watching. Their Christmas tree and ornaments were strewn, shoes, clothes and furniture were floating, appliances were tipped over and mud was everywhere. It was a long road to clean up and recovery. Since none of us were in a Flood Zone, none of us had Flood Insurance. FEMA gave each of us a little money, but it wasn't close to what we all had to spend to replace all that was lost. Financially, it was another hardship that none of us needed at that terrible time.

When I think about that terrible day, my first thought is about that 3 month-old baby. She slept in a cradle on the floor – if the flood had happened during the night, she would have surely drown. My next thought is I'm glad that my parents and grandparents did NOT live to see this terrible tragedy – it would have killed them. This farm was their pride and joy, to see it not only flooded, but strewn with garbage and debris; equipment ruined, fences gone, feed/hay lost. Really, for all the damage that this flood did to houses, barns, animals and equipment – we were lucky that no one died. The emotional toll is an unmeasured part of the flood. The kids' homes were completely destroyed – they lost EVERYTHING. I still cry when I think of what my daughters and their young families had to endure – it is not fair; I am so proud of them for the strength they have shown in rebuilding their homes and their lives.

Next, not only did my home, both daughter's homes and neighbor's homes flood, but I am a Vice President at Security State Bank and the Gold Street Branch and Administrative Building also flooded – but that is another story. The water had no mercy. So, when I finally got back to work after dealing with my home flooding, there was more to deal with at work.

In conclusion, I know the only reason we flooded was because the Chandler Road and Leudinghaus Road bridges were dammed up with logs and mud that come from the hills. They finally broke, sending the water down the road at amazing speed and reckless abandon. <u>The only logical solution to prevent another tragedy like this would be for water retention. It just makes sense to STOP the water BEFORE it comes down to destroy everything in it's path.</u>

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. We acknowledge your support for water retention as the solution to mitigate the potential for future flood damages. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. Recommendations in the final report include moving forward with the additional work needed to determine if water retention is feasible as part of a suite of actions to address future flooding.

William Hunter 8/27/12

Melissa:

It is my understanding that you are seeking comment from people who experienced the 2007 Chehalis River flood.

I was a resident of the Boistfort Valley in a home that was flooded to a height of nine (9) feet. The second floor of the home was okay, but the first floor was entirely under water. With the rising water, I was “trapped” in my bedroom on the second floor with the family dog. The dog and I were rescued by boat, the boat owned by a local resident who, on his own initiative, was getting people out of their flooded homes, with help from emergency personnel.

We were taken to a building on the east side of the Chehalis River south fork bridge, where it was reasonably dry. There we waited until we were again rescued by Navy helicopters and flown to the Chehalis airport, then from there, taken to a Red Cross shelter set up at W. F. West High School in Chehalis.

What is clear from the experience is that nothing quite this devastating had ever happened before and, more to the point, no one who suffered through the experience wants it to happen again, ever.

I have attended Flood Authority meetings and have on occasion registered comment with that group. I have relocated from the Boistfort Valley to Pe Ell, where I am just as concerned about the possibility of another flood – perhaps even more concerned.

But, whatever my personal concerns or insights, the main issue for everyone is that something tangible be done about flooding. The issue does not need to be talked to death – it needs to be dealt with directly and expeditiously.

Unfortunately, there are some who, for political or ideological reasons, have absolutely no interest in solving the problem. We have seen this in the “battles” among Flood Authority members and the comments of un-elected bureaucrats who, because they are accountable to no one, can say whatever they like.

Let me state clearly that, so far as I can determine, the only workable, reasonable plan that has been put forth to deal with flooding is the proposal for water-retention facilities near the headwaters of the Chehalis River. The Corps of Engineers plan initially put forth is essentially useless; other plans to build levies that would only protect I-5 and nothing else are also essentially useless. There has been a great clamor that we need more plans. But, where are they? So far, five years after the flood, THERE ARE NO OTHER PLANS.

William G. P. Hunter
P. O. Box 314
Pe Ell, WA 98572-0314
360/291-3231 home

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. We acknowledge your support for water retention as the solution to mitigate potential future flood damages. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions.

Recommendations in the final report include moving forward with the additional work needed to determine if water retention is feasible as part of a suite of actions to address future flooding.

Vince Panesko 8/27/12

Comment on WSDOT Report:

Figure 1 on Page 41 depicts 2007 flood water 2-3 feet over I-5 and then depicts the effect of a dam where water is less than a foot over I-5. Page 23 of the draft Ruckelshaus report states that I-5 was covered by over 12 feet of water in places. This depth was consistent with reports in the Chronicle of depths over 10 feet.

If a dam would lower flood water from a future 2007-flood in Chehalis by only 2 feet as shown in Figure 1 on Page 41 in the WSDOT report, that would leave over 10 feet of water over I-5, not the less-than-one-foot shown in Figure 1.

The modeling shows the effect of a dam in a future 2007-flood to lower water approximately 4 feet in Chehalis and 3 feet in Centralia (see Ruckelshaus Report). Therefore, even with a dam, the existing elevation of I-5 would be covered by 8 feet of water in the Chehalis area, not the "less than a foot" shown in Figure 1 on Page 41.

The WSDOT report needs to address the "more than 12 feet of water over I-5," and then explain that if a dam lowered the water 2-3 feet, there would still be 8-9 feet of water over I-5. Figure 1 on Page 41 needs to be modified to be consistent with I-5 covered by 12 feet of water.

Thank you for the opportunity to comment.

Vince Panesko
2132 Harris Ave.
Richland, WA 99354-2021
Phone: (509) 946-1229
e-mail: vince@owt.com

Response to Comment

The water depths described in this comment appear to be in alignment with water depths witnessed along I-5 at the Chamber Way Interchange. Figure 1 is depicting a representative cross section of I-5, south of the Chehalis-Centralia Airport near the West Street crossing. The final report has been updated to clarify the location of this cross section. The WSDOT report describes how each potential I-5 protection alternative would perform in flood scenarios with and without a dam on the upper Chehalis.

Dan Kay 8/27/12

Melissa,

Good morning. It appears comments from the WSDOT report are to be directed to you. After attending the DOT presentation last week discussing proposed options for I-5 flood protection, I have a few comments regarding options 3 and 4 for the express way and temporary bypass as presented by Bart Gernhart. This was the first time I was aware of these two proposed options. As for the creativity of the options we can certainly appreciate the options; however, the District is challenged with the options as they deal with one of our current projects. The District owns the property at Main and Quincy Avenues in Chehalis. The Tacoma rail track borders our property to the east. This is where the route for Options 3 and 4 were proposed. The District is currently is final stages of construction of a substation construction project on our property. This new DOT proposed route would encroach on our project as it is being built and would cost significant dollars likely well into the 100s of thousands of dollars to relocate electric facilities that would be impacted by such an expressway or bypass construction along the rail corridor. This would be a burdensome cost that should be placed on the District's customers.

Regards,
Daniel E. Kay, P.E.
Chief Engineer
Lewis County PUD
360.740.2435

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Barry Panush 8/28/12

Melissa:

I was told you wanted information as to how the 2007 flood affected the Boistfort Valley and its residents.

At the time of the flood, I was the Fire Chief for Fire Dist. 13. At about 2:30 AM, the morning of the flood, I got a phone call from Central Dispatch saying that PE Ell was getting a lot of water. We had not had that much rain in our valley and I was at a loss as to what to do with that information as it was still dark. I went on line to see what the river gauges were at that time. I was unable to get on line and chose to wait until daylight. Just before 7:00 AM we were toned out for a water rescue. As the Crews left for the call, I called my cousin at the upper end of the valley for a visual check of the river. He stated that they had not had that much rain but would check and call back. We returned to say the river was up higher than he had ever seen it and may loose his bridge. He did. I then called Emergency services and reported and told him to expect at least 2 feet more than they had ever seen. Just happened to be right on. Then I called KITI radio and told a friend there the same information. Since I was not an expert, he could not use my information. Now I am an expert because I have a county sponsored Noa radio. Go figure.

I put things up on the table and bed and left the house to report to the Emergency center. That is the procedure we teach out firemen. Get your family safe first so you can concentrate on the needs of the Department.

My house was built in the early 1930's and had never been flooded. We were 4 inches short of having 8 feet of water in the house. After the flood we removed over 50 yards of mud from in and under the house. It is a two story house of just under 2,000 square feet. We had no flood insurance because it had never flooded before.

We now know how high the river can get and can better prepare. We now have a new Doplar Radar system on the coast that can tell us of impending weather. We hope the river gauges continue to operate but with advanced notice of bad weather and internet viewing of the river gauges, we can get out safely. From my training and knowledge of the valley, I can safely say that if this event had happened in the dark, lives would have been lost. I don't think that is near the issue with current updates.

The problem as I see it on the Chehalis River is too much water in the winter, at times, and not enough in the summer. The only thing that seems to address this is "Water Retention".

That is a Dam on the upper Chehalis.

In past years, I have along with others, followed the crest of the river as it flows to the Pacific. Knowing what and when is not the issue. It is the amount of water and what it does.

The Chehalis has more rock and dirt in it as a result of the floods and is being choked by the invasive grasses. It does not handle as much flow as it use to. They were grasses introduced years ago the grew much faster than native grasses and they grow very well near water. These are facts that must be taken into account if we are to stop erosion and property loss.

I have moves 6 miles, up stream, from where I was before the flood. I am on Stillman/Mill Creek. Any of the Dams proposed will not help me where I live but they are the right thing to do.

My history is as follows: My grandparents (Mothers side) homesteaded on the upper end of the South Fork of the Chehalis. On my father's side, they did the same in the Adna area. My parents purchased the Curtis Store in 1948 when I was one year old. Other than three years in Portland and one in Vietnam, I have been there my entire life.

Barry Panush
PO Box 54
Curtis, Wa. 98531
(360)245-2952 hm (360)736-2952 wk

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. Your support for water retention as the solution to mitigate the potential for future flood damages was acknowledged. The final report acknowledges the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. Recommendations in the final report include moving forward with the additional work needed to determine if water retention is feasible as part of a suite of actions to address future flooding.

Gary and Kirsten Klein 8/28/12

Jim Kramer, Chehalis Report Project Manager, Ruckelshaus Center

August 29, 2012

Dear Mr. Kramer:

My wife and I would like to comment on the Flood Mitigation Alternatives Report. We have been residents of Lewis County since 1980 and have lived in the West Side of Chehalis at 675 NW Saint Helens Avenue since 1992. The floods that we have seen have been devastating to our friends, neighbors and the community.

In 1996 and 2007 the Dillenbaugh Creek rose above the level of the Chehalis River, and came through the culvert under Main Street and also over Main street to flood the residences on Prindle, our back yard, the residences on Oregon, and then work its way down to the residences and businesses along Saint Helens and Maryland. The water subsequently rose until it could flow over the top of the center barriers of I-5. This was significantly higher than the maximum height that the Chehalis River reached.

The Chehalis River did not flow over the freeway and into this part of town. The water flowed in the other direction.

I believe that our back yard used to be a drainage to the Chehalis River for the local area, but since I-5 was built, that drainage is effectively dammed by I-5.

Obviously, any dikes added to protect I-5 between 13th Street and Chamber of Commerce Way, higher than the existing center barriers, will cause the flooding in this part of town to increase substantially. Our house, which has not been flooded in 128 years, would be susceptible to flooding.

For this part of town, it is imperative that measures to protect us from Dillenbaugh Creek are implemented. The most obvious would be to reduce the restriction of Dillenbaugh where it passes under I-5, and to provide dikes and flood gates to keep it from flowing north across Main Street. If anything could be done to improve the drainage of the West Side area underneath I-5, that could also help.

We would also like to comment on the proposed alternative express lanes or emergency bypass lanes. We highly object to these proposals. They would put a berlin wall through the center of our town. The lanes would not be attractive. They would add noise. We would be living underneath trucks looking down on us. Privacy and enjoyment of our houses and yards would be substantially reduced.

We are in favor of the upper Chehalis Dam proposal. It would be able to moderate the peak flows and reduce damage for the whole basin.

Sincerely,

Gary and Kirsten Klein, 675 NW Saint Helens Ave, Chehalis, WA 9853

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. The final report acknowledges the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. Recommendations in the final report include moving forward with the additional work needed to determine if water retention is feasible as part of a suite of actions to address future flooding.

With respect to the I-5 protection alternatives, WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. Similarly, any impacts from I-5 flood walls and levees would need to be understood and avoided, where possible, and fully mitigated if avoidance were not possible. If projects move forward, WSDOT will provide opportunities for people to provide comments and suggestions as part of the planning process.

Kristie Swanson 8/28/12

I've put a lot of thought into how I want to share my flood story. It's tempting to emphasize only the emotional difficulty we've all faced, but I also think it is important to stress the value of water retention in mitigating future disasters.

I grew up in the Boistfort Valley along the south fork of the Chehalis. I am a landowner in the Valley, with plans to return there to raise my children. At the end of 2007, my husband deployed to the Persian gulf, and I returned to the valley to stay with my family during that time. I flew back to Washington the evening of December 3rd. I woke up early on the4th and looked out the window onto a completely different place from where I grew up. Despite the alien appearance of my childhood home, I soon realized that my parents received only a glancing blow from the flood at their house. That first day was spent restoring the destroyed water supply for the house and farm animals and clearing the "back road". This was necessary because my parents' driveway crosses a bridge, which had been washed out by the flood. (Ironically, mu parents would have been granted FEMA funds to replace the access to their house, but my father is a farmer, and so there is a business at the same address, precluding them from receiving FEMA funding. In case you wondered, bridges aren't cheap.) The next day we headed down the valley to check on my sister's family. Suffice to say, aerial pictures do not do justice to the horrible scene we saw. They simply don't provide enough vertical scale for the destruction. Landslides, ruined homes, wasted fields full of logs, dead animals in power lines, you name it, we saw it. And mud. Mud everywhere. It has taken years to repair the damage done to the land and homes, and we are still pulling sticks out of fields and finding deposits of flood mud.

As bad as the destruction was, over time I've come to realize that the human toll is far worse. I watched as strong, capable people were immobilized by fear and shock. That might have been the greatest gift brought by all the volunteers: action. We're the kind of people who will wake up and pitch in to help those who want to help us. My sister is still scarred, and scared every winter when the rains come. But she is still in the valley, carrying on the family's farming tradition. Perhaps most difficult for me is watching my father tell his flood story. It took me a couple years to realize that for him, the pain was in hindsight. We lost my brother when I was young. For my father, realizing how easy it would have been for him to also lose his oldest daughter and grandchildren still terrifies him.

This brings me back to the most important part of all this: action. While 2007 and 2009 brought unimaginable, record floods, it is conceivable that these events will become more commonplace. With climate change bringing wilder weather and irresponsible logging practices reducing nature's ability to mitigate these events (I have a degree in forestry, don't even get me started on how inappropriately the Willipa Hills are being managed), we have a responsibility to enact basin-wide relief. The only feasible solution is water retention. It is the only option that, quite frankly, has science on its side. It will reduce high water flow, improve fish habitat, and even more importantly, improve things for the entire basin. It is unbelievable to me that any solution that makes flooding worse for half the basin would be considered, which is what the other options would do. That is tantamount to placing a monetary value on human life, and then deciding a road is more valuable. Mind-blowing.

I urge you to remember that while economic impacts are significant, without the amazing, industrious, hardworking people of this state, those impacts are simply numbers. It is our citizens that make Washington worth living in, and water retention facilities will protect those citizens, their livelihoods and the basin.

Thank you for your time.
Kristie Swanson

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. The final report acknowledges the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. Recommendations in the final report include moving forward with the additional work needed to determine if water retention is feasible as part of a suite of actions to address future flooding.

Dave Fenn 8/28/12

This is a follow-up comment on the Kramer report. My original comments are included in the report. I saw nothing in the report or the recent WSDOT report to change my original opinion that water retention is the only project that will make a significant difference in flood levels for the entire basin. Those of us upstream from Chehalis will not see any appreciable benefit in terms of flood reduction in any other proposed plan. Retention helps us and everyone else. Retention also has significant other benefits to the area as well, in particular increasing water flow in the summer.

Thank you,
Dave Fenn
Boistfort Valley resident

Response to Comment

We acknowledge your support for water retention as the solution to mitigate the potential for future flood damages. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. Recommendations in the final report include moving forward with the additional work needed to determine if water retention is feasible as part of a suite of actions to address future flooding.

Vince Panesko 8/29/12

Comments on the Chehalis Basin Flood Mitigation Alternatives Report, July 16, 2012 Draft.

1 - Page 1: The first sentence states that “Flooding is a common occurrence in the Chehalis River Basin…” This sentence is not accurate. High water and lowland flooding is a common winter occurrence but floods causing major property damage are rare, e.g. the most recent being in 1990, 1996, 2007 and 2009.

It is inaccurate to portray flooding in the Chehalis River Basin as a common occurrence when there was no major flooding in 2011, 2010, 2008, 2006, 2005, 2004, 2003, 2002, 2001, 2000, 1999, 1998, 1997, 1995, 1994, 1993, 1992 and 1991.

2 - Page 1: The Executive Summary fails to address the question of increased businesses, houses and farms in the floodplains (something we have political control over) versus those aspects of nature which we have no control over. As a result of ignoring this fundamental question, all of the possible governmental programs aimed at removing structures from floodplains are ignored. The report should have a new section which addresses all of the various government programs available to cities and counties to return floodplains to their fundamental use as floodplains, and to remove businesses, residents and all structures from floodplains.

3 - Page 1. The Executive Summary states that “In 2007 and 2009, the basin suffered two catastrophic floods approximately 18 months apart.” It is inaccurate to characterize both floods as catastrophic, leaving the reader to believe both floods had the same severe property damage. The 2009 flood should be characterized as different from the 2007 flood. The 2007 and 2009 floods are lumped together again on page 11.

4 - Page 2. The first bullet addresses a dam located upstream of Pe Ell. The report fails to mention that the dam is located 2 miles from the center of Pe Ell. Every time the location of the dam is mentioned in this report, the words should be, “a dam located two miles upstream of Pe Ell.” This wording addition is important because all the State and Federal agencies have been misled by Lewis County and the PUD that the dam was on the upper Chehalis river upstream from Pe Ell without specifying the distance was only 2 miles. Because of requirements for emergency evacuation, it may be impossible to locate a dam within 2 miles or 5 miles or 10 miles from a town. The permittable distance may be established by the time it takes for a town to evacuate once the dam is breached. For example, Carnation is located 20 miles downstream from the Tolt River dam, and thus has 20 minutes to vacate in the event of a dam collapse. It would take about 20 minutes for the wall of water to wipe out the town and school.

Thus an earthen dam 20 miles upstream from Pe Ell may have a chance of being permitted whereas a dam 2 miles from the center of Pe Ell would never have a chance of being permitted. The report needs to discuss the possibility of no permit due to proximity to a population center.

5 - Page 2: The Executive Summary fails to note that in the history of the State of Washington, no earthen dam 288 feet tall and a half mile wide has ever been built two miles from a town with a population of 700 residents plus 300 school students during the day. This is a fatal flaw of the report, because the report naively treats the dam as a possibility, when there is no assurance it can be permitted. The report should more clearly address the permitting issues of the dam being located so close to PeEll, and the need to resolve those permitting issue before spending any more state or federal money studying the dam. This is where the Ruckelshaus report can be of most use to government officials in that the permitting of the dam must be resolved before spending any more money on geology or fish (because if the dam has to be 20 miles upstream, the geology and fish impacts at the 2 mile location will be meaningless.)

6 - Page 3: The Executive Summary gives credit to the dam as lowering flood elevations without providing context. For example, the flood level at Mellon Street in Centralia would be lowered approximately 3 feet. Those residents near Mellon Street who had 8 feet of water in their houses will now only have 5 feet of water in their houses. That should make them very excited about the PeEll dam project. These residents would question spending almost a billion dollars on a dam that does not eliminate major flood damage. And the Ruckelshaus Center would be misleading government agencies by only communicating how much the dam would lower flood waters, without communicating how much more the flood waters have to be lowered to completely protect residents. Areas near Mellon street need floodwaters reduced 8 feet or more, not a mere 3 feet. The Ruckelshaus report needs to examine complete flood protection and not be satisfied with costly projects that provide only a partial drop in flood levels.

7 - Page 9: The first paragraph talks about policy-level discussions without recognizing that different neighborhoods in Chehalis and Centralia require different solutions. For example, large portions of Centralia's flooded residents could be better protected by levees whereas residential areas west of I-5 in Chehalis may be better suited for buy-out actions. The focus has been on a dam, raising I-5 and a levee here and there without focusing on what is most cost effective on a local basis.

For example, in Centralia the levees have the advantage of protecting neighborhoods regardless of where heavy rains fell south of Centralia. West of I-5 in Chehalis, the least expensive long-term solution may be to buy out the houses and prohibit structures in the floodplain, something that Chehalis has been unwilling to do. The lack of legislation regarding buy-out in floodplains may be another opportunity for the Ruckelshaus Center to take the lead. This report should raise the possibility of new legislative efforts to reduce long-term, re-occurring property damage by moving people out of the floodplain. This report should answer the question: "What legislative action is required to facilitate buying out and relocating residents and businesses in floodplains."

8 - Page 9: There are large areas of Lewis County which the dam and levees will not provide protection from flooding. For example, the Boistfort Valley experienced flood damage which a dam above PeEll or levees in Centralia will not ameliorate. Flooding in the Newaukum Valley will likewise be unaffected by the proposals for a dam and levees. The Ruckelshaus Report gives slight mention to these areas, and offers no solutions for these areas. The Report should be expanded to list those areas which received heavy flood damage in 1990, 1996, 2007 and 2009, and which are not receiving any attention. There should be a policy decision made to spend time to determine the options available to these people, including the option of buyout (maybe buyout of structures only with owners keeping their land for agricultural or recreational use.) One of the positive accomplishments of the Ruckelshaus Report could be to draw governmental attention to the areas of the basin which are not receiving adequate attention for relief from future property damage.

9 - Page 23: One of the bullets on page 23 state that I-5 was covered by over 12 feet of water in some locations. This is consistent with reports in the Chronicle that flood waters in 2007 were greater than 10 feet over I-5. On page 3 of the Ruckelshaus Report, the statement is made that the proposed Pe Ell dam would reduce flood elevations for a 2007-type flood 3 to 4 feet in the Twin Cities which is where I-5 is located. If the dam only reduces flood waters by 3 to 4 feet in the Twin Cities, there still would be 8 feet of water over I-5. One of the fatal flaws of the Ruckelshaus Report is to conclude on Page 48 that because of the dam, there would only be minor flooding (less than a foot of water) over I-5. The facts as presented in the Ruckelshaus Report do not support such a conclusion. The facts presented in the Report show that a PeEll dam would lower the flood elevation over I-5 from 12 feet to 8 feet. The proposed dam does not provide the protection of I-5 as claimed by the Ruckelshaus Report on page 48. Eight feet of water over I-5 is still a huge problem that the Pe Ell dam does not solve. The Ruckelshaus Report needs to come to grips with the realization that the proposed PeEll dam is far too small to solve the flooding problem in the Twin Cities.

10 - Page 32: The Upper Mainstem usually refers to the Chehalis River above PeEll or the Chehalis River above the junction with the south fork (next to Hiway 6 near Curtis). Therefore, lumping the Boistfort Valley with Pe Ell-Doty-Dryad is not consistent with the usual discussion of the area. The Boistfort Valley should probably have its own separate designation as “The South Fork” with the rest of the Chehalis River westward designated “Upper Mainstem.” The discussion of major farm damage on page 34 applies to the Boistfort Valley in 2007.

The Chehalis River through PeEll-Doty-Dryad has minimal farming adjacent to the river. Flood damage was mainly to residents along the river.

The inclusion of Adna as Upper Mainstem is also unusual insomuch as Adna is more connected to the Twin Cities area than Boistfort or Dryad.

11 - Page 48: The last paragraph on page 48 begins by stating the proposed Pe Ell dam would still result in “several inches above the low point on the (I-5) road surface.” As stated in an earlier comment, the flood elevation over I-5 was over 12 feet in places, and with only a 3-4 foot drop (caused by the proposed Pe Ell dam), there would still be over 8 feet of flood water over I-5, not several inches as stated on Page 48. The discussion on Page 48 needs to be re-written.

12 - Page 56: The paragraph under Figure 4 states that summer flow augmentation by the proposed Pe Ell dam MAY increase spring Chinook salmon. All the proponents of the dam are now running around proclaiming the dam saves fish. This is nonsense. The bigger picture is that augmented flows remove the spawning grounds which are not replaced because the dam stops the movement of replacement sands and gravels. Eventually the spawning grounds disappear and the spring Chinook salmon disappear.

The Chehalis river continuously moves sands and gravels through Pe Ell, replenishing spawning beds downstream. Once a dam is built 2 miles upstream from Pe Ell, the movement of sands and gravels ceases past the dam and spawning beds downstream eventually disappear. This means that if a dam is built, the spring Chinook salmon may benefit from augmented summer flow and for a few years may show increased numbers. But eventually the dam causes the spawning beds to disappear and the spring Chinook salmon disappear. There is nothing to cheer about.

The Ruckelshaus Report on page 56 states (regarding increase of spring Chinook) “however, there is not agreement about the certainty or extent of these potential benefits.” The report should then add a sentence about the loss of spawning beds for spring Chinook due to the proposed Pe Ell dam stopping the replacement sands and gravels from moving downstream.

13 - Page 60: The report calls for properly reflecting uncertainty in benefit-cost ratios; however, the report fails to note that the Phase IIb report failed to address uncertainty. The Phase IIb report gave a benefit-cost ratio of 1.2 but did not include numerous costs which would have lowered the ratio to 0.5 to 0.6. For example, there is a large uncertainty over how much soil needs to be removed for the east end of the dam. As the Phase IIa study pointed out, there is a huge ancient landslide on the east end of the proposed dam site known as Charlie’s hump. This hill is cast off from a higher hill located to the southeast. Charlie’s hump has been sinking for years. Over the past 73 years the hill has had several landslides which blocked Road 1000 which is the main road up the Chehalis River south of the Weyerhaeuser Shop. One landslide back in the 1950s was so large it took several months to remove and reopen Road 1000.

In 2007 a portion of Charlie’s hump slid into the river, carrying Road 1000 with it. The point is that the east hill against which the dam is proposed to abutt, is unstable. The uncertainty lies in just how much of that hillside must be removed before solid rock can be found. Another uncertainty is where to put the dirt that is removed, and how far must it be hauled. These are costs which are not in the benefit-cost calculation in Report IIb.

Also not in Report IIb is the cost of transporting dense rock to the dam site. Report IIb made the assumption that rock is available at the dam site; however, that is an unsupported assumption. Discussions with the Corps of Engineers has indicated a high density rock is required so that weathering does not compromise the strength of the dam over time. Discussion with Weyerhaeuser staff has indicated that high density rock can be found at their Vail Operations which would require an immense transportation cost to move high density rock from Thurston County to PeEll. This transportation cost has not been included in the Report IIb benefit-cost ratio.

Therefore, there is an uncertainty in the Report IIb benefit-cost ratio which is so large that it is doubtful the dam will meet the required 1.0 benefit-cost ratio. Unofficial calculations by technical experts show the ratio is below 0.6.

The Ruckelshaus Report points out that using a single point benefit-cost ratio is insufficient "because it does not adequately reflect the full range of potential outcomes." However, the Ruckelshaus Report fails to specifically use the Phase IIb report as an example of an insufficient benefit-cost ratio. It chooses to allow readers to make that connection on their own.

The Ruckelshaus Report would be of greater value to governmental agencies if it pointed out that the Phase IIb report needs to have a range of uncertainty for the benefit-cost ratio which reflects the unknown costs. Without the full range of costs, the Phase IIb benefit-cost ratio of 1.2 is meaningless.

The people sponsoring the dam studies respond by arguing these studies are only preliminary and will be replaced by more detailed studies later on. This is disingenuous because the dam proponents are running to government officials claiming the benefit-cost number of 1.2 is a green light for the dam to be built. The Ruckelshaus Report should help to curtail the rampant speculation that the dam should be built as quickly as possible, ignoring geology reports, ignoring safety of Pe Ell citizens, and ignoring proper benefit-cost ratios.

Thank you for the opportunity to make these comments.

Vince Panesko
2132 Harris Ave.
Richland, WA 99354
Phone: (509) 946-1229
e-mail: vince@owt.com

PS: I have 50 years experience in writing and reviewing technical reports in the nuclear defense industry. Between 2000 and 2003, I authored nearly two dozen benefit-cost studies for the Department of Energy, Tank Focus Area in Washington DC. From 1990-1995 I chaired a technical review team for large construction projects ($4 billion the largest). Our job was to ensure the safety analyses were properly performed, and that all safety issues were properly addressed at USDOE sites across the country. I have worked in technical management at Hanford for 50 years and am currently a member of the Hanford Advisory Board. I also own and operate tree farms in Lewis County including the Panesko Tree Farm south of Pe Ell. The south footings of the proposed dam would be on my property. I have been familiar with the dam site for 73 years because that is where I played as a small child and camped as boy scout from Chehalis. The most surprising aspect of the Chehalis river is the large mass of gravel and sand which moves down the river even in years when there is only routine high water. The river banks in that location are constantly changing every year. I have constant bank erosion which is contributing to new spawning grounds downstream.

The 2007 flood left a pile of debris on my property covering the size of a football field, 10 to 20 feet high. It is impossible to climb over that debris which is a jumble of logs, waiting for the next major flood to be carried down stream. This process has repeated itself over the last 73 years. Logs come and go. Gravel comes and goes. Sand comes and goes.

My wife and I were working on my tree farm the weekend of the 2007 storm. Thanks to Dean Dahlin's weather report of impending snow and high winds, we left our property before the Road 1000 bridge blew out. Three campers who were camping on Weyerhaeuser land south of mine were not so fortunate, and were marooned for 3 days until Weyerhaeuser helicopters lifted them out leaving their vehicles behind for months until roads and bridges could be rebuilt.

Response to Comment

Thank you for your comments. All were taken into consideration in the final report. We acknowledge your concerns about the potential for a dam on the upper Chehalis. In addition, specific responses are below.

1 - Given the magnitude and frequency of recent and historical flood events in the Chehalis basin, the statements in the report on the frequency of flooding have been retained.

2 - The report contains a section on local land use and programmatic changes, and continuing to use programmatic approaches to encourage appropriate floodplain management is part of the recommendations in the final report.

3 - The report was edited to reference the two storms as major, not catastrophic.

4 and 5 - According to the dam safety regulations the dam will have be constructed to a higher standard based on the downstream population and this is factored into the design and cost work done by EES.

6 – The report is clear that the dam would not eliminate all flooding in the Basin. The final report describes the diversity of concerns and perspectives on the dam, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions.

7 – Your comment was taken into consideration and alternative approaches to protecting the different neighborhoods in the twin cities can be included in the recommended next steps as endorsed by the Governor's capital budget recommendations.

8 - The report acknowledges that more work would be needed to address flooding in areas such Newaukum and Boistfort Valley that may not be addressed by a dam on the upper Chehalis; the report also states the potential benefits of the dam. The potential for buyouts of homes affected by flooding in the Basin is acknowledged the Local Projects and Programmatic Approaches section.

9 – The model predictions in regards to protecting I-5 are described in detail in the final report. Water retention would provide some protection for I-5 and additional actions would be necessary

to achieve full protection in major flood events. the report recognizes that this hydraulic model, while an improvement over past efforts, still has areas of uncertainty and potential inaccuracy, and that additional improvements should be considered for the future.   The report also recognizes that the model predicts potential, not certain outcomes.

10 – The report was edited to note that the Chehalis River through Pe Ell-Doty-Dryad has minimal farming adjacent to the river. The division of the Basin into sub-areas was meant to convey the how the people, property, and natural resources of the Basin live with the river and are impacted by floods. It was not meant to be an exact division, but rather representative of the differences in the Basin.

11 - See response to comment 9.

12 – The report states that there are significant uncertainties with the Anchor results and acknowledges the need for the necessary biological studies that must be completed if a water retention project moves forward. These studies will allow for a more accurate prediction of the impact of a dam on fish and the environment; this point is reinforced in the final report.

13 - Please refer to Appendix D for an evaluation conducted by the UW Cost-Benefit Center on Benefit-Cost Work Regarding Chehalis River Flood Control

Susan and Rene Remund 8/29/12

Melissa,

It is probably difficult for people who have not experienced a devastating flood to understand the enormity of the losses.

While we work in Chehalis and Centralia, we live west of Chehalis on a small farm at Curtis.

All but one of our pigs, two steers and a pet goat drowned in the December 2007 flood. How the one pig survived, we don't know. She not only survived but farrowed three months later.

Our 130 year old home was inundated to the top of the first floor, destroying everything not impervious to water and mud.

Our house guest, who has limited mobility, was alone in the home and feared the home would wash away or he would be trapped and drowned before he was rescued by boat from a porch roof.

We learned later that one of our older neighbors was trapped in her manufactured home. The water pressure sealed her door and she could not get out. She was standing on her kitchen table putting farewell notes on the ceiling when her neighbor came in a boat, broke out a window, and rescued her.

The flood deposited approximately eight inches of clay and wood debris onto our property. Over 500 cubic yards of mud and debris were eventually removed from around our home, garage, and barn.

Within two days our neighbors and friends who were not flooded arrived to push the mud out of the house, haul away all the furnishings and appliances from the first floor and then strip the home to the studs. That work was followed by church groups, a local restaurant delivering soup at noon and the local Grange feeding flood victims and volunteer workers for many months.

After nearly five years the physical signs of the 2007 flood have been largely removed, but the fear of repeated flooding returns during every serious winter storm.

The only solution to catastrophic flooding is water retention. Everything else is either impractical, a half measure, or a means of pushing floodwaters onto someone else.

Immediately following the flood there was little political support for anything other than the Corps proposal to build levees to protect portions of Chehalis and Centralia. Through the concerted effort of flood survivors and a group called One Voice, the legislators of our area and Governor Gregoire have committed themselves to finding a basin wide solution to our recurring problem.

For this we are thankful.

The leaders of the water retention effort recognized from the beginning that the environmental effects and specifically the effects on fish would have to be satisfactorily addressed for this single most effective flood prevention measure to be built.

Of the measures included in the report, some, such as the WSDOT flood walls for I5, should be rejected other than to the extent minor installations are required to supplement the benefit of the upper river dam. The conservation projects likely have marginal benefit during major storm events.

For the Chehalis River valley to be economically productive and physically safe for residents, control of devastating flooding is necessary. Construction of a dam near Pe Ell would provide sufficient storage to reduce flooding within the entire basin. It is the only proposal that removes the source of our problem-too much water.

The 2007 flood cost nearly a billion dollars in damage. The impact on people was incalculable.

Future losses of life, property, and security can be prevented.

The answer is containing flood water in the upper river and then using that water for electric generation and increased water flow in late summer.

Water retention is best answer.

People in the Chehalis River basin should regain their security. Falling rain should not be a terror.

Sincerely,
Susan and Rene Remund
213 Boistfort Road
Chehalis, Washington

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. We acknowledge your support for water retention as the solution to mitigate the potential for future flood damages. The final report acknowledges the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. Recommendations in the final report include moving forward with the additional work needed to determine if water retention is feasible as part of a suite of actions to address future flooding.

Michael Smell 8/30/12

30 August 2012 Comments on WSDOT meeting 8/23/12

I thought the presentation by Bart Gernhart was very informative and well done. WSDOT should put the Bullseye back on, however. I think the Governor knew this venture was a no-win situation from the get go. I am afraid all the hard work from the WSDOT crew will go for naught. I cannot believe that there were people at the meeting that actually thought that any of the alternatives but the first one were serious. The maps used do need to be updated since there has been development between Prindle St, Main St, and I-5 in Chehalis in the past few years that was not shown and should be taken into consideration on placement of a levee. Also, the Newaukum is a river not a creek. I thought Alternative One had some very good flood protection parts especially for the precious Airport/Strip Mall area as well as the SW Chehalis area. The 600 “Buildings no longer flooded” would be a good result also. But, because I-5 was involved, the powers that be will always object. Any project that would be accomplished in this 5 mile section of I-5 lessens the emphasis for their “Basin-wide approach”. It was also not their idea and I have found in Lewis County that that usually means a negative opinion on a subject. Good Luck to WSDOT. Alternative one or two may be acceptable in 20 years or so.

By, on, and in the Newaukum River
Michael L. Smell
Chehalis

Response to Comment

Thank you for your comments and your perspectives on the various I-5 protection alternatives. The final report has been updated to acknowledge that the Newaukum is a river. Regarding the placement of a potential levee relative to new developments in Chehalis, if a levee project moves forward, this will be taken into consideration.

Karen and Raymond Monroe 8/30/12

Date: August 30, 2012

To Whom it Concerns regarding WSDOT Draft and Flood Mitigation Alternatives report

My husband and I have lived in the Westside Neighborhood for 15 years. We were drawn to this neighborhood and staying in Chehalis because it was family friendly, and peaceful. There is a park nearby and also a very friendly daycare that we were using at the time.

I am concerned about some of the suggestions being made in this process of flood protection in the area. I appreciate the draft report saying on page 8 "The goal for all projects is the full protection of I-5 from 13th Street to Mellen Street, protection of the Chehalis-Centralia Airport, improved access to infrastructure, and optimization of any potential ensuing benefits to people, communities, and the environment. It is only appropriate to spend hundreds of millions of dollars on a project if it will provide full protection." However I am concerned; as I read further it also says " Any modification or new construction of dikes or levees should be built at this level to ensure robust, reliable protection for I-5 and the Chehalis-Centralia Airport." On page 9 it says "WSDOT considered six main alternatives to protect I-5, the airport, and infrastructure in the Centralia and Chehalis area." Only on page 8 does the goal address benefits to the people and communities. Otherwise the concerns seem to be about objects (I-5, airport which could be addressed easily separately, and infrastructure which I take to mean ease of largest portion of Chehalis to get around). I hope in the final deliberations the affect to the people and communities (aka neighborhoods that have not had flood issues) are greatly considered.

Here are my thoughts and concern:

Alternative 1: <u>"I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee"</u> Seems alright. Does not address the issue of needing to expand I-5 which is needed. It also, sadly, creates more of an impact to the wetlands but they all impact the natural habitat of the area so this will not be addressed again.

Alternative 2<u>: "I-5 Raise and Widen Only"</u> Honestly, I already hear I-5 from my house and I'm not interested in hearing more of it. However, that said, I realize it needs to be widened. Regularly, cars are backed up on I-5, especially heading north. If widening improves the transit time for everyone on I-5 AND helps against flooding, then I think this needs serious consideration.

If this alternative is considered, please DO NOT put West Street Bridge back in. As I understand it, in order for cars to cross over the street at West Street once the freeway has been expanded, it will not look anything like the current bridge due to codes. Due to these codes, it will be much larger and will seriously cut into the neighborhood, park and many homes. This in turn will lower the value of homes in this neighborhood and cause immense deterioration. This is the neighborhood where the history of Chehalis is seen by the homes and property that have been lived in for a long time. In these past 15 years living here, our girls have started in the school system and graduated from the Chehalis School District. I run a piano studio and have students that take the bus here on occasion. I believe this is the only neighborhood that is so family friendly it takes the bus two trips from the schools to get the kids back and forth both in the morning and in the afternoon. This neighborhood will not be conducive to families if a large road/bridge (encouraging even more traffic than has already been encouraged in last 2-3 years) is next to the park and possibly even reducing the park's size-let alone make it difficult for residents to maneuver their own neighborhood.

I am a bicyclist and have felt a shortage of safe bicycle routes in the area. Every time I visit my parents on Seattle and Mercer Island I admire their network for bicycle routes. Instead of putting a bridge back in for cars, please consider a bridge that is just for pedestrians and bicyclists. This would make it much safer for kids to bicycle to the other side of the freeway and to some of the stores up the road to the north. I believe there is room to put a bicycle path paralleling the freeway which would increase safety if that road becomes busier due to more people choosing to go over the freeway at main street. Putting a bike path over the freeway would be attractive to STP riders and those that do the Lewis County Historical bicycle tour. Making this bike path would seem to me a way to relieve some traffic congestion. This path would be one more step closer to connect a healthy (yes, pun intended) network of pathways in the county for people to exercise on, go do their errands by (I've spent time in Holland and its is incredible what they do on their bicycles) and increase their health, like they have in Seattle and other areas. Keep in mind there are 2 other bridges cars can use very close by.

Alternative 3: "I-5 Express Lanes" It does not address it in the Draft but this option also really negatively affects the community in Chehalis in Westside Neighborhood (East of the freeway) as well as many others. It will greatly lower the values of homes, it will cause many homes to be destroyed and it will change the appearance of Chehalis greatly making it seem more like we are in Chicago with the expressway running so close to downtown and homes in this small, quiet town.

Alternative 4: "I-5 Temporary Bypass": Does not address the I-5 clogging issue. Forget it.

In summary I consider Alternative 1 and 2 are only viable options and only ones that really address the I-5 crowding condition. As stated earlier one of the goals is to protect the people and community. By tearing up a long-standing historical neighborhood in Chehalis via express lanes (alt 3) or a new West street bridge you are protecting traffic on I-5 on occasion there is a flood as well as businesses (which if I had a say would not have been allowed to be built in the floodplains). If express lanes are allowed via alternative 3 you ARE INSTEAD damaging a major neighborhood and many homes that have been safe from floods (and we chose to live where we did to avoid risk of flooding and don't feel we should be penalized for this). You would be breaking up a peaceful rural community and history for this community.

My recommendations is Alternative 1 (short of seeing impact of what the levees might do to the environment) and/or 2 and turn the west Street bridge into a pedestrian/bicycle pathway instead of cars. No express lanes! (I've never heard of any other town our size or even somewhat bigger getting an expressway put in in the middle of their neighborhoods to relieve congestion of I-5.).

Thank you for your consideration,

Sincerely,
Karen and Raymond Monroe

Response to Comment

Thank you for your comments and your perspectives on the various potential I-5 protection alternatives. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

John Cramer 8/31/12

To: Jim Kramer, Chehalis Basin Flood Mitigation Alternatives Report Project Manager, Ruckelshaus Center and Principal, Kramer Consulting 206.841.2145, jkramer.consulting@gmail.com; and Melissa Kuehne, Ruckelshaus Center, WSU West, 520 Pike St., Suite 1101, Seattle, WA 98101, Melissa.kuehne@wsu.edu cc: [See separate list attached.]

From: John F Cramer, MSEE University of Washington, 33.75 years in Boeing Aerospace, including 22 years in Engineering Management and Systems Engineering for Classified Military Projects.

Subject: John F Cramer's Advice, Comments, Criticisms Tues, Aug 28, 2012 on Ruckelshaus 16 July 2012 Draft Report concerning the Impacts of flooding in the Chehalis River Basin and Potential Flood Mitigation Alternatives.

The Ruckelshaus Foundation and Jim Kramer performed a valuable service by writing and compiling an extensive report on the importance of finding a solution to the Chehalis Basin flooding. We were encouraged that two of the three sets of projects outlined as worthy of consideration include the flood control dam in the upper Chehalis.

As a Manager and Systems Engineer concerned with the social welfare of all Citizens and businesses along the Chehalis River Basin from Pe Ell, WA to the Pacific Ocean, I have criticisms and suggestions that hopefully will be addressed prior to final report release.

First, the report does not state clearly enough, without equivocation, the benefits of upper Chehalis River Basin water retention using a dam above Pe-Ell [and gage above Doty]. Eliminating the dam eliminates the only project that benefits the entire Chehalis Basin.

Second and quite important, the Benefit - Cost Analysis [BCA], discussed in Appendix D by the UW Grad student, Tyler Scott and BCA Center Director, PhD Richard Zerbe, is biased against the dam above Pe Ell on the Chehalis River main stem for flood retention and biased in favor of your Alternative project set number One that eliminates the dam. In addition, our understanding is that Scott and Zerbe comments cannot be relevant to this decision process as the BCA necessary to obtain Fed funding for any Flood Control project must strictly follow the Corps of Engineers Benefit - Cost Methodology [as EES has done].

Third and crucial, all analyses should assume that there is at least 80,000 Acre-feet of free storage space in the dam at the start of any flood event; regulations require this dam to be operated thus. It is not clear in the Hydrology section that this is the case. Rock Creek constitutes the only major flow above the Doty gage that is not captured by the dam, but this flow contribution based on rainfall and drainage area has not been made clear. We are concerned that unstated assumptions have resulted in degraded simulated capability of the dam to lower Doty flood levels by some eight [8] more feet in a 2007 size event. This reduces a primary dam benefit and deleteriously affects all the Chehalis Basin, and also I-5 protection by the dam. [see Hydraulic Model, Appendix F]

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The report failed to state directly that WITHOUT an Engineered dam on the Chehalis main stem above Pe Ell there will be NO EFFECTIVE FLOOD MITIGATION for the gestalt Chehalis River Basin. Eco-damage from flooding is very much worse without a dam and Eco-damage will not be stopped by a handful of bandaid projects. The "I-5 only" project does not qualify as a "real", "effective" Chehalis River Basin Flood Mitigation measure in our considered opinion because it addresses only a narrow strip containing I-5.

We note that Chehalis River flows in the summer are not big enough to keep river water temperatures down as fish need them to be. Not only will there be over 80K Acre-feet of flood storage in the dam above Pe-Ell, there will be another 65K Acre-feet for the purpose of maintaining summer river flows over minimum requirements and lowered temperatures within fish comfort range to improve rearing habitat for salmon and steelhead, similar to the operation of the Alder Dam on the Nisqually River. Additionally, the 65K Acre-feet will support the revenue gathering Hydro-Electric power generation capability of the dam.

The Tacoma Public Utilities Alder lake Dam has a Federal License for prioritized operation in addition to electric power generation. They must ensure at or above minimum river flows and these have been very successful in improving river rearing habitat for salmon and steelhead, resulting in runs that are greater than what would naturally occur without Alder dam. We expect the same type of operation for the dam above Pe Ell. This is important for all us fishermen. Dam Fish Saving Technology shall also be incorporated.

We note Alder dam also has a requirement to keep the lake elevation high during prime recreation months and we expect that the dam above Pe-Ell would also have this operation.

Although Alder Lake is a "small reservoir", Tacoma Power still lowers the elevation of the lake when possible to enable capture of high water inflows from rainstorms and snow melt.

Since a primary purpose of the dam above Pe Ell is flood control, operations would make sure that over 100K Acre-feet of storage was available by Dec 1 of each year. This would undoubtedly be written into the License for the dam.

We note that the Yellowtail Dam [named for Robert Yellowtail, chairman of the Crow Tribe], at the Bighorn River Canyon National Recreation Area [MT, WY] was built for the purposes of Flood Control, Power Generation [250 Mega watts], Irrigation and Recreation. All purposes have been successfully met and they have a World Class Trout Fishery. It is the most fished stream in Montana and yields one of our favorites, the Rainbow Trout.

WA State and US Federal governments understandably want the I-5 corridor protection to avoid 4 day closures at a cost of some $47Million for 4 days in Coast trade. However, we all must understand this cost is dwarfed by 2007 losses of some $500M in Lewis County alone. This does not count untold mental anguish suffered by citizens of 3 counties.

On the benefit-cost issue, saving Lewis County from the catastrophic damage expected from one (1) each 1996 or 2007 size storm is worth about twice the total cost of the dam.

Only by very seriously over-estimating the value of any possible ecological downside could the dam be shown to have less than stellar net benefit. The dam is the very clear winner.

UW's Scott and Zerbe suggest good decisions can only be made given Benefit-Cost Analysis [BCA] with sensitivity analyses. [Note: EES was required to use US Army Corp of Engrs method of computing benefits and costs. Unless the dam is built using only local funding with none, zip, nada Federal funding, then the USACE procedure must be used.]

Scott and Zerbe suggest doing a Monte Carlo Simulation [MCS] model of the projects. I led a Boeing group and built a successful, complex MCS of the Minuteman Weapon System Communications. Building a BCA MCS can easily use up a dozen man-years, one year + schedule time [decision makers really cannot afford another years delay] and $1Million+ of taxpayer dollars. Businesses were profitable before BCA MCS models and computers; they successfully dealt with "uncertainty" and "efficiency" and still do. In my considered opinion, the Scott/Zerbe BCA MCS is counter-productive due to the time delay and extra tax money spent for results with questionable benefits to decision makers.

Scott and Zerbe thrash on "opportunity costs" which imply some project other than the dam is more important or desirable upon which to spend tax money [political speak this week is "invest"]. Zerbe says a discount rate of 6% to 8% reflects the opportunity cost of funds. The 10 year treasury note now earns about 1.5%. We consider that Zerbe's discount rate is useful for one thing: doing nothing, i.e. the "null alternative". Zerbe's analysis approach appears to have as it's main goal the killing of the dam project.

With the dam, you need far less expenditures on other measures like flood walls and levees. EES reports that with a dam in a 1 in 500 year event like a 2007 flood [~ 2.9σ on a normal cumulative probability distribution], and with improvements to the airport levees, that I-5 flooding is minor. One problem is attributed to Dillenbaugh Creek at Labree Road Inter-change. Another is in the vicinity of Greenhill school. A third potential problem area is the on and off ramps south of the SR 6 interchange. We think any Greenhill and SR 6 flooding issues could and should be corrected with minor modifications to I-5 when DOT designs and constructs the 3rd lane through this area. We are given to understand that the Labree Road flooding is totally unrelated to the Chehalis River and the Newaukum tributary and will have to be addressed separately by DOT for any I-5 protection scheme.

Scott and Zerbe proclaim that their "personal communications with DOT" [page 181] indicates the dam would not be sufficient to prevent I-5 from flooding [they do not say possible flooding might be inches to about a foot, for only a few hours not days, and the cost of some ½ $Million, not $12Million] in an event comparable to the 2007 flood. In their mind, this hearsay session with DOT calls into question [introduces ambiguity into] the cost savings of no longer having to raise I-5. Fixing I-5 does not help the Chehalis Basin.

Even very conservative railroad companies only build for 100 year threats [2.39σ on a normal cumulative probability distribution] and not 500 year threats. Therefore, Scott/ Zerbe's assertion that there is ambiguity of required DOT action must be rejected; the dam must be credited with flood prevention, period. Their assertion, based on unofficial inputs, clearly indicates bias against the dam.

We all know the Chehalis River dam above Pe Ell benefits the whole basin down to the Pacific Ocean, 3 counties, numerous cities, towns and districts from the day it holds water to projected end of life, perhaps 100 years later. Net benefit will likely be several $Billion.

As regards the UW's Tyler Scott and Richard Zerbe evaluation of Benefit-Cost Analysis [BCA] of the Chehalis River Flood Control, let us say that I also am enamored of math, computers, Monte Carlo modeling, etc. However, that said, the value of analysis and modeling lies in the ability, if at all possible, to make the executive decision process more simple, more direct and straight forward, sooner rather than later and certainly not more complex and indirect as appears to be the case in Scott/ Zerbe's BCA MCS and multiple scenario approach. With the presently available level of detail and accuracy in definitions of and data for alternative projects, it is doubtful that the Scott/Zerbe BCA approach would yield any improvement in the presentation of aids for decision makers. If knowledge of data is plus or minus 10%, it makes no sense to try to develop curves accurate to less than 1%.

<u>Scott and Zerbe say on page 169 bottom [their issue 1]</u> that it is insufficient to determine whether estimated project benefits exceed estimated project costs; rather net project benefits should be evaluated against the potential returns from an alternative project [other than the dam] or an alternative use of public funds [read spending taxpayer money].

John Cramer's Answer to Scott/ Zerbe issue 1 is as follows:

Scott and Zerbe ASSUME there is more than one "EFFECTIVE project set" that could accomplish the task with equal quality and quantity measured over the total affected flood area and time. When considering the gestalt Chehalis River Basin, this IS NOT the case.

After 50 to 75 years of study, no project other than the dam above PeEll has been identified that provides anywhere near the benefit magnitude for the Chehalis basin for similar cost.

We understand the flood mitigation objective is not just to protect the I-5 Transportation Corridor, but is to protect as much of the basin as possible from destructive floods and attendant losses. Yes, the airfield at Chehalis/Centralia must be protected as necessary by levees, but also the economic capabilities of the three counties involved, which include farm businesses as well as businesses located in towns along the River system, etc, etc; all must be protected. We understand a levee is needed on the south side of the airport and the road into the airport needs to be raised, but this is not a large project; it could be done now.

It has been noted that protecting only the I-5 Corridor makes flooding worse in some areas. In the case of a dam on the upper Chehalis main stem, the dam restrains over 80,000 acre feet [26Billion gallons] of water, for whatever period of time necessary; ergo the destructive force of the flood water on the main stem is converted into revenue enhancing “clean” electrical power generation. The dam can keep ALL flood water in the watershed above the dam impounded until the Chehalis tributaries recede below the flooding stage and are within bank. This reduces the flooding problem all the way from Pe Ell down to the Pacific Ocean, including Native American property. No other project provides nearly this much protection to this much area [for whatever the required time], farm businesses and other businesses as well as individual houses, animals, farm land, habitat for fish and game animals, etc, etc. The walls and levees around I-5 certainly do not do this and therefore cannot be sold as “flood mitigation”, it is “transportation corridor protection only”.

It is crucial to design the dam such that in the worst case [or near worst case] year that we can find in the historical records, where it rains all year and there is no summer, that the dam has enough retention capability in Nov through Mar to restrain the total amount of storm/ flood water that falls on the Willipa Hills and drains into the Chehalis main stem above Pe-Ell. Dam operations strategy will also be important to ensure at least 80K Acre-feet of capacity will be available whenever needed. In a “normal” year, it will be easy in a dam that has 80K basic plus 65K for Hydro-Electric, etc Acre-feet capacity to arrange for somewhere between 90K and 120K Acre-feet in December through March. [The drainage area was measured to be 79,063 acres. M Reiter [of Weyerhaeuser] said that for the main part of the flood in 2007, their rain gage at Rock Creek measured 14.35 inches in 24 hours and Raccoon measured 13.85 inches in 24 hours. Averaging these, then the drainage above the dam may have collected some 93K Acre-feet of rain in 24 hours. Perhaps we should revise the required flood retention capacity of the dam from 80K up to 100K Acre-feet.]

We contend that the best strategy is to use a dam on the upper Chehalis main stem to subtract out all [ALL] the flood waters that fall on that section of the Willipa Hills [which is where a major part of storm water falls], [google Maryanne Reiter, Hydrologist for the Weyerhaeuser Co, rain distribution report, Title: Dec 1-4, 2007 Storm Events Summary]. Then after you have provided for the restraint of the 80K or 100K Acre feet [or whatever it may be], you can take such other action as necessary to solve any residual problems.

Given a free hand to design a total system to solve the flooding problem, we would next put a dam on the South Fork of the Chehalis above Boistfort/Curtis, for there is where another slug of water usually occurs. But, we were informed this would be considerably more complicated, and maybe not economical, due to rock sub-structures along the South Fork. This area also does not get nearly the quantity of water that the upper Chehalis occasions. We understand some 20,000 acre feet of water was involved in 2007. This is a lot if you are in its’ path. It may be possible through coordination with the NRCS, the Lewis County Conservation District and local area farms and landowners to pursue a 20,000 Acre-foot dam on the South Fork to supplement the flood storage provided by the PeEll dam and provide farm, conservation and ecological benefits as defined by NRCS criteria.

One long time resident said he had a really good close-up view of lake Boistfort which is normally farm land. In the 2007 flood, water from the main stem of the Chehalis backed water up to the store in Curtis. The store was flooded to the ceiling in 2007, but had never before been flooded. The dam above Pe Ell would cure this problem [among many others].

Usually, storm water falling on the Willipa Hills is about double that on the hills to the east of I-5. So a dam on the main stem of the Chehalis River efficiently covers most storm cases.

Yes, we realize that there are storms where the Cowlitz gets hit and other areas get hit by still other storms and action should be taken to help in those areas, but the really bad ones usually dump the most water on the Willipa Hills at the Chehalis main stem headwaters.

Note: Realize that we do not have any “skin in the game” for we are ridge runners and live at 1100 feet altitude. If we get flooded, all western Washington State is in serious trouble.

Therefore, the point is that there is no competing alternative single or even a combination of mitigation projects that can come anywhere close to the monetary, farming, business, animals and people benefits provided by the dam above Pe Ell. “The I-5 only” project monetary benefit is only about one-tenth that of the dam and does harm to people and property in Lewis County, not benefit them. We have heard of no projects for the alternate use of funds that provide the tremendous benefit that the dam gives to Washington State.

We contend that Scott/Zerbe issue 1 is solved; no additional work is necessary on this issue. The dam is effective in protecting the whole basin; “I-5 only” protection is only 10% of the benefit the dam gives in dollars and no benefit for the people of the three counties affected.

<u>Scott and Zerbe have a second issue</u>. They say that simple benefit and cost estimates are inadequate to reflect uncertainty [in costs ballooning and benefits not realized].

Assuming Federal dollars are involved, the USA Corps of Engineers would be involved. Their process is iterative for deriving requirements, additional preliminary design, geotechnical information, environmental, fish benefits, etc, etc, so the Corps of Engineers BCA will be updated at each process step until the Contract for Dam Construction is let.

Presently, we have the history of flooding and the attendant costs of destruction. Given the dam and the correct hydrology model, the attendant benefits will be realized. How much could benefits vary? We have to ask how accurate is the present hydrology model?

<u>Context switch temporarily to Hydrology</u>:

We have analyses of how much the flooding will be reduced. We previously assumed that the hydrology model was verified for taking out 80,000 Acre feet of water from the 2007 flood example. However, we are not at all sure this is the case; there is no explanation.

Do the assumptions and modeling equations made in the hydrology model give you +,- 2%, 5%, 10% errors, or what? Table 6 on page 225 shows a summary of model validation for flows for the Dec 2007 event. For Grand Mound, the model result is HIGH but within 4.5% for peak flow magnitude; the model missed the event volume [also high] by 28.3%. At Porter, the model is LOW by 16.9% on the difference in peak flow magnitude but within 3% for event volume. The report states that the rest of the numbers for different stations are within 10%. Perhaps they are. Perhaps they are not.

However, the not quite readable charts on pages 236 through 239 tell an interesting story. [Note: instead of 2 charts per page, surely the data can be arranged such that the charts have 12 point readable type with one chart per page. Someday, you also will be old.]

Hydraulic Model Simulation Results Disappoint: For the Dec 2007 flood, the station upstream/south of Doty [above Elk Creek confluence] and north of Pe Ell [below Rock Creek confluence], at cross section 100.95, shows a water surface simulated elevation of 328.1 feet without the dam and 315.8 feet with the dam for an improvement of only 12.3 feet. Using the USGS Water Information web site, we get 48K cubic feet per second at 328 feet elev and 12,000 cfs at the 315.8 ft elev. If you really believed the max average flow was 63,100, then the USGS Water Info site indicates a gage height of 31.36 plus the gage datum of 301.1 feet = 332.36 elevation, not 328 feet that the model shows, a difference of 4 feet.

The 315.8 feet has to be the result of the water coming down Rock Creek [within a few %]. Now, Rock Creek watershed is 13,010 Acres and the RC gage [Weyerhaeuser] measured 14.35” in 24 hours, so ~ 15,558 Acre-feet [677,697,405 cu ft] of water fell in 24 hours. This gives you an average flow of 7843 cfs assuming that input equals output [accurate to X%]. The USGS web data shows 7843 cfs occurs at 311.5 feet elevation, not 315.8’. Therefore it appears to us that the dam benefits have been shorted at least 4 feet with the dam and another 4 feet without the dam for a total of 8 feet that “the model” shorted the benefit of the dam. Total dam benefit should be 20 feet, not just 12 feet. This makes a 1 or 2 foot more flood level reduction at I-5 and Mellen Street [this needs verification]. Some folks complain that the dam would not protect I-5 by 1 or 2 feet. Our expectation is that the dam will [just] protect I-5 for a Dec 2007 [500 year?] size event.

Without more detail explanation, we do not find the model results totally believable.

The WEST constructed, FEMA approved 100 year flood specification shows 323.2 feet without and 313.0 feet with the dam when simulated. We doubt these numbers also. We are given to understand that FEMA has an agenda to increase the levels associated with a 100 year flood for the purpose of cementing in larger, more expansive flood plain and floodway definitions that certainly are not needed with a dam and probably not needed anyway. This generates more flood insurance premium money to refill FEMA flood insurance coffers depleted by hurricane Katrina in 2005. It appears to be just another sneaky tax increase.

PROBLEM: If the 2007 flood was a 500 year flood, then we need to see the derivation of the numbers to prove the FEMA 100 year designation. Was Feb ’96 a 50 year flood?

The Feb 1996 numbers show a simulated 318.1 feet without and 307.2 feet with the dam. Are there any Doty gage numbers to back this up, or not? Why should the Flood Authority believe these numbers? Information given to me has it that the flow at the Doty gage was 27,400 cfs in Feb 1996 which should put the water level at about 322 feet without a dam, some 4 feet more than the simulation. What should we believe?

Finally, the Jan 2009 flood [which was primarily in the eastern and northern portions of the Basin, BUT significant rain fell in the upper Chehalis watershed and was the 2nd largest on the South Fork of the Chehalis after the 2007 flood] shows a simulated water level at Doty of 314.4 feet without and 306.7 feet with the dam. What was the Rock Creek flow?

The dam should [shall] be designed to stop ALL water flowing into it from the above dam watershed in a 2007, 1996, and 2009 flood event. The simulated water level at the Doty cross-section for these events should be reconciled with Rock Creek rainfall data and explained for/ to the Flood Authority well before final report release.

The max average flow in the Rock Creek watershed in the 3 Dec 2007 flood is about 7843 cfs for the first 24 hours of the storm. A 328’ level at the Doty gage gives about 48,000 cfs total flow including Rock Creek. This says only 40K cfs is attributed to the main stem above the dam location. We note that Rock Creek is about 16.3% of the total water that is in the main stem. How do you get from 48K cfs and 328 feet height of water to the USGS guess of 63,100 cfs and a gage height water level of 332.36 feet altitude? Please explain.

Of course the time phasing of the flows is important, but when [near] steady flows should have been established, the Rock Creek flow was still some 16.3% of that in the main stem. However, steady main stem flow did not occur because of all the log jams on the main stem in 2007. Rock Creek was about as big as it was going to get by the time that the log jams broke and the transient wall of water swept down stream and took out the Doty gage somewhere just above 51,000 cfs flow rate. Was the max average flow really 63,000 + cfs? Not likely. The big transient slug of water resulting from log jams above Pe Ell breaking gave the erroneous maximum height of flood water readings [obtained by measuring debris height in brush]. Keying in on the max transient height of the surge introduced errors in the max flow USGS guess [WAG] of 63,100 cfs at Doty. We understand that when the flow rate exceeded 51K cfs the gage failed [the 37K lb concrete block/gage was moved across the river]; no one really knows the actual max average flow rate. But, the 63K + cfs number matches the FEMA agenda for more flood insurance [tax] revenue, so they ran with it.

THEREFORE, it appears that the benefit of the dam in reducing flood levels could well be understated by some 8 feet at Doty [unless proven otherwise, which we doubt]. This means that the flood level at the Airport levee and at Mellen should be perhaps a foot lower [eye-balling the data for 2007 on page 236]. We also would expect lower flood levels along I-5.

The Flood Authority will surely be quite interested in the detail explanation for all this.

We are given to understand that the benefits of the dam was understated in the ESS Consulting Phase 2 analyses as the benefits of reduced flooding only included Lewis County. At that time, the hydraulic model below Grand Mound [Thurston and Grays Harbor Counties] was not completed, so the benefits of reduced flooding in Thurston and Grays Harbor Counties could not be attributed to the dam above Pe Ell at that time.

Back to Scott and Zerbe:

Since there are no alternative approaches that come close to the dam benefit for the whole basin by a factor of over 10, the dam is the winner, given intelligent design and operation.

But, you say, the dam might cost more than estimated. That is true, particularly if you specify that “prevailing wages” must be paid for everyone working on the dam project.

If you want better estimates of the cost of the dam, then hire someone who knows what they are doing to build a Specification for the dam and do a Preliminary Design of the dam to the level that is necessary to make a firm, fixed price bid on the dam construction. You can put into the contract for the System Engineering and Preliminary Design for the dam a provision that should this Company get the contract and build the dam, and the cost come out more than X % above the agreed-to number, the Company will be assessed penalties.

Confidence costs money and time. The question then is how much confidence do you want for the estimate and when do you require a high quality estimate? When a Company does the System Engineering and Preliminary design is the time they should define the upside and downside to the point estimates because then there is good data. Sensitivity analyses at present on the cost of the dam would just be wild speculation and thus hamper decisions.

Doing a cost model now, at the present level of definition of the dam and work necessary to construct the dam, is a waste of time and money in my considered opinion. If a company has built a similar dam in a similar physical and regulatory environment with similar requirements and site characteristics, you can get a guesstimate on a comparable dam and apply deltas to get an approximate answer.

The potential “Fly in the Ointment” in Zerbe’s second issue is “an environmental impact prove(s) far greater than anticipated”. We find it very difficult to believe you can find an environmental impact for a dam above Pe Ell even one millionth [10^{-6}] that of the 2007 storm/flood on the Chehalis River Basin. Without question the environmental impact of doing nothing is tremendous, maybe every ten years. We suppose someone could conjure up some imaginary big dam environmental impact, depending on what they happened to be smoking at the time. How it could be large enough to be of serious concern is a mystery.

We consider issue (2) adequately answered.

Scott and Zerbe have an issue (3), namely the time frame on which benefits and costs are modeled to occur. This is where they get into the "opportunity cost of funds", project viability versus interest [discount] rate for the costs and benefits, etc. They say that when benefits and costs are modeled to occur greatly affects the outcome of the Bene-Cost Anal.

We know for sure the lack of a dam [for some $250M] on the upper Chehalis resulted in $500 Million in destruction in Lewis County in 2007. The amount spent on the dam was essentially zero and the benefit was very negative. How many more of those events do decision makers want or can WA stand? We had a 1990 flood, a 1996 flood that some folks call a 100 year flood [2.17σ on the normal probability density function] and a Dec 3, 2007 flood which some are calling a 500 year flood [about 2.9σ]. We already have messed around [pontificated, cajoled, argued, blustered, got red in the face, etc] for 4.5 more years and have not even started on the construction of any flood mitigation project. We surely do not need to waste another year and another Million Dollars of taxpayer money generating more "uncertainty by analysis" where acceptable uncertainty should and does now exist.

We also know with certainty that there will be no benefit until something [like the dam] is designed, built and operation commenced, and with certainty we know money will have to be spent before the benefit will be potentially available. What we do not know is exactly when the need for the beneficial water retention dam will occasion. However, looking at history, we see a major storm about every 10 years where destruction is great and a very significant percentage of this could be prevented given a dam on the upper Chehalis.

Now, we think that Scott and Zerbe can construct a time related scenario and a discount rate such that nothing [the null alternative] is what one would do. But that surely does not help meet the objective of seriously reducing the flood destruction along the Chehalis basin. Zerbe's 6% to 8% rate would likely kill all useful flood mitigation projects in our opinion. They have not shown how their analysis approach supports flood mitigation objectives.

If folks are serious about meeting flood mitigation objectives, it would be good to know the interest/ discount rate [and time related scenario] required to do something useful, and most useful is, in my considered opinion, to build the dam above Pe Ell [if you could do only one thing]. We can wish that Scott and Zerbe would use their considerable expertise to bring good scenario and discount rate tidings, but this may be like trying to win the lottery.

What we do hope is that the infamous Murphy and the Storm Gods take a nap long enough to where we can obtain funds, get the dam specified, designed and built [and other needed provisions done], so we are ready when the next big storm arrives, as it most surely will.

<u>Scott and Zerbe have an issue (4)</u> [pg 170], they state as follows: An appropriate basis is needed for project comparisons, namely "a benefit-cost analysis should estimate the difference in outcomes between what is likely to occur if a project is funded and if it is not." "Project benefits and costs should not include changes or expenditures that are likely to happen even if a project is not implemented." "This is particularly important when considering the selection of multiple projects, since numerous small programmatic or non-structural projects might obviate the benefits of a large structural project" [read dam]. Note: this statement also shows anti-dam bias.

John F Cramer's Comments on the Scott/ Zerbe issue (4):

If you add up all the benefits of ALL the numerous small programmatic or non-structural [i.e. non-dam, levees and walls] projects, the benefits cannot even come within sight of the benefit of a dam, they are miniscule by comparison [even though marginally useful]. This Scott/Zerbe statement shows a clear lack of understanding of the magnitude of the flooding problem and what it takes to solve the problem. We recommend they come to Adna to experience the next big storm and flood to obtain a full measure of wisdom. Bring a boat.

The dam is the 5 ton elephant in the room in terms of the benefits as compared to the partial ounce shrews such as critter pads. Do not mis-understand me, I think critter pads should be done now [this year] to help if the big boys and girls cannot get around to doing something useful like a dam. Also, there are areas where dams and levees/walls, etc will not help much, if at all, and the critter pads are vital. They are still miniscule by comparison.

If we have the dam, levee improvements around the airport, etc. it is still a good idea to dredge out the Chehalis from, say, Adna on downstream to at least the Chehalis Tribe Casino to significantly lower river levels, particularly during a flood. I am given to understand that this segment tends to be polluted and silted up and the fish [which we all love, you certainly must comprehend this fact] will not spawn in this section. Particularly important is the confluence point of the Skookumchuk and the Chehalis Rivers.

We were just informed by a Local who was born and raised in Adna that the Chehalis River was navigable from the Pacific all the way up just past Chehalis at Claquato by Stearns Rd and that dredging was a normal activity in the past. [Note: I have not verified this with the Historical Society.] But the dredging stopped and the Chehalis River has become all silted up which raises the level of the river, particularly during flood events.

However, we were informed that such dredging was way too expensive and would require repetition. It was suggested that rules be changed so licenses could be granted to allow local people to dredge the rock out of certain short segments where dredging was needed.

In this way, the value of the gravel obtained by selective dredging offsets the cost of removing gravel. It would have to be done at a time and in such a way that fish are not harmed. We are not sure that this would work, but may be worth some thought.

The Hydrology Report, page 232 speaks to dredging downstream of Mellen Street to just downstream of Lincoln Creek [River Mile 67.29 to RM 60.51]. The modeled excavation had a 120 ft bottom width trapezoidal channel and would lower the channel bottom by as much as 15 feet in some locations. The ends of the excavation would be faired into the existing channel. This takes out a natural rise in the river bottom thought to be bedrock. Lowering the bottom will help the flow and lower upstream levels. Every foot and inch you lower the level helps to reduce flooding of areas like the proposed event center in Centralia. We hear pictures at the event center location show flooding was some 2 feet deep in 2007.

Everyone who has taken a hydraulics class at the U of WA understands that sharp changes in direction and bottlenecks in a stream significantly reduce stream flow capacity, so it is important to remove these restrictions to lower the level of the river flow upstream. We are given to understand that one of these restrictions occurs at the Mellen Street Bridge in Centralia. Lowering the flow level there will certainly reduce twin city flooding.

NOW, Flood Walls and Levees along I-5 have very limited spatial influence and benefits [and significant flooding downsides in nearby areas of residences and businesses; like MD's, we should do no harm]. Their total benefit is maybe a maximum of $47 Million for 4 days [i.e. not net] compared to some $500 Million for the dam in Lewis

Co per event [up to a major portion of $800M for the whole Chehalis River Basin.] Therefore, in a big 1996 or 2007 style storm event, we expect the benefit of "I-5 only" protection to be less than 10% of the Socio-Economic benefit of a dam above Pe Ell, and no help to the Chehalis River Basin.

Say that the life expectancy of the dam is 60 years [it should be designed and built to be useful for > 100 years] and during that time we occasion 6 big Pineapple Expresses that hit the coast and the Willipa Hills. If it is a 2007 size event that dumps over 80,000 Acre feet of water on the watershed above the Pe Ell dam, then the benefit of the dam to the gestalt Chehalis Basin could be some $500 Million times 6 events or $3 Billion in today size dollars. It will actually be more because of additional development protected over the years.

If we freeze all costs and prices at today's dollar value, the comparison of the dam to the "I-5 only" protection is useful. The dam is over 10 times more Socio-Economically useful and beneficial than an I-5 only set of projects. The dam also eliminates a tremendous amount of mental anguish and suffering that the I-5 only projects do not and cannot address. What is not understood about ten (10) times the benefit [of the "I-5 only" project] that the dam gives? If necessary, refine the numbers a bit. But do not take a year to do it.

There is no need to make the analysis any more complicated than this to make a reasonable decision to go forward with the dam. You say it is too simplistic? Well, there you go again. It is really, really clear [unambiguous] what the answer is and should be, like it or not.

Therefore, we reject the issue 4 assertion that "numerous small programmatic or non-structural projects might obviate the benefits of a large structural project" [read dam]. A handful of band-aids cannot replace or outperform a tourniquet. We need to get serious.

In Appendix D, Evaluation of Benefit-Cost work regarding Chehalis River Flood Control, Introduction, page 171, Scott and Zerbe say they identify and discuss five important issues that merit consideration for facilitating comparison across projects. (1) Policy goals and objectives; (2) Risk and uncertainty; (3) The yearly distribution of benefits and costs over the project time horizon; and (4) An appropriate baseline for comparison.

Then they take time out for several pages to talk about "moving forward with existing analyses and data" and declare that a benefit-cost analysis is "an exceedingly difficult exercise". This is interesting to know, because this negatively impacts future BCA work [i.e. drives cost up but for what, if any, benefit] and also any decision to begin such work.

They discuss causality which involves the question as to whether an expenditure directly results in a change in net benefits. [Apply this also to BCA to see if BCA supports a flood Mitigation Program.] We all understand that a critter pad built above a flood can save cows, sheep, horses, etc and we know animal sale prices so we can measure the monetary benefit [but really not the great benefit of saving the daughter's only 4 H animal which may auction off at SW WA Fair to help her education fund for $4000, as happened in 2012].

There is also a direct causality link for a dam that retains 80K to 100K + Acre-feet of water and uses the retained water over time to generate "CLEAN" electricity which is sold for revenue. A large amount of monetary benefits will be accrued over the dam lifetime.

We know, because we saw it, that the 2007 flood shut down I-5 with water many feet deep. The rapid, flowing water disconnected and displaced quite a number of the 5.5 ton concrete Jersey Barriers. The barriers were strewn about as if they weighed nothing. Even when there was no water left on the roadway, the barriers still had to be moved back into their proper place before traffic could resume. Similar things happened in 1996. Are we 100% certain that concrete walls along I-5 will always prevent I-5 from closing down? You may be, but I would not be until the concrete walls were tested by a flood. I would be concerned that the walls might be undercut by a raging torrent. [A dam prevents the raging torrent.]

Of course, part of the answer is driven by what flood levels were used for the flood wall design. If the flood event exceeds the level for which you design, the walls are overtopped and I-5 will be shut down for the usual 4 days at $12 Million per day, and perhaps longer, depending on whether the walls now become a dam that holds in the water. Presently, flood waters in south Centralia east of I-5 cannot escape properly due to various impediments and one way flood gates, and this stretched a 4 day flooding event to over a week at an acquaintance's residence, thereby compounding his losses. His property value was also cut in half by the fear of future flood events like the FEMA approved 100 year flood levels.

We should like very much to examine the derivation of the FEMA approved 100 year flood description and suggest that this be included in your final report in a separate appendix.

We note that a great benefit of the dam is the expectation of reduced risk for flooding all throughout the Basin. This will cause property values to return to what they were before the 2007 flood [at least] and should also reduce the size of the floodway and flood plain. Do not forget this also reduces flood insurance rates. FEMA hates this because they want to pick 100 year levels to keep the artificially large floodway/ floodplain which drives up insurance cost and replenishes their coffers. This makes immediately suspect their approved 100 year flood definition.

Given a dam above Pe Ell with 80,000 Acre feet of basic storm storage and 65,000 Acre feet of Hydro-Electric storage that also provides fish with cold water in the summer months, and given that storms normally come in late fall and winter when the reservoir water level is down, the storm size would have to be some 120,000 Acre Feet [some 40 Billion gallons] of water to use up the dam storage capacity. This should take the flood levels at I-5 down by 1 or 2 feet more [this needs verification]. So the dam can make almost certain that flood levels at I-5 are below the I-5 surface level in 2007 type storms. If we have also dredged segments from Adna down past Galvin, this should reduce flood levels another foot or so [we have not seen this analysis yet, perhaps this could also go in the final report]. Unofficial inputs indicate fish do not spawn in this stretch of the Chehalis River anyway because of rumored water quality and summer heat. Salmon cannot live in warm water. When we raise water levels below the dam in the summer, we increase spawning habitat.

Then, on page 172 in the 4th paragraph comes the inditement against the multi-purpose dam for crimes against humanity and your brother fish. Scott and Zerbe take issue with Anchor QEA's model which predicts that spring-run Chinook salmon stock will increase by 140% given several assumptions that Scott and Zerbe find most questionable. However, they apparently have no issue with studies of other fish that found a down side. They also charge that there is absolute certainty that the dam eliminates SOME salmon-spawning habitat. They very carefully do not say why this should be so and how much habitat, but we are left to assume they think it is a terrible problem that cannot be overcome and is a fatal flaw for the dam. We say "Hogwash", since we must be restrained and civil in this document. We recall what President Harry S Truman would have called the inditement.

Scott and Zerbe hold harmless the Walls along I-5 particularly with respect to people and fish and suggest that re-vegetation of upstream lands would help fish stock. Our comment is maybe it would, until the next big storm which would wash it all out again as it has many times in the past. Scott and Zerbe failed to mention that re-vegetation would have to be done many times. Maybe the Walls along I-5 do no harm to fish, but the floods throughout the whole basin surely would continue to do gobs of harm. Some folks believe, with good reason, that the walls and levees redirect the flood waters and harm nearby residents.

Scott and Zerbe show on page 173 a figure 1 from the Anchor QEA salmon impact study [QEA figure 6-2, page 75] regarding winter steelhead number of spawns versus analysis scenario. Reading the chart indicates an optimized flood storage multi-purpose dam with passage for fish would reduce spawns from the existing 620 to 420, give or take.

We understand that Chinook salmon spawn in the main stem of the river, whereas other salmon species spawn in ponds in the headwaters of tributaries. Cold water from the dam in sufficient quantity for greater water depth of flow in the summer improves conditions for both of these groups, so we expect improved fish runs. Yes you will lose some habitat above the dam for spawning, but you will also see more habitat below the dam. It is yet to be proven whether there is a net gain or loss. Other streams with dams saw increases. This is particularly true when there is habitat mitigation; you see increased fish runs.

What this does for me is indicate the need to figure out a way to at least gain back what QEA thinks that we would lose in spawns. It is a problem to be solved, not a fatal flaw for the dam. To say it is a fatal flaw values fish way above the value of humans; we reject this contention.

Scott and Zerbe have now made their bias against the upper Chehalis River dam obvious.

Our position is totally clear that the dam is by far the winner, but this is not bias, folks, it is just objective truth. Yes, some action may be required at Dillenbaugh and Salzer creek crossings and for the ramps where I-5 and Hy 6 cross and almost certainly the levees/road around the airport should be addressed immediately. There are a couple of low spots on the west side of I-5 north of the Chehalis 13th street exit that probably will have to be solved regardless. These are all local actions that have local effects. The dam saves huge areas of Socio-Economic importance not addressed at all by the "I-5 only" and the local projects.

Scott and Zerbe then discuss tractable estimation of benefits. They say that often the estimation of non-monetary benefits and costs injects a great deal of uncertainty into BCA. We agree since it is difficult to assign a reasonable value to saving, literally, the life of the dairy farmer whose death was the direct result of losing his dairy farm and animals for which he had worked his whole life. How do you assign a value to the disrupted lives when these folks have to retrain for a different type of work because of a flood? How many fish was the dairy farmer worth? How many fish for the person that had to be retrained?

DO you seriously not want a dam because a few fish may not spawn? How many fish is Mr Tyler Scott and Mr Richard Zerbe worth? Pick a number. Is 150 fish too low? How about 1000 fish? O.K., What about 100,000 fish for a U of WA PhD. Now, is a dairy farmer worth less than a U of WA PhD? Consider it carefully.

There are hundreds of cases like this from the 2007 flood that would not have happened should there have been a dam above Pe Ell. HOWEVER, note that these cases of loss and heartbreak would still have happened given only the protective walls and levees around I-5.

What are your objectives?

<u>MAJOR PROBLEM for Zerbe</u>:

A major problem with UW's Benefit-Cost Analysis approach by Richard Zerbe, PhD, that stresses solution cost-EFFICIENCY is that it does not work well if you are trying to compare anything but apples-to-apples, i. e. systems that have exactly the same objectives, requirements and functional performance. If you try to compare Dirigibles to Fire Hoses, it does not work at all.

You may say that for the upper Chehalis River dam versus the I-5 walls and levees that we are trying to protect people from the flood in both cases. That is clearly not true. The “I-5 only” cares nothing for Citizens of our 3 counties.

In the case of the dam above Pe Ell, we are working to protect the people, animals, farms and businesses [in the whole Chehalis River Basin for the whole length of the River] that are in the flood plain and the floodway for the worst case flood experienced to date. If we choose not the worst case, at least we endeavor to protect these for a 100 year plus storm of the “Pineapple Express” type that hits the Willipa Hills, which historically wreaks the most basin damage and havoc. This very significant protection will be afforded to the tribe(s) as well as non-tribal populations. One thinks the Tribe also should hate to be flooded out.

This protection is available since ALL storm waters that fall on the Willipa Hills in the watershed above the dam at Pe Ell is subtracted out of the flood equation for the duration of the storm. This is true if the storm mostly happens in just 12 hours and was essentially done in 24 hours as in the case of the Dec 3, 2007 storm, or whether it sits on the Willipa Hills for a whole week. The 80,000 Acre feet storm storage and 65K A-ft Hydro-Electric Generation capacity is available. On Dec 1, a net capacity of some 120K Acre-ft is expected. This is 39 Billion gallons of water the dam can take out of the flood equation. Beautiful.

For Ruckelshaus Alternative # 1 with no dam, NO water [none, zip, nada] is extracted from the equation. It all rushes down to the ocean carrying significant portions of 3 counties with it and wreaking tremendous destruction valued at some $800Million for the whole basin. It also effectively throws away, discards as valueless, enormous quantities of clean electricity revenue that can be generated given the Hydro-Electric Generation capability of the dam.

For the case of “I-5 only” walls and levees, people, farms, and businesses in the three counties are not protected at all. Rather, more of these are inconvenienced because the walls and levees just direct the flow of the water in the flood plain and protect a small strip of land; land containing I-5. The objective is just to protect a strip of land so the transportation of goods, services and people on I-5 is not interrupted. This is a different objective than that for the dam. The dam helps protect people in the Basin AND also I-5, though perhaps not I-5 to the total perfection desired by some.

THEREFORE, we do not have a direct apples-to-apples comparison when we consider the dam above Pe-Ell to the “I-5 only” protection. The two approaches serve different objectives [functional purposes] and have very different effectiveness and benefits with the Socio-Economic benefit of the dam being some 10 times [or more] that of the “I-5 only” protection per flood event.

The “I-5 only” protection is totally ineffective for protecting the people, farms and businesses in the Chehalis River Basin. These program strategies [dam versus “I-5 only” protection] are not at all interchangeable or comparable.

In contrast, the upper Chehalis River dam does afford significant protection to the I-5 corridor while it restrains flood waters and generates electricity.

Even in the Dec 3, 2007 flood event, described by some as a once in 500 year, 3.3σ event, some argue that I-5 would be completely protected and some argue that there would be a low level of flood water on I-5 for a few hours, not 4 days. Since the cost of a one day closure is about $12 Million, the net cost for four (4) hours would be some $2 Million.

The total cost of the 2007 storm and flood was some $800 Million with about $500 Million of this occasioned in Lewis County, not counting all the mental pain and anguish suffered by the people during and after the flood along the whole river length. The 4 days of closure of I-5 is said to cost $47Million so you see that what the dam would protect is at least 10 TIMES the value of what the “I-5 only” protection affords PER EVENT of the 2007 size.

Since history says that we will occasion a big storm and flood about once in 10 years, and since a dam will have a useful lifetime of over 60 and maybe over 100 years, the dam would potentially save those protected from 6 to 10 events at, say, an average of some $500Million per event for a total of about $3Billion to $5 Billion saved from destruction. This compares to the benefit of $300Million to $500Million for the “I-5 only” protection.

NOTE: BUILDING A MODEL TO ESTIMATE BENEFITS AND COSTS VALUES TO WITHIN 1%, WHEN THE EXISTING DESIGN AND COST DATA IS ONLY ACCURATE TO, AT BEST, 10% IS NEITHER “EFFICIENT” NOR “EFFECTIVE”.

So, in the first big flood event, some $500 Million would be saved and the dam will cost less than that. Present estimates are about $250Million. It is easy to see that the dam pays for itself in the first big storm that happens after it comes on line. If we do not continue to mess around but rather go ahead and build the dam, perhaps the first big storm would come in the first fall/ winter after the dam is constructed and employed. Now folks, that would be efficiency.

Think of buying a tool, and the first time that you use the tool it earns back in savings more than you paid for it. Would you think that purchase was a good “investment”? We would.

It appears to us that you would likely not have to wait 10 years to completely offset the total cost of the dam. Then, you are on the positive side economically, regardless the value of the interest rate or the discount rate. Common sense says that building the dam is good to do.

In the case of only doing your report’s Alternative # One with the walls and levees along I-5, etc. and no dam, you could still see $500 Million of loss in Lewis County per storm and flood due to flood damage of homes, farms and businesses; because the I-5 only protection does not work that problem at all.

Now, on page 174 their section IV. Important Issues for Consideration in Comparing Projects, Scott and Zerbe consider first Policy Goals and Objectives. They say that in an economic BCA, the objective is to maximize social welfare benefits, which greatly increases the complexity of the exercise [partially] since defining social welfare is a vexing political question. We suppose that one can make it complex and vexing if one desires to do so.

We believe there is no virtue in analysis methods that greatly increase analysis complexity for a small gain in insight into the decision process. We were taught that simplicity and clarity were next to Godliness. We think, without vexation, that saving people, property, businesses, livestock and the basin environment gives maximum social welfare benefits.

Since dam effectiveness meets the goals and objectives of maximizing the protection of the Chehalis River Basin from Pe Ell on down to the ocean, including the I-5 corridor, and saves some 10 times the cost of destruction that the “I-5 only” projects do, for what good reasons would one then engage in a complex analysis that muddies the water, so to speak.

Perhaps if one fish was as valuable as one dairy farmer, you might be able to make a case, but we doubt it. If the worth of a dairy farmer is taken to be that of a U of WA PhD in Socio-Economic Analysis, and this value is equal to 100,000 fish, then the dam is by far the winner, as everyone comprehends.

Page 175, 1st paragraph states that what is wholly unambiguous is that BCA takes efficiency to be the justification for policy decision-making.

Very well, we say that unless the set of projects meet basic requirements for EFFECTIVENESS, then efficiency is totally meaningless.

In this regard, the walls and levees protecting I-5 fail spectacularly to protect the people, animals, farms and businesses in the Chehalis River basin from Pe Ell to the ocean and therefore fail the effectiveness test miserably. Ergo, we must reject Alternative project set number one that discards the dam.

It is also for this reason that we take the carefully considered position that Benefit - Cost Analysis is not needed since it ignores the effectiveness of the solution sets and tries to compare, as equals, grossly different projects with grossly different objectives, requirements and performance.

We maintain that it has already been adequately shown that the net benefits gained by the expenditure of project costs for the dam grossly exceeds the opportunity cost of those funds and the dam totally will pay for itself in the first ten years with reasonably high probability. We think you should not leave the taxpayers money in an interest bearing account at 1% or 2% interest nor bury it in the back yard [which is almost equivalent these days], but should use it on the most effective project for the whole basin, namely the dam. There will be no benefit until one builds the dam and renders it operational.

The dam clearly produces the most benefits and this is particularly true when one out-fits the dam with fish saving capabilities, with Hydro Electric Generation [HEG] for revenue, and for supplying cold water in the Chehalis in the summer for fish. The dam provides additional recreation opportunities which are valuable in and of themselves. The dam clearly yields the most social welfare benefits. The HEG surely pays for itself at today's electricity prices and we have no doubt that the HEG has a good and acceptable net benefit cost ratio. We think it will be difficult to find a set of activities that come close to the HEG net benefit. The $90 Million for HEG, etc will prove to be a bargain as it will also give additional flood capacity. We are surprised Scott and Zerbe are trying to bring this into question. Apparently they are trying to bring every piece of the dam project into question.

We are not here talking about cashing in a Lotto ticket or an annuity, so defining a bunch of scenarios and wrestling with net present value we think is a waste of time. The net change in social welfare is clear and the dam wins hands down. It would be a very bad political decision to not build the dam. One would certainly not want that as their legacy.

We think that with a dam, the I-5 highway would not have to be raised from Napavine to Rochester. Since the benefit of the dam is so large, we are not sure whether any savings on I-5 are counted as a benefit or a negative cost will change the answer that the dam is the winner. Should it matter, obviously we count it as a negative cost since this boosts the net benefit/cost ratio for the dam.

Complexity and obfuscation are the enemies of good decisions. We need neither of these.

On Page 177, Scott and Zerbe discuss "Uncertainty", inherent, irreducible uncertainty. They opine that even with perfect and complete data, system outcomes cannot always be accurately or precisely predicted.

NOW, everyone should realize that nothing is perfect, particularly the analysis models which are full of implicit and explicit assumptions, each model with varying degrees of imperfection in the abstract representation of reality. Assumptions are made by those building the model to simplify their work such that they can get the analysis done within time constraints, within the constraints of the language they use to build the model and within the constraints of the computer system upon which they run the model. It is folly, total folly to treat models as dispensers of truth.

There are times that even the analyst does not recognize implicit assumptions such as the assumption that the dam and the I-5 only flood walls/levees are of equal effectiveness across the total Chehalis Basin in relieving flooding effects and destruction costs before one can reasonably compare the efficiency of the "solutions". Without equal effectiveness across the solution space, efficiency comparisons between potential system solutions are meaningless. Theory is wonderful, but reality can be hell.

Scott and Zerbe say they are especially troubled with the way uncertainty is treated [or not treated] in the present analyses given the high variability associated with flood events. The high variability that has them all fretted up includes flood timing, sizes, distribution of rainfall, pre-existing conditions such as soil saturation, snow accumulation amounts in the Willipa Hills just prior to the main event, etc, etc, etc. Get used to it, that is nature, folks.

What is needed is a flood mitigation strategy that works across as many of these variables as possible. We look for a strategy that handles the usual experiences from the past, such as 1996 and 2007 floods, and that handles as many variables as possible given the actual physical environment in which we find ourselves. Over the years and many flood events, the rainfall distribution that occurs often, with maximal impact, is the "Pineapple Express" hurricane type storm that dumps water on the Willipa Hills in the watershed of the upper Chehalis and the water flows down the main stem through Pe Ell and the Doty gage.

To intercept the flood above Pe Ell is likely the most effective strategy available. It reduces significantly the flooding along the whole Chehalis River Basin. The "I-5 only" flood walls/ levees do nothing [are no help] until water gets to Chehalis and then it only directs the flow away from I-5, BUT does not reduce flooding at all anywhere else except that narrow strip on I-5. The people, farms, livestock, and businesses in the Basin still take the massive direct hit of the flood and the resulting costly destruction.

The "I-5 only" strategy is not an effective flood mitigation strategy for the Chehalis Basin. That is why it is called "I-5 only".

Recent experience [the last 100 years] indicates that one should expect a "100 year" storm about every 10 years of the "Pineapple Express" variety. So we may have 5 years left until the next one [Note: this is longer than the USA was involved in and committed to WWII]. We understand well enough the cost of not being ready for the next big flood, therefore we are compelled to protect businesses, farms, animals, people, etc as quickly as possible.

We are certain that uncertainty will bite us much less than the next big storm.

The decision makers need to make the best decision they can with the data now in hand. The model makers can do whatever folks think may be useful in parallel with building the dam, if they wish, but let us not delay because we know that the "perfect" [even if you could achieve it, which we very seriously doubt] is the enemy of the "good" when it comes to decision making.

In the making of abstract models of reality there is certainly no end. We have nothing against models and theory and efficiency, etc, and the making of new PhD's in Socio-Economic Analysis as long as it does not impede getting the job of protecting the Chehalis River Basin done NOW before the next big "Pineapple Express".

We think that the so-called “expected value”, and “point estimates” for benefits and costs illuminate the choices adequately.

When you combine these with an understanding of the experiences of flood history, one can easily see that while it may be safe in Seattle at the U of WA over the next 5 to 10 years, it certainly is not safe along the Chehalis River Basin from the threat of a repeat of a 1996 or 2007 type flood event. If we move to solve these, we will have moved from a position of DREAD of the next big storm to a position of relative confidence where we can consider what else one should do in addition to the dam. The dam should clearly be first, and then fix the remaining smaller challenges.

Our experiences with flooding tell us clearly that to mess around with assigning a yearly value of 1/500th of the cost associated with the estimated damages from a “500 year event” on the Chehalis is not clever in the least.

Our experiences indicate that our understanding of “100 year” and “500 Year” floods is somewhat amiss when we seem to get a “100 year” or worse storm every 10 years or so. We should probably study what is going on and see if it is possible to come up with a new understanding of the probability of occurrences of storms of various sizes. However, this also should not stop us from building a dam as soon as possible.

And, let us not forget global warming and global cooling and what effects they may have on the ferocity and frequency of storms. It seems that both the believers in global warming and the believers in global cooling think that storms will get worse and more frequent in the future. Are they all pessimists? We think it unlikely that there will be any measurable difference in storm frequency or ferocity probabilities in the next 10 years. It would be good to understand just what those probabilities really are now from historical data.

You probably are by now getting a clear picture of our thoughts.

We think that the penalty is very large, unacceptably large, not only in monetary terms but also in terms of human suffering, for doing nothing or doing something that is far less effective than a dam in preventing the devastation of a flood from a big storm in the gestalt Chehalis River Basin. Something like “I-5 only” protection simply does not satisfy flood mitigation requirements for the Basin.

No reasonable Citizen of Lewis, Thurston and Grays Harbor Counties supports the “I-5 only” project at the expense of the upper Chehalis River dam above Pe Ell that protects the whole Basin.

Protecting “I-5 only” is far, far less effective than the upper Chehalis dam and therefore does not deserve our support.

We like protecting I-5, but not at the expense of all the folks, farms, animals and businesses along the whole Chehalis River Basin.

No efficiency argument can change these facts and the obvious conclusion that the dam is the winner with the most Socio-Economic benefits by a factor of about 10.

There is no reasonable excuse to delay the decision to start the permitting, design and construction of the dam on the upper Chehalis above Pe-Ell as soon as possible, should one be serious about saving the Chehalis River Basin from more destruction and also protecting I-5 from the next big storm and flood.

Let us all pull together and get this done.

Sincerely,
John F and Nancy R Cramer; cell 880.1934, email JFC451934@aol.com

Response to Comment

These comments were forwarded to Mr. Scott and Dr. Zerbe for consideration and were carefully considered. The final report acknowledges that there are differences in perspective on how benefit cost analysis should be used in decision making and on benefit cost analysis methodologies. If any large-scale capital projects move forward, additional benefit cost analysis likely will be needed.

In addition, Mr. Scott and Dr. Zerbe prepared the following response.

"We thank Mr. and Mrs. Cramer for their comments and consideration,

We also, however, have several reservations regarding their comments that we feel reflect a misunderstanding of both the key issues involved and the underlying economic theory.

First, we note that the use of sensitivity analyses, probabilistic simulations, and other more informative modeling tools for policy analysis are simply not as time consuming or cost prohibitive as Mr. and Mrs. Cramer contend. Modern computers and programs make implementing such analyses highly expedient and much more convenient (for our analysis, in fact, we performed several of our own

The fundamental utility of benefit-cost analysis is that it provides a common frame of reference on which various public projects can be compared. The benefit-cost analysis does allow us to compare public projects. Just as consumers compare apples and oranges on the basis of price, so too then can we compare different flood mitigation and retention projects on the basis of their monetary costs and benefits. It is imperative that we do make such comparisons, because it is simply not apparent, as is contended by Mr. and Mrs. Cramer, that "the net change in social welfare is clear" (pg. 71). Assumptions of this nature, particularly as related to large public works projects, have long led to inefficient and wasteful government spending, which we assume Mr. and Mrs. Cramer do not desire.

We do not contend that monetary costs and benefits are all that should enter into a policy decision, but we do find that these metrics can provide a common framework on which policy alternatives can be discussed. Perhaps the most important aspect of this common valuation framework is that effects, whether borne to dairy farmers or salmon stocks, cannot simply be dismissed. Because of this, a comprehensive analysis allows us to move beyond suppositions about what must "surely be the case" to an informed, reasoned discussion about public expenditures and investments In a world of limited resources, every firm, public agency, and household must consistently weigh both the efficiency and the effectiveness of their actions.

Regarding the use of interest rates in the analysis of public projects (pg. 58), we note that modern economic science demonstrates that the opportunity cost of funds to private citizens (e.g., the interest rate available on a private savings account) is completely different than the opportunity cost of funds to government entities. The correct opportunity cost for government entities is not the interest rate available at the local bank, but rather the rate of return that said entity would receive from other investments.

Numerous public investments, whether in infrastructure, education, development, social programs, or flood mitigation and reduction, offer a rate of return far great than 1.5%. Thus, the current yield of a 10-year treasury note (pg. 58) simply does not reflect an accurate opportunity cost of funds, and is far below standard rates used in both the public and private sectors.

Regarding issues raised in our original report concerning the treatment of risk and uncertainty (e.g., pg. 63), we note that the concern raised is not simply that estimates might be incorrect. Indeed, such is the inherent nature of estimates. Rather, the concern we outline in our analysis is that the assumptions on which the alternatives have been modeled are predominantly "best case" estimates and thus do not comprehensively reflect the nature of the projects. This type of "best-case scenario" approach is why so many past government infrastructure projects have satisfied a pre-hoc benefit-cost test only to experience vast cost overruns when implemented. We see numerous recent examples of such an occurrence right here in the state of Washington.

In conclusion, we thank the Flood Authority and the Ruckelshaus Center for the opportunity to be involved in this project. We also thank Mr. and Mrs. Cramer for their interest and their comments, and would encourage them to contact us directly if they desire clarification or wish to discuss elements of our report. We would encourage the Flood Authority and other involved parties to make use of any and all information available, and to use benefit-cost analysis to carefully and openly consider any and all alternatives, not simply to justify a preferred course of action."

Sincerely,

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Travis Nelson 8/31/12

Date: August 30, 2012

Subject: Chehalis Basin Flood Mitigation Alternatives Report, draft July 16, 2012

The Washington Department of Fish and Wildlife (DFW) has reviewed the Draft Chehalis Basin Flood Mitigation Alternatives Report (Alternatives Report) and offers the following comments for consideration.

Our comments are offered based on our interest in protecting species that may be affected by alternatives identified in this report. We are also interested and willing to continue the dialogue on the flooding issues in the Chehalis basin to assist in identifying basin wide solutions that include fish and wildlife protection and mitigation.

GENERAL COMMENTS

The report identifies few options other than a dam to address flooding issues as a basin wide solution . Even though there are alternative evaluations and considerations pending, the report seems biased towards a dam.

SPECIFIC COMMENTS

The executive summary references the Anchor QEA Fish Impact Study (Anchor Report) and identifies the potential for *flow augmentation that may increase the number of spawning spring Chinook in the upper mainstem by 22%-46%.* The suggestion for potential improvements in fish distribution and spawning is uncertain at best and relies upon downstream habitat that is suitable for spawning. This is an unsubstantiated claim that should be removed from the Alternatives Report. The statement would be more accurate to state that the flow augmentation from a dam could potentially improve water quality downstream.

There is also the reference to the Anchor Report which predicts *reductions in winter steelhead populations to be 32%-81% and coho by 28%-67%* respectively in the upper mainstem. The Alternatives Report mentions that *people who support water retention recommend mitigation like side channel restoration and removal of fish passage barriers to mitigate these effects*. It is misleading to suggest that removal of spawning habitat in the upper river can be mitigated by improving access to lower quality habitat in the basin and reconnecting side channel rearing habitat. The presumption is that the fish will simply relocate. Steelhead, in particular have a high fidelity for spawning location and generally do not stray from these areas, year after year. If the spawning habitat is eliminated, it is likely the rearing habitat mitigation could have little or no use. August 30, 2012 Page 2

Page 30, there is a typo at the beginning of the last sentence of the paragraph. The word “Information” is misspelled “Informaiton”.

Page 31, the chart “run sizes and escapements” needs more explanation to help identify the gap between the solid and dotted lines as harvest to demonstrate the significance of the Chehalis fisheries.

I have also included reference photos for use in the report at your discretion (figures 1-5).

Thank you for the opportunity to provide these comments. Please contact me at 360-902-2390 or Travis.Nelson@dfw.wa.gov if you have any questions.
Travis Nelson

Response to Comment

Numerous technical clarifications and corrections were made in the final report based on these and other comments from the state technical team. Thank you. With respect to the modeling of Chinook spawning: The SHIRAZ model predicted a 122%-146% percent change in the median number of Chinook spawners over a 50-year simulation period between the existing conditions and an optimized multi-purpose dam scenario (i.e. optimized flows and temperatures for salmon spawning and rearing). The Shiraz model is a peer reviewed model and uses scientifically-documented functional relationships to determine model outputs. The Fish Study analysis was based on the best available information gathered through data compilation and collection efforts. Significant efforts were made to compile available data and collect data to address those data gaps that could be filled in the timeframe of the project. In applying these data, the analysis of potential impacts to the species studied was based on scientific literature and well documented.

Further explanation on the chart "run sizes and escapements" section of the report was included to identify that the gap between the solid and dotted lines as harvest and to acknowledge the significance of the Chehalis fisheries.

Brain Raymor 8/31/12

08/30/2012

To whom it may concern:

I am writing this letter to express my concern about the proposed changes involving I-5 and the West Side bridge in my neighborhood.

My name is Brian Raymor and I am a 7 year resident of the historic West Side neighborhood. My property is in a constant state of improvement as I attempt to add to the sense of community that is felt in this area. I feel strongly that my neighbors contribute to this end and it is important that this neighborhood remain as unified as possible.

The suggestions proposed by DOT would effectively cut the neighborhood into two distinct areas divided by a larger road. We would also experience increased traffic and noise due to large trucks being free to drive down West street.

Additionally, under this plan home owners in this area will suffer a reduction in property values as some of the equity in our properties is tied to the desire to live in a quiet, family oriented area absent large transit trucks and traffic. Surely there will be those among us in the neighborhood that will propose to resolve the various conflicts of interest and damages by litigating the issues in court. This is an expensive option that would best be avoided by finding a way to resolve the DOT flooding concerns without affecting our neighborhood.

Thank you for your considering my opinion.
Brian Raymor
654 St. Helens Ave
Chehalis, WA 98532 (360) 508-6049

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Marlene Hampton 8/31/12

Hello My name is Marlene Hampton. I have lived in Rochester Washington since 1980. I can in no way describe to you what it is like to be flooded to make you understand the trauma a person goes through. It is one of those experiences you have to experience to fully understand. I was very disillusioned when I heard awhile back that our governor was more interested in the commerce of out state than she was the flood victims. I went to a meeting last week hosted by WSDOT which reiterated the states goal not to interrupt commerce at the expense of the people. From what I understand the walls they plan to construct will make flooding on the west side of I-5 worse! What kind of a solution is this? Wouldn't it be great to have a advocate to expedite the Dams process. This would benefit EVERYONE and the money spent on the walls could be put towards the Dam project. The craziest aspect of the whole idea of the walls is that some tax payers will be helping to fund a project that will causing them to be flooded more!!! I honestly don't know how the folks that make these decisions can sleep at night. This is like throwing a drowning victum an anchor!

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. We acknowledge your support for water retention as the solution to mitigate the potential for future flood damages. The final report acknowledges the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. Recommendations in the final report include moving forward with the additional work needed to determine if water retention is feasible as part of a suite of actions to address future flooding.

Deanna and Lewis Zieske 8/31/12

August 31, 2012

Ruckelshaus Center, WSU West

520 Pike Street, Suite 1101

Seattle, WA 98101

We appreciate this opportunity to provide comments on both the Chehalis Basin Flood Mitigation Alternatives Report prepared by the Ruckelshaus Center as well as upon the WSDOT Draft Report: I-5 protection from 13th Street to Mellen Street near Centralia and Chehalis, both of which address flooding issues in the Chehalis River Basin.

Addressing how to prevent and/or mitigate recurring flood damage in the Chehalis Basin has been a topic of concern and discussion for over 100 years. More recently the interruption of commercial and personal travel along I-5 during major flood events has also come to the fore. Both issues now seem to be coming to a head.

In the more than 22 years that our family has lived in Chehalis we have lived through the largest flood events this basin has experienced during the lifetimes of all but any centenarians residing in our communities- those of 1996, 2007 and 2009. There have been almost constant debates about how to address flooding. And no resolution. Politics, personal interests, economic constraints and a myriad other factors have prevented action. Hopefully the current approaches outlined in the Chehalis Basin Flood Mitigation Alternatives Draft Report will lead to a different result.

It is with that hope, and as a gesture of appreciation for the work that has gone into both the Flood Mitigation Alternatives Report and the WSDOT Draft Report: I-5 protection from 131 Street to Mellen Street near Centralia and Chehalis that we offer the following comments on the two reports.

Comments on Chehalis Basin Flood Mitigation Alternatives Report

Proposals to provide flood protection to I-5 as set forth in alternatives contained within the WSDOT Draft Report are being criticized by some policy makers and local officials because protecting I-5 does not offer basin-wide flood mitigation benefits. The rationale those individuals use in supporting that criticism is that focusing on protecting I-5 will dampen the pressure to undertake other flood protection measures to provide relief to areas outside of the I-5 corridor.

What those criticisms of the I-5 protection alternatives fail to take into account is that there are no proposals under consideration (or to our knowledge that have even been conceived) that,standing alone, protect the entire Chehalis Basin. And there is no politically viable prospect for marshalling local, state and federal funding in an amount sufficient to accomplish a basin-wide approach at one time. Face it, basin wide flood protection and mitigation will have to be phased in and should begin immediately. The surest way to niake a start- and the way that provides the earliest and greatest positive impact - is by securing the I-5 transportation corridor with its accompanying protection to the more heavily populated areas in Chehalis and Centralia. Thus, our later comments on the WSDOT Draft Report will address the specifics of what we believe is the preferred manner for protecting I-5.

Having said that, and not wanting to ignore the balance of the Chehalis Basin, we want to now begin to address the Chehalis Basin Flood Mitigation Alternatives Report.

A large water retention dam near PeEll appears to be a popular alternative for maximizing protection throughout the basin because it is easy for a lay person to understand. But that alternative is very expensive and has drastic ecological and environmental impacts, some of which we believe are unacceptable. Furthermore, it does not preclude flooding. It merely reduces the 2007 flood level by 3 to 4 feet in the Twin Cities. A dam alone, if not augmented by I-5 protections, would still inundate and close I-5 in a flood event comparable to the 2007 flood.

It would also still leave water depths of 5 to 6 feet on Prindle Street in Chehalis and intrude about 2 feet or more into the lower level of the historic round carriage house located on our property.

And should the dam fail (which does happen, as recently as this week in the Southeastern United States) there would be catastrophic damage to property downs.tream and potentially a significant loss of life. A dam failure would also drain the reservoir area creating additional environmental havoc.

Presently, instead of a dam we believe a better basin-wide approach to mitigating flooding is to encourage implementation of programmatic options like those set forth at page 47 of the Chehalis Basin Flood Mitigation Alternatives Report. Land use management, flood plain regulations, limits on fill and development in flood plain, structure modification and raising and other options of that sort can be implemented at the lowest cost to the public at large.

We recognize the great drawback to this approach. It transfers the cost of flood mitigation to landowners through reduced property values and limits on land uses. That runs afoul of the politically conservative residents who comprise the majority of the residents here in the Upper Chehalis Basin. And our experience in trying to enforce the State's Growth Management Act here in Lewis County clearly shows the depth of political and public opposition to such measures that would be faced and would have to be overcome. But in the long run the benefit is well worth the effort.

As a fall-back position if political opposition to programmatic options cannot be overcome and a "big project" approach is undertaken, we prefer some version of Combination 3 outlined in the Flood Mitigation Alternatives Report that includes Option 1 from the WSDOT report. For that reason we now turn to comments on the WSDOT Draft Report: I-5 protection from 13th Street to Mellen Street near Centralia and Chehalis.

Comments on the WSDOT Draft Report: 1-5 protection from 13th Street to Mellen Street near Centralia and Chehalis

As residents of the Historic Chehalis Westside neighborhood and business owners in Chehalis the proposed solutions for protecting I-5 from flooding contained in the WSDOT Draft Report are of particular personal relevance to our family. Our home is located at 647 NW St. Helens Avenue in Chehalis. We travel from home to our downtown law office in Chehalis several times daily. Both our neighborhood on the Westside and the downtown Chehalis business district are National Historic areas about which our community is proud. We have lived in our home on St. Helens Avenue since early 1995. Our property is approximately one acre in size and slopes downward to the alley abutting the residences on Prindle Street. Our property includes a home built in 1910 that is on the National Historic Register and a large round carriage house/ bam built in 1900 that is also on the National Historic register and may well be the largest surviving round carriage house in Washington1 •

Since we moved into our home in 1995 we have lived through the major floods of 1996, 2007 and 2009, all of which closed I-5 for varying periods of time. The lower part of our property, including the carriage house, was flooded in each of those major floods, with water being more than 5-feet deep in the carriage house and to a depth of 12-feet or more in the lowest part of our yard during each of those floods. During each of these three major floods in sequence the flood waters came closer and closer to the residence itself.

In addition to those three great floods we have seen flood water intrude into our yard several other times, usually with less than 6 inches of water reaching the carriage house on those occasions. Fortunately, because our home is several feet above those flood levels and also because we do not store personal property of high value in the lower level of the carriage house, the flooding has not caused us any significant monetary loss. Our neighbors, though, especially those abutting our property on Prindle Street, have suffered huge losses from flooding.

Nevertheless, we are extremely interested in measures, including protection of I-5, that will mitigate or eliminate flooding in our neighborhood. Thus, our interest in and these comments on the WSDOT Draft Report are offered for consideration in evaluating and/or revising proposals for flood control in our area.

Of the six proposals (four analyzed briefly and two mentioned but dismissed by WSDOT as financially infeasible) discussed in the WSDOT draft report, the one we favor is Alternative 1: I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee, reflecting widening ofl-5 to six lanes and constructing protection assuming no dam being built in the Upper Chehalis basin. Elevating I-5 in some places should be considered as an additional alternative. We favor this approach for the simple reason that protection is needed for the Chehalis/Centralia area immediately. I-5 is not only crucial to the economy of Washington State and the west coast, it is vital to the economy and lives of the people in Lewis County. Those losses to interstate commerce, as well as to the businesses and home owners whose property is flooded when I-5 is threatened, must not be allowed to be repeated over and over again.

While several years may pass before the improvements in this alternative will be completed, prospects for basin-wide agreement on any plan, let alone an extremely costly dam above PeEll is extremely controversial. Prospects for construction of a dam are both much more speculative and the timing of construction, if it ever occurs, is likely to be much later in the future.

Frankly, the savings from proceeding with Alternative 1 now regardless of the outcome of a dam proposal will save more in losses from a single flood like that of 1996, 2007 or 2009 than it will cost to construct the levees, walls and I-5 widening.

While Alternative 1 is our preferred option from among those contained in the WSDOT Draft Report, there is one aspect of that alternative we want to see changed. It reflects widening ofl-5 necessitating replacement of the overpasses at Main Street, Chamber Way and West Street. The Main Street and Chamber Way exits are less than a mile apart. A new bridge at West Street would offer no access to I-5 and serves no purpose in easing the flow of traffic on I-5. But it would have two severe impacts upon the Westside Chehalis Neighborhood.

The first is the increased volume and speed of vehicle traffic through the Westside neighborhood, particularly of large trucks. The existing bridge is narrow and has a sharp curve at its western end that makes it difficult for trucks to navigate. Widening and lengthening the bridge and its approaches will make it easy for large trucks to navigate that route allowing trucks going to National Frozen Foods and/or Sorenson Trucking's terminal on State Street to get to their destinations without having to travel by way of either Chamber Way or Main Street. And a new bridge will encourage more cars to use that route through our quiet neighborhood to get to the airport, to the shopping area along Louisiana Avenue and to the Riverside Golf Course. That increases noise in the neighborhood and the potential for children and other pedestrians to be injured.

The second negative impact of replacing the West Street Bridge is its impact upon the Westside Park and the access to homes on New York and Ohio Avenues. New road construction standards will require a replacement bridge to be much wider and higher than the existing bridge. In addition, widening I-5 will push that interstate east toward Maryland Avenue and New York Avenue south of West Street. The bridge approaches for a new bridge will block access to West Street from New York and Ohio Avenues and will either take part of the already small (3/4 of an acre) Westside Park or result in retaining walls eliminating the sidewalk that runs adjacent to the park on West Street and blocking access to the park for those living north of West Street.

Two of the proposals put forth in the WSDOT Draft Report are unacceptable. Alternative 3, the I-5 Express Lanes, and Alternative 4, the I-5 Temporary Bypass, have such a negative impact upon the City of Chehalis and the Westside Chehalis neighborhood that regardless of their costs (which are for all practical purposes unknown since the availability of the Tacoma Rail Line right of way is up in the air) that they should be rejected as politically infeasible.

Both alternatives contemplate using the Tacoma Rail right of way through Chehalis as the route for a single lane of traffic each direction. Both involve construction to a height that places the surface of the express lanes/bypass lanes, including the guardrails, some 22-feet above the existing street surfaces at Main Street, Prindle Street (and St. Helens Avenue as it joins Prindle Street where the Tacoma Rail line crosses Prindle) and West Street at State Street. Depending upon whether the option will be a temporary bypass or express lanes, the roadway through the urban development area of downtown Chehalis will be a 40 to 50 foot wide wall with vehicle and pedestrian access between the Westside and Downtown area only through the three bridge crossings at Main Street, Prindle Street and West Street.

What those two options do is bisect the City of Chehalis, separating the Westside neighborhood, including the businesses located there, from the rest of our community and permanently altering the overall nature of our city. Even worse, they result in the Westside neighborhood being completely surrounded by freeways making the area an isolated island of primarily residential development exposed to even more noise from high speed motor vehicle traffic and accompanying exhaust pollution than currently exists or would exist with a simple widening of I-5 to six lanes.

The homes in the Westside neighborhood include some of the largest, most expensive and historic homes in Chehalis. The history of our community was written by the original owners of these lovely homes - judges, bankers, politicians, prominent business leaders, etc. Evaluating Alternatives 3 and 4 looking only at construction costs, as was done in the WSDOT Draft Report, does not take into account the very real historic, cultural, social and other very important costs associated with building either of those two alternatives.

It ignores the cultural impact that will occur when either alternative severs our community. It ignores the huge impact that removing the rail service to the Wilco Agricultural Center and CENEX has on those major businesses as well as the impact upon the new Lewis County PUD electrical facility that construction of the elevated roadway there will have. It gives no consideration to the negative impact that the increased noise and pollution will have on residents of the Westside, particularly those whose homes are immediately adjacent to the proposed express or bypass lanes and to the elderly and infirm residents living at Chehalis West, a nursing home that abuts the existing Tacoma Rail right of way. And it does not take into account the tremendous loss in real property values to the homeowners living immediately adjacent to the Tacoma Rail right of way on Prindle Street, St. Helens Avenue, Division Street, Hawthorne Place and Rhode Island. Everyone else owning property on the Westside will also be damaged as a result of the inevitably loss in property values occurring because their property will be a much less desirable place in which to live if bounded on all sides by freeways and cut off from downtown Chehalis by Express Lanes or a Temporary Bypass.

We thank you for this opportunity to comment upon the Ruckelshaus and WSDOT Draft Reports. Sincerely,

Deanna M. Zieske Lewis Zieske

Response to Comment

Thank you for your comments and for your perspectives on, and preferences among, Chehalis flood hazard mitigation alternatives and the I-5 protection alternatives analyzed by WSDOT. Recommendations in the final report call for moving forward with a suite of approaches that includes further work to determine the feasibility of large capital projects (such as a dam and I-5 protection) and a variety of other actions including smaller, more local projects, programmatic approaches, and approaches that would rely on floodplain protection and enhancement.

With respect to the Westside neighborhood issues, WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Dan and Larissa Maughan 8/31/12

Our family would like to add our comments to this report. We live close to Adna WA and were greatly impacted by the Dec. 2007 Chehalis River flood. It is impossible to describe the prolonged stress and difficulties that this brought. Our major clean-up and repairs took six months and $70,000 to complete. We are in the cattle buying business and due to destruction of our fences and damage to our corrals we were unable to operate for those six months. The financial burdens are going to be long-standing. Emotionally the experience was crushing. A flood control plan that merely includes dikes to protect I-5 will put us at greater risk. There should not be a few winners and many losers in the end result of a movement started to protect the entire Chehalis River basin. We encourage those considering the different options available for flood control to work towards the combination of solutions that will help as much of the basin as possible. Dan and Larissa Maughan

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. The final report emphasizes the need for a Basin-wide approach that provides flood hazard mitigation for people and communities throughout the Basin.

Karen Valenzuela 8/31/12

Hi, Melissa. To the writer/editor of this report, compliments on the actual writing in the report. It's beautiful!! Good writers are rare and worth their weight in gold --thanks for a technical report that's lucid, easy-to-read, and nicely laid out

Comments/questions:

1. p. 1 of Executive Summary, second sentence, please say "...the Basin suffered two catastrophic floods ONLY FOURTEEN months apart..." instead of 'approximately 18 months apart.' It's important to recall that essentially two years in a row, big floods hit the Basin.
2. p. 3 of Executive Summary and p. 48, final sentence under water retention paragraph: Not ALL hydrologic analyses show these benefits of a dam (esp. the 2 feet at Montesano), so adding a qualifying sentence or phrase about what different reports and analyses show would be more accurate here.
3. p. 9 of the Executive Summary and p. 52: excellent summary of our group's discussion on what a 'Basin-wide approach' meant to each of us. Speaking in terms of 'hallmarks' or 'principles' of a Basin-wide approach is a helpful way to frame the problem.
4. p. 49, final paragraph under '...Upstream Water Retention Facilities': I think it must be said here that NO analysis shows that a dam offers complete protection from an 07-like event, and even less for an 09-like event. The proposed dam doesn't prevent flooding, it merely reduces the height of the flood. The report should be explicit about what the data/analyses of the dam show. The graph on p. 59 that seems to compare the benefits/effects of the three different project combinations, for example: doesn't this depend on which storm event you're looking at?
5. p. 60: at the end of the 'Another Way' section, I think a summary discussion of the 2010 Earth Economics report would be helpful. Here's the gist of what I suggest:
   In the 2010 Earth Economics study commissioned by the Flood Authority, "Flood Protection and Ecosystem Services in the Chehalis River Basin," the authors identify and estimate the economic value of natural systems (floodplains, forests, wetlands, free flowing rivers, permeable soils, etc) in the Chehalis River Basin, many of which provide flood protection. When these natural systems are impaired or ruined by built structures like roads or buildings, two costs are incurred: the loss of these free ecosystem services that protect against flooding, and the need to build additional structures (dams, levees, flood walls, etc) to protect the first built structures. The report identifies at least $11 billion or more worth of free ecosystem services in the Chehalis River Basin, the loss of which should be part of the calculus of any benefit/cost analysis when considering some of the large capital flood protection projects discussed in the project combinations section above.
6. The report makes nice use of photos and quotes throughout. Here's a quote I suggest be added wherever most appropriate (a photo to go with it would also be nice):

"By taking a comprehensive basin-wide approach to flood protection, inclusive of communities affected by flooding, and areas that provide flood protection, the Chehalis River Basin Flood Authority is set at the right scale to integrate flood protection with development and conservation goals across jurisdictions, industries, ecosystems and communities." [cite from *Flood Protection and Ecosystem Services in the Chehalis River Basin*, Earth Economics, May 2010]

Thank you for the opportunity to comment on this report.
Karen Valenzuela

Response to Comment

Thank you for your comments. Responses are noted below:

1 – Suggested edit was made in the final report.

2 - The report qualified the reduction at Montesano as during an "event like December 2007". Since the December 2007 flood was the largest seen in the lower watershed the report discusses benefits in that event to a greater extent than in other floods.

Flooding at Montesano during some events is due primarily to tidal conditions and as such no upstream project will have much benefit (or impact). This is the case in the February 1996, January 2009, and 100-year events where the dam reduces water levels by only 0.3 ft, 0.1 ft, and 0.7 ft respectively.

3 – The report highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions.

4 - Language on the benefits/effects of the dam were clarified based on storm events.

5 - Specific language from the Earth Economics report was added to the final report.

6 – This quote was included in the final report.

Arthur Grunbaum 7/24/12

Thank you for the opportunity to participate in the outcome recommendations on the Draft Chehalis Basin FLood Mitigation Report. We appreciate that this is a very complex project and hope our input will be of assistance in making decisions that will benefit the environment, visitors and residents of the Chehalis Basin Watershed.

FOGH is a broad-based 100% volunteer tax-exempt 501(c)(3) citizens group made up of crabbers, fishers, oyster growers and caring citizens. The mission of FOGH is to foster and promote the economic, biologi- cal, and social uniqueness of Washington's estuaries and ocean coastal environments. The goal of FOGH is to protect the natural environment, human health and safety in Grays Harbor and vicinity through sci- ence, advocacy, law, activism and empowerment.

As we all know, the Chehalis basin drains 2,660 square miles and is broken into two separate WIRAs, the upper 23 and lower 22, which empty into the Grays Harbor Estuary and the Pacific Ocean. It goes without saying that what happens upstream affects the ecology of those waters downstream. As a result the water-quality, water-quantity and timing of flow are of significant importance to the health and economic vitality of the region.

We are concerned that consideration is given to any sort of dam or water retention configuration and strongly oppose that as a solution, partial or in whole. Dams have proven to be destructive to salmon and steelhead runs. As Mark Cedergreen, CEO of the Westport Charterboat Association and advisor to the Pacific States Marine Fisheries Com- mission stated, referring to the salmon run on the Columbia River, "...its production today [is] about 10-15 percent of what it was pre-dam." The Chehalis runs are smaller to begin with and they cannot suffer a decline from their present levels.

The treaty tribes, such as the Quinault Nation depend on the delicate balance that nature provides to sustain their culture and sustinance. The natural flow of waters during flood events depends upon healthy and natural storage of wetlands and riparian areas. Any interruption of this natural process only exacerbates problems elsewhere - usually downstream.

A comprehensive review of all zoning law, exemptions and variances should be done in and around the basin drain- age area. Stringent prohibitions should be made to filling or modifying wetlands and riparian areas. Mitigation for projects should NOT be allowed out of area or kind. If the proposed project would jeopardize existing functions and values then it should not go forward.

We note that the basin is described as Forestland making up approximately 84 - 87% of the WRIAs. Considerable data has been collected and various reports have shown that large trees have a greater water storage capacity rela- tive to water use than smaller trees. We encourage that forest practices need to be enforced and special consider- ation should be given to the critical areas that lie within those permitted areas. Perhaps the cut cycle of the forest practices should be studied and a calculation used to determine the effects of water storage in trees if the cycle is increased to 80-years from its current level.We concur that dredging practices will negatively impact and dramaticlly affect flooding in the lower main stem and downstream cities. Actions which speed drainage from the upper WRIA will interfer with and potentially overwhelm the rivers, streams and other tributaries as they begin their own natural drainage system of storm gen- erated waters.

In summary
Problems with dam proposal:

1. Would not protect I-5 under all flood events
2. Highest risk for damage to ecological functions – salmon, steelhead
3. Highest cost of all proposed projects. Cost-benefit not analyzed yet
4. Limited federal funding for new large scale projects like water retention
5. Project design is still in early phase and cost estimates may change significantly
6. Need for significant additional technical and design work if the project moves forward, including for fish pas- sage facilities
7. Process for approval and construction of a dam can take 8–15+ years, with many opportunities for challenge by opponents
8. Damming rivers is the most expensive, most damaging alternative and should not be considered.

Problems with dredging:

1. Impacts for increased flooding in lower main stem and downstream cities.
2. Significant environmental impacts, damage water quality habitat, damage high quality riparian zones.

Problems with levees:

1. Levees would increase flooding in other areas.
2. One proposal for levees would only provide I-5 and airport with protection - not a Basin-wide approach.
3. Levee proposal for Twin Cities –same concerns as above – increase flooding in other areas; not Basin-wide approach.

We encourage that before any structural solutions are considered that a long view of the problem and its solutions are instituted for the long-term. Enforcement of existing wetland and forestry rules should be augmented by reviewing culverts, blockages and improper practices.

Sincerely,
Arthur (R.D.) Grunbaum, President

Response to Comment

Thank you, we acknowledge your concerns about the potential for a dam, and with potential levees and dredging. All comments were taken into consideration for the final report. Please refer to Appendix A for more detailed descriptions of the potential benefits, concerns, and implementation issues associated with specific projects, including water retention and levees. Please refer to Appendix C for a Washington Department of Natural Resources report on improving forest practices in the Chehalis basin. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. Recommendations in the final report emphasized the need for efforts to improve Basin fisheries to move forward in tandem with potential future flood hazard mitigation projects.

Cynthia and William Tahl 8/31/12

616 NW Hawthorne PL Chehalis, WA 98532

August 30, 2012

To whom it may concern:

We are writing this letter regarding the proposed 1-5 Express lanes.

Our home/property is on the Historic Westside of Chehalis, sitting approximately 125 feet west of the Tacoma rail line.

We have been resident homeowners here for 33 years. For many years the rail line was active and busy and was of little disturbance to our neighborhood or our lives. Lately the rail line is used much less and in open to the Historic Steam Train during the tourist season.

The proposed express lanes would turn our quiet historic neighborhood into an unsightly nightmare; our neighborhood would become or at least resemble an industrial area with bridges, concrete walls, noise & pollution. This would without doubt adversely affect the property values in our historic neighborhood.

While we are well aware of the need to improve access through this part of the 1-5 corridor, this

2-lane expressway is not a logical alternative. A two lane expressway would not have useful traffic flow during normal traffic days, and would be a virtual parking Jot during an emergency. Currently, with four lanes available, our area of 1-5 moves at a crawl every weekend. This expressway location is just not a viable option as it will not provide the solution sought.

Regards,
Cynthia Tahl

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Westside Chehalis Neighborhood Association 8/31/12

Chehalis Basin Flood Mitigation Alternatives Report and 1-5 Expansion, 13th Street to Mellen Street

Westside Chehalis Neighborhood Association Comments

August 31, 2012

We value this opportunity that citizens and the Tribes living within the Lewis, Grays Harbor, and Thurston County portions of the Chehalis River Basin have been given to comment on the difficult task Governor Gregoire has assigned the Chehalis Basin Flood Authority with assistance from the Ruckelshaus Center. Developing a basin-wide flood mitigation plan that addresses everyone's interests and concerns is a virtual impossibility. But giving citizens an opportunity like this to provide comments and suggestions at every stage of the planning process offers the best opportunity to achieve something at least approaching a consensus.

We also value the opportunity granted by Jim Kramer, Chehalis Report Project Manager, of the Ruckelshaus Center to favor our request for extending the comment period for its report to allow us and other communities to utilize the contents of the WSDOT Draft Report in our responses.

In November, 2011, the President of the Westside Neighborhood Association, in her capacity as a member of the Scoping Committee for the I-5 Expansion from 13th Street to Mellen Street, presented written information gathered through a series of three local meetings in our neighborhood to help WSDOT understand our views about I-5 expansion during the WSDOT early planning for exEansion ofl-5 through Chehalis. Since then the WSDOT Draft Report on I-5 Protection from 13 Street to Mellen Street has been completed and made available for comment.

Following receipt ofthe August 17,2012, WSDOT Draft Report and WSDOT's community meeting at the Veteran's Museum the Westside Neighborhood Association met again to address that report's content and to develop additional comments concerning flood mitigation planning in the Chehalis Basin.

For nearly a half-century the residents of the Chehalis Westside have worked together in an organized fashion to improve our neighborhood and foster a friendly, attractive, and safe community. The current version of that organization is a not-for-profit 501(c) corporation called the Westside Chehalis Neighborhood Association working on behalf of the more than 270 residences located on the west side of Chehalis. Our association encompasses all the residences from State Street to I-5 (east to west) and Main Street to Geary Street (south to north). While there are several businesses located within this area, we do not claim to represent them or their interests.

As residents of the Historic Westside Chehalis neighborhood who will be significantly impacted by expansion ofl-5 between 13th Street in Chehalis and Mellen Street in Centralia we on the Westside want our thoughts and recommendations about the I-5 expansion project to be considered. Because of our proximity to I-5, the disruption that will result from construction operations during the expansion work and the long-term impact that I-5 changes and expansion will have on air pollution, noise levels, traffic volume adjacent to and through our neighborhood, and the flow of water in and through our neighborhood during flooding, the Westside Chehalis Neighborhood Association invited all members of the Westside community to prioritize and voice their concerns, to discuss and ask questions, and to offered suggestions to be included within comments made on behalf of the Association to the Ruckelshaus Center and WSDOT.

As a result four significant questions arose and are presented here.

1. Should 1-5 be elevated between Main Street and just passed Chamber Way so that future floods will not cause a closure of that vital transportation route? Yes. Our neighbors expressed a very strong interest in making sure that the freeway is designed to remain open during all floods.
2. Should the planning for 1-5 expansion take into account the impact of the freeway on flood mitigation and floodplain management? Absolutely. Westside residents are very concerned that changes to I-5 should not adversely impact the extent of flooding in our neighborhood and that planning should incorporate responsible flood plain management considerations. Dillenbaugh Creek is the source of our south side flooding.
3. Should dense and oversized sound barriers be installed to reduce noise impact on the Westside neighborhood? Yes. We are very much in favor of adequate noise control measures being included in the I-5 expansion project, including installing oversized sound barriers. Foliage such as trees and plants also would quell some of the sound.
4. Once the West Street Bridge is removed to allow the widening and relocation of1-5,should the West Street Bridge be replaced? No. Not replacing the West

Street Bridge was strongly favored. Eliminating that bridge would significantly reduce itinerant traffic speeding through the neighborhood and increase neighborhood cohesiveness. We are not interested in a replacement of West Side Bridge over 1-5 ending in a roundabout at Louisiana, especially one costing more than $6,000,000.

Specific Ideas Put Forth at Neighborhood Meetings

Specific ideas and/or recommendations offered by those attending the neighborhood meetings are listed below.

Designing for Handling Water Flow

- Make a concentrated effort to pursue funding for the elevation of and the I-5 expansion because it surely will flood again and again, continuing to destroy and damage residences and businesses through this corridor.
- Protect and keep the Westside Residential Neighborhood safe from flooding, air and noise pollution. Protect and keep the Chehalis River healthy.
- Elevate I-5 from Main Street to Chamber Way allowing water to collect and flow away from the roadway while protecting the residential neighborhood.
- Planning for I-5 expansion should make use of Preliminary FEMA Maps.
- Homes on Prindle Street near I-5 are the ones that flood in virtually every flood incident.
- We propose that the State purchase at fair market value all homes on Prindle Street West from Quincy Street to I-5. But leave the existing alley to allow access to the City of Chehalis Pump Station and for St. Helens Avenue home owners' access to the back of their property.
- For drainage dedicate the vacated property on Prindle Street for a large retaining pond, not for any further development of or expansion to Liberty Plaza.

Noise Control

- Retest Sound Density levels emanating from I-5 into the Westside neighborhood.
- Build extra tall and dense sound barriers for the residential neighborhood beginning at Main Street and extending to Chamber Way.

- Maintain the elevation of West Street as it currently exists and Dead End West Street at New York Avenue.

West Street Bridge & West Side Park

- Historically this % acre park was part of an elementary school playground. During the 1949 earthquake the school suffered extensive damage and as a consequence demolished. What remained became the West Side Park. The present West Street Bridge with the narrow lanes and extreme curve at its western end was constructed in the 1950s.
- Following its removal, do not replace the West Street Bridge with one designed for the use of autos or trucks. Rebuilding and extending West Street and the Bridge will disturb, widen, and invite even more unwanted speeding traffic to cut through our neighborhood. Not replacing the West Street Bridge will eliminate West Street as a dividing barrier in our neighborhood.
- Construct a handicap accessible covered pedestrian/bicycle bridge over 1-5 from West Street to the Airport Loop Trail
- Don't encroach upon the existing West Side Park. Where homes on New York Avenue are removed for I-5 expansion use the vacated property wherever possible to enlarge West Side Park

Other Suggestions

- Add a cul-de-sac to every dead end street for emergency vehicles access.
- Prindle Street dead ends at I-5 and currently does not have a cul-de-sac as required or any place for emergency vehicles to turn around.
- Several of the homes nearest to I-5 in the areas flooded have been raised as a form of flood mitigation. But the ones closest to I-5 are vulnerable should large vehicles go out of control and veer off the freeway toward the east. Some sort of protective barriers need to be installed to protect those homes.
- Maintain our neighborhood character. It is a National Historic District with a friendly and cohesive neighborhood character.

WSDOT Draft Report: 1-5 Protection from 13th Street to Mellen Street

It is imperative in making progress on this extremely complex and emotional project that we remain calm and explore the options laid out before us and perhaps some that have not been mentioned. We believe one option WSDOT states is not viable because it is cost prohibitive does deserve consideration. That option, elevating I-5 for a limited distance between Main Street and just past Chamber Way is one that could have an impact on flooding because I-5 does cause closure from flooding for that distance. Combine that option with the New SW Chehalis Levee allowing the flood waters to run freely under I-5 while protecting homes and businesses.

While varying opinions regarding flood issue combinations were obvious, there is no doubt that two alternatives provided by WSDOT got resoundingly and unanimously rejected at our neighborhood meeting! Both Alternative 3, I-5 Express Lanes, and Alternative 4, I-5 Temporary Bypass, prompted the most vigorous discussion. The end result of that discussion are the following: No, No, and No!

Either of those alternatives negatively affects our entire community is drastic ways without offering significant benefits to mitigating flooding or protecting I-5. The WSDOT Draft Report at page 20 states, "However, the lanes likely would be visible from some homes on the edge of the West neighborhood in Chehalis. A noise study has not been conducted yet, but cost estimates for the project include funding for noise walls in the event they are needed." That statement comes nowhere near describing the adverse impacts of those two alternatives.

Express Lanes and Temporary Bypass Lanes at 22 feet in height and at least 50 feet width with bridges at Main Street, Prindle Street at St. Helens Avenue, and West Street at State Street would be visible and heard from most Westside streets, not to mention home owners' private property they would invade. Residents of some historic streets directly affected by the ugly sight and sounds of Alternatives 3 and 4 are West Street, Rhode Island, Hawthorne Place, Division Street, Quincy Place, St. Helens Avenue, Prindle Street, State Street, Pennsylvania Avenue, Gertrude Street, Folsom Street, and Westside Park.

Tacoma rail line traverses through the Historic Westside Neighborhood, Historic Downtown Chehalis, some industrial area, and under the Chamber Way Railroad Bridge. Is the rail line wide enough, is the existing Chamber Way railroad bridge high enough, and does it flood there are additional questions not even addressed in the WSDOT Draft Report.

Thinking about Express Lanes, Temporary Bypass Lanes, and a bigger than life West Street Bridge isolating the Historic Westside makes one know how the citizens of Kalama, Washington, must have felt when I-5 bisected their city.

The Lewis County Historic Museum, located in the former Burlington Northern Depot, sits adjacent to the Northern Pacific/Burlington Northern main line at the intersection of Market Boulevard and West Street. The museum offers the *Pennsylvania Avenue - West Side, National Historic District A Public Guide,* as a *walking tour* beginning at the downtown Chehalis Museum crossing the tracks and up West Street into our neighborhood. In part it states,

"The National Register of Historic Places is the federal government's official list of cultural resources worthy of preservation. It was authorized by the National Historic Preservation Act of 1966 and is part of a program to encourage public and private efforts to protect historic and archaeological resources. Properties listed in the National Register include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and culture. The National Register of Historic Places is administered by the National Park Service, United States Department of the Interior, Washington, D.C." Why would any Municipality or State authorize interstate express lanes/temporary bypass lanes with unhealthy, unsightly bridges or promote the deterioration of a National Historic District by building an unneeded hulking ugly West Street Bridge through the middle of that Historic District?

To add some perspective to our concerns about the impact that WSDOT Alternatives 3 and 4 have on our community we have included as an attachment to these comments a series of photographs of the area where the bypass or express lanes would traverse.

At our most recent meeting to discuss the flood mitigation planning that is going on participants offered the following specific comments about the WSDOT alternatives contained in its Draft Report.

There are essentially two issues associated with protecting the Chehalis Basin from flood damage: the issue of flood damage and the issue of keeping transportation and commerce flowing through the area on I-5. The flooding issue may best be addressed through alternatives like a retention dam, but ifWSDOT cannot wait to protect I-5 until after retention dam is completed then the Westside residents of Chehalis would prefer

Alternative 1 from the WSDOT Draft Report.

- If Alternative 1 is adopted the residents of the Westside Chehalis Neighborhood recommend that the existing West Street Bridge not be replaced. That opposition arises because replacing that bridge with a higher and wider bridge will result in substantially increased traffic through our neighborhood, particularly by commercial vehicles and large trucks. Construction of approaches to a raised and widened West Street Bridge will also block access to West Street from New York and Ohio Avenues and will likely cause loss of some of the land that is currently occupied by the Westside Park. A bridge blocking New York and Ohio Avenues due to extended ramping will also preclude access from West Street to those two residential streets from either direction by emergency vehicles and residents.
- If either the Express Lanes or Temporary Bypass alternative is adopted residents of the Westside Chehalis neighborhood will have their real estate property values negatively impacted. If this is the direction taken then those property owners would like a "buy out" option under which they can be compensated for the lost value or have their property purchased outright at fair market value. That option should be available to all property owners on the Westside, not only to those whose property is immediately adjacent to the Tacoma Rail right of way or whose land may be used in part for construction of the new roadway.
- We don't like the idea of a being "blocked in" and set apart from our City of Chehalis.
- If the proposal for either express lanes or a temporary bypass is adopted it will lead to extensive litigation by opponents.
- NOISE! NOISE! NOISE! Express lanes will dramatically increase noise and pollution levels in the Westside neighborhood caused by trucks and automobiles. The noise will be coming at us from both the east and the west as we will be surrounded by I-5.
- Look at the west side ofl-5 for solutions to protect that arterial.

At our most recent neighborhood meeting we also received the following comments associated with Chehalis Basin-wide proposals to mitigate flooding.

- A Basin-wide approach to flooding problems is so far off in the future and there is so little agreement about what options for addressing flooding throughout the basin that WSDOT is going to be forced to protect I-5 from flooding before a basin wide plan will ever be agreed upon or funded.
- The Proposal for a Retention Dam Near PeEII

If a retention dam near PeEll is to be seriously considered as a basin-wide approach to flood mitigation it is important that the residents of the entire basin, but especially those in the PeEll area, be educated about and involved in the planning process from start to finish.

The cost estimate for the proposed dam near PeEll, an earthen dam, 300 feet high and *Yz* mile long, for water retention is most likely too low. The proposed PeEll Dam site is approximately 2 miles from town and not in sight from town. Warning systems and evacuation plans for the 700 residents and about 300 school age children are concerns.

There are residents of the Chehalis Westside neighborhood who do and those who do not favor a retention dam as a way of reducing flooding below the dam site.

A retention dam may be a good idea and it may help solve flood problems in the basin. But it does not solve the I-5 flooding problem.

- Other Comments Offered for Dealing With Potential Flood Damage

Improved timber practices, including management of harvested timber, need to become part of any proposed Basin-wide approach to Chehalis Basin flooding.

- Any Basin-wide approach to flooding must also address flooding that is caused by groundwater levels that have increased during periods of flooding causing flooding from water intruding from beneath the ground's surface in low lying areas not otherwise affected by surface water flooding.

Respectfully submitted on behalf of the Westside Chehalis Neighborhood Association,

Deanna M. Zieske Psresident
P.O. Box 1272
Chehalis, WA 98532
August 31, 2012

Response to Comment

Thank you for your comment and for your perspectives on, and preferences among, the various Chehalis flood mitigation alternatives and the I-5 protection alternatives analyzed by WSDOT. With respect to the Westside neighborhood, WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Ted and Darlene Held 8/31/12

I-5 Protection from 13th St. to Mellon Street

My husband and I live in the Chehalis West Side area and belong to the Westside Chehalis Neighborhood Association. We have become very concerned with proposed alternatives being considered for flood protection and have attended the public community meeting hosted by WSDOT at the Veteran's Memorial Building in Chehalis and a meeting at our local neighborhood association on August 28th.

After considering the alternatives with the information presented, we feel we cannot endorse the temporary bypass or the express lanes. The only plan that we feel might be worthy of considering would be the earthen levy as it could keep our neighborhood from suffering from the flooding that has been an issue in the past. While our home has not flooded, we have had many neighbors and friends that have and they still are suffering. Some have not completed restoration of their home and property yet.

The temporary bypass or the express lanes would be an eyesore and a barrier that would cut off this area from the historic downtown shopping area and could create two towns. It would cause lost revenue to the already struggling small businesses. I speak from experience as we sold our business seven years ago, and during the 22 years that we owned it we found that something as minor as a change in the weather would affect our sales. The bypass/express lanes would also cause air pollution, noise and a decrease in our property values.

Please take these issues into consideration. We do not have the answers, but don't feel these are either.

Ted & Darlene Held
451 NW Division St.
Chehalis, WA 9853
August 31, 2012

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Marion Ruth 8/31/12

Melissa Kuehne • Ruckelshaus Center WSUWest
520 Pike Street Suite 1101
Seattle WA 98101

Dear Ms Kuehne,

I attended a meeting of the Westside Association regarding the flood mitigation Report A. We did not learn about other options but I wanted to be sure you knew my feelings about the one presented. I had to leave the meeting early but my husband stayed and said the audience when polled were mostly against the I-5

Express lanes or Temporary Bypass. (I have attached the picture we were given.)

In my opinion it would ruin our very nice historic district. The raised two lane expressway would look so poorly with the rest of the neighborhood. The district is made up of three blocks of all maintained homes with tree lined streets. Our property values will really suffer with an elevated expressway as you enter the neighborhood.

We formed our Westside Association years ago in order to maintain the District and improve what we can. Recently we added flowering fruit trees to our playground. We payed for this with money raised at the holiday tour of homes we which we sponsored for several years. When we requested to be on the State register of historic homes the gentleman who came and evaluated the neighborhood told us it was the best in the state because all the homes were together in one place and were so well maintained for the period in which they were built. Some go back to the early 1900's.

Please consider other plans and let us keep our district the way it is now.

Sincerely,
Marion A. Ruth

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Lewis County Commissioners 8/31/12

LEWIS COUNTY COMMENTS

THE RUCKELSHAUS CENTER CHEHALIS BASIN FLOOD MITIGATION ALTERNATIVES REPORT

GENERAL:

1. We, the Lewis County Board of County Commissioners, having reviewed the Ruckelshaus Center Report, note the thorough and objective process through which the document was prepared. We want to compliment all of those who contributed to this document which we believe helps the public to understand the complexity of the problem.
2. We do want to note that this Report is a compendium providing background and analysis on a number of alternative projects stipulated in ESHB 2020, Section 1033, and is not intended to be the definitive recommendation as to the approach to achieve "The Best Basin Wide Solution to Flooding." For that reason we will make comments on each of the alternatives, separately, and leave the discussion on what combinations of projects are the best alternative to a basin wide solution to the Governor's Ad Hoc Committee.
3. The Chehalis River Basin, as the river wends its way down the 125 mile main stem, creates unique problems for the residents in each of its major segments: Upper, Middle and Lower Basin. We in Lewis County are impacted by those problems created in the upper basin which is characterized by mountainous terrain and narrow valleys in the west and emptying into a broader more populated plain in the I-5 corridor. This area has been subjected to numerous 100 year or greater floods (the most recent being in 1990, 1996, 2007 and 2009) which have closed I-5 and caused millions of dollars in damages (over $500 million in the 2007 flood).
4. The report does not fully communicate the impact of flooding in terms of human suffering, damaged property and livelihoods. Breaking the cycle of disaster, discussion, and inaction requires a shared understanding of the impact of an event such as the 2007 flood. Without a shared understanding – up and down the River – of the cost of flooding, including in particular the human cost, we will find it difficult to reach a common understanding on how to address flooding.
5. The costs tallied by think-tanks, accountants or mathematicians do not include suffering, broken lives, or other impairments of human capital such as the diversion of available savings from a planned college education to rebuilding or refurbishing a business or residence. The impairments to existing human capital are already greater in the Basin communities than in the Puget Sound area or other urban communities in the State. Grays Harbor and Lewis Counties and the rural areas of southern Thurston County already suffer among the highest unemployment rates in the State and among the lowest rates of educational achievement. The additional diversion of household and public capital to rebuilding from flooding required by "living with the river" reinforces these underlying trends.
6. The report needs to include a paragraph that expresses the magnitude of the 2007 flood. For example, in June we were informed that 300,000 acre feet of water flowed by Grand Mound during five days of the 2007 flood. We also were given the visual that 300,000 acre feet of water is the amount of water that would cover I-5 with a column of water one-half mile wide and five (5) feet deep from Portland to Seattle, a distance of approximately 180 miles. That kind of visual, given the common experience of the public in travelling between the two cities, would help the public to understand the magnitude of the problem in weighing the suggested solutions.
7. Anyone who has lived through one of these events understands the tragedy created by flooding and the compelling need to put an end to a preventable cycle of flooding. There have literally been 100's of studies conducted on flood mitigation, with none to date providing any relief. The public is tired of studies and want to see solutions implemented.

8. Throughout the document, there are assumptions based on hydraulic or other models. These models predict potential outcomes based on scenarios that are to be analyzed. These model runs are based on assumptions and the results are not hard facts. We suggest whenever the potential effects based on a model are described, the results should be clearly stated as potential, using such terms as could, may, might, possible, probable, anticipated, etc., rather than absolutes such as will or would. For example, on page 5 of the executive summary, in the first paragraph: "Protection of I-5 and the airport provides collateral flood hazard mitigation to homes and business in some parts of the Twin Cities and increases flood elevations in some other parts." This sentence relies on modeling to suggest that protecting I-5 may protect other areas and may pose risk to other areas. The key here is "may." Models have a built in margin of error and are only predictive models. Model predictions are not exact results or outcomes, especially in a dynamic situation with many variables. They are an educated guess as to the potential results of any particular scenario based on the assumptions used to build the model. In such cases, the report language should reflect such uncertainty by using appropriate language to convey uncertainty rather than some absolute fact. That being said, the above sentence should more appropriately read: "Protection of I-5 and the airport may provide collateral flood hazard mitigation to homes and businesses in some parts of the Twin Cities and may increase flood elevations in some other parts." The entire report needs to be reviewed to make sure that potential or even probable outcomes are not portrayed as absolutes.
9. The FEMA maps based on the recent floods are draft maps and have not been finalized or approved. The 100 year flood maps are preliminary. Throughout the report, such as on pages 4 and 51, the draft maps are assumed to be the regulatory maps. References to the 100 year event or 100 year floodway or floodplain should be to the "adopted FEMA flood maps", "adopted 100 year floodplain" or "adopted 100 year flood level." In such cases, such as on page 4, speaking to the raising of the Chehalis Airport levee, the levee is proposed to be constructed to an elevation three feet above the "adopted 100 year flood elevation."
10. Additionally, the report does not describe the differences that exist among the communities on the River that, in the past, have prevented a consensus on how to address flooding and its consequences. However, the report can and should highlight, to a greater degree than it does, the singular achievement of bringing these disparate communities "to the table" to participate in this discussion and to reach a decision.
11. An issue which is not addressed in the Ruckelshaus Report, and was raised in ESHB 2020, is future governance over flood mitigation in the Chehalis River Basin. The current Chehalis River Basin Flood Authority is a loose collective of twelve government jurisdictions bound together by an Interlocal Agreement. It does not include all of the government jurisdictions in the watershed, and it specifically does not include the Quinault Nation or the Confederated Tribes of the Chehalis Reservation. It is not a municipal corporation so the function of managing money and projects is provided by Lewis County acting as fiscal agent. The Flood Authority hired a consultant, FCS, who conducted a year plus study on governance; however, implementation dissipated over "trust" issues and no agreement was reached. We are now at a point where at least some funding for projects and project maintenance will need to come from local resources; and, procedures for approving projects that are shared by or impact multiple jurisdictions will need to be promulgated. There are several options: a Basin Wide Flood Control Zone District, County Flood Control Zone Districts bound by Interlocal Agreement; County and Municipal Jurisdictions bound by Interlocal Agreement, etc. This issue needs to be addressed.

WATER RETENTION PROJECT ON THE MAINSTEM:

12. It is not viable, as stated in the report, to raise or relocate all residences and businesses from the floodplain. It may not be possible to prevent the repetition of widespread destruction by enacting new land use restrictions, restoring wetlands, removing the Airport area, or installing several small diversion dams, because the sheer volume of water draining through particular points in the Basin at the height of a 100-year flood event will overwhelm the protection provided by those measures.
13. From our perspective water retention must be a part of any basin wide solution. During the 2007 flood event 376,000 acre feet of water flowed passed the confluence of the Chehalis and Skookumchuck Rivers during the seven day flood, with approximately 64,000 acre feet of water effectively stored (dammed) in the I-5 corridor behind the Mellen Street choke point at the peak of flooding. There is no solution that will work for us unless we can hold back at least 80,000 acre feet of water from entering into the main stem of the Chehalis River. Further, the narrow valley and population base provide no alternative diversion projects that will work. We believe that the studies conducted to date by the Lewis County PUD, EES and Anchor QEA have shown that building a diversion or multi-purpose dam is feasible, that there are no "fatal flaws," and that mitigation can be provided against damage to the fish population. In addition, water retention is the only solution which provides some degree of protection to everyone in the basin.
14. Unless and until the necessary geological, biological and other studies are undertaken and completed as part of the permitting process for a dam, no one can confidently predict the impact of a dam on the environment. Moving forward does not require final or irrevocable approval of an alternative. For example, the decision may be made to begin the permitting process on a proposed retention facility without committing irrevocably to completion of a dam. The permitting process will require the completion of geological, fish, and other studies long before any excavation is made at the proposed site. If those studies establish the lack of viability or safety issues of the facility, then no construction of the facility will ever be undertaken.
15. We acknowledge that the decision to move forward on water retention is dependent upon additional studies on location, design and safety of a dam which will be so close to Pe Ell; and, we will have to further study fish mitigation options before we will receive buy-in from all of the Flood Authority members, state and federal government agencies and the Native American Tribes. However, we do think the evidence shows that water retention is the only solution that works for the upper basin and provides benefit to most of the rest of the basin. It is time to take the next step. We also acknowledge that water retention alone will not solve the problem and that other mitigation projects will need to be implemented throughout the basin, including the upper basin.

PROTECTION OF I-5 AND THE CHEHALIS-CENTRALIA MUNICIPAL AIRPORT:

16. This is probably better identified as the Washington State Department of Transportation (WSDOT) set of six proposed projects, along with improving the Airport levee to 100 year protection, to provide protection against flooding and closing of the Interstate during a flood. Two of the proposals were thrown out as being too expensive. However all of the projects were without benefit of water retention and while protecting the freeway, they did not provide substantial protection to the population living in the corridor. Protecting the freeway and not the population is just plain NOT ACCEPTABLE!
17. Of the six alternatives, the only one in our perspective which has any merit is Alternative 1: I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee; however, we do not believe it can be a standalone project. We believe that a water retention project needs to be included and then the scale and location of levees and walls can be substantially reduced both in size and location. Several of the proposed projects in this alternative, especially those from the south end of the Airport Levee and running south to 13th Street should be looked at in developing a protection plan for the corridor. We

think previous plans to divert Dillenbaugh Creek into the Newaukum River further south still are worthy of consideration; however, no plan is workable without including water retention as part of the plan.

18. Alternative 2: <u>I-5 Raise and Widen Only</u>, Alternative 3: <u>I-5 Express Lanes</u>, and Alternative 4: <u>Temporary Bypass</u> are clearly unacceptable because they are only variations of protecting the freeway from flooding without mitigation of the impact to the surrounding residents in the inundation zone. We have said from the very beginning that a solution which leaves the freeway high and dry while leaving our residents in a bathtub below is not our idea of fixing the problem –and Governor Gregoire has promised us that would not happen.
19. We are very skeptical of the accuracy of the hydrology impacts reported by WSDOT, both from the perspective of downstream impact and the inundation maps provided as appendices. There have been extensive studies conducted by the US Army Corps of Engineers (USACE) in their 16 year study of the Twin Cities Levee project that indicate that a levee protecting the I-5 corridor and the Twin Cities would force water through the Mellen Street Choke Point sooner and in greater quantity. For that reason the USACE included additional water retention at the Skookumchuck Dam to provide mitigation against this increased flow.
20. WSDOT's predictions of increases in downstream elevation (from Mellen Street) of 0.1 to 0.2 feet are simply not believable. Furthermore, the inundation maps give an optimistic picture of reductions in flood elevation in the I-5 corridor on the east side of the freeway of 1.4 feet. The fact is that a substantial amount of land on the east side is inundated and some of it substantially. In the 2007 Flood parts of the Fairgrounds were in 12 feet of water so a reduction of 1.4 feet would still leave that area under almost 10 feet of water.

US ARMY CORPS OF ENGINEERS LEVEE SYSTEM AROUND CENTRALIA AND CHEHALIS:

21. For all intents and purposes this project is as good as dead. After 16 years, and millions of dollars in expenditures, USACE determined that this project did not meet their cost-benefit ratio and should be terminated. We could argue about the veracity of the USACE cost-benefit model and the merit of project components (Skookumchuck Dam modifications) and/or restrictions (not building levees to 100 year protection) which guaranteed failure. But the fact is that project design at 35% plus completion was laden with deficiencies that either left significant population or commercial areas inundated or created new areas of inundation. We believed from the start that the minimum additional water retention (11,000 acre feet) was insufficient and in the wrong location. We believe that the project could have been significantly downsized and could have provided better protection to both the freeway and population if it were combined with at least 80,000 acre feet of water retention on the main stem of the Chehalis River.
22. The one component of the project that deserves further consideration is that it provides a federal source of flood mitigation funding and the magnitude of any basin wide solution would benefit from federal funding. However, we are concerned about the alternatives the USACE has presented on how to proceed.
23. The first is: <u>Terminate the project; flood mitigation might be pursued under the Chehalis Basin General Investigation (which would require a local sponsor) or as smaller components under the Continuing Authorities Program (CAP) authority</u>: There is already a General Investigation (GI) on the Chehalis River for Ecosystem Restoration. A two year attempt to add flood mitigation to this GI resulted in a projected timeline of 14 years and $14 million dollars in study costs. There have been hundreds of studies in the basin, including those of the USACE, yet the USACE insists on going back to base line and starting the study from scratch each time there is a change of focus. Whether we do a combined GI, or we do a flood mitigation focused GI, we do not believe it is necessary to throw out what we already know and start all over again. The CAP program is not an alternative because it is restricted to projects under $7 million and there is currently no funding anyway. Our experience is that this is not the route to take.

24. The second is: Fully reformulate the project under a General Reevaluation Report: If it is possible to get federal funding, then we think this is the route to pursue. We believe that there are salvageable parts of the original project; however, the focus of water retention needs to be larger and on the main stem of the river; and, with better water retention the need and size of levees in the corridor could be drastically reduced. We do believe that to be successful Congressional intervention with the USACE will be required to both scope and approve a federal appropriation.
25. The remaining options: Conduct a limited Post Authorization Change Report and remove unjustified separable elements or modify separable element to a level where they are justified, and Move forward with a Post Authorization Change Report concurrently with a Basin wide flood risk management study under the Chehalis Basin General Investigation, in our estimation, are not workable. The project as proposed does not provide the needed level of protection and removing or modifying elements would only result in further deterioration of protection. Moving forward with a Post Authorization Change Report in conjunction with another GI would just return the project to the slow and costly USACE process without promise of any results in the near term.

OTHER FLOOD HAZARD MITIGATION ALTERNATIVES:

26. We are aware that there are different problems to be addressed on the river other than our concern about developing water retention and protecting the I-5 corridor. Certainly, solutions that focus on the I-5 corridor alone do not address our concerns in the basin up-river of the corridor; or, for that matter, either impacts down river or other local problems in the middle and lower basin. We believe we should be good neighbors and make sure that our projects mitigate downstream impacts. We also believe that a basin wide solution must address all of the concerns in the basin and that the process of achieving a solution will be long term. For that reason we would be open to investigate any projects that will provide local protection and contribute to the eventual objective of a basin wide solution.
27. Some of the solutions will be more difficult than others. Obviously there are opponents to both dredging and flood water bypasses that will impede and cripple the approval process making pursuit not practical. There may, however, be some level of dredging or “soil modification” in parts of the river that provide mitigation and may be doable.
28. There are many other projects that can be accomplished separately with a net benefit to flood mitigation and we would fully support such projects. We also believe that achieving a basin wide solution is a long term project and that we will have to achieve parts of the solution incrementally. We will support any projects which have been properly planned and for which there is basin wide consensus that the project contributes to a basin wide flood mitigation plan. In other words, we support the Hallmarks of a Basin-wide approach presented in the Ruckelshaus Report.

F LEE GROSE	PW “BILL” SCHULTE	RON AVERILL
Commissioner, District 3	Commissioner, District 2	Commissioner, District 1
Chairman	Vice-Chairman	Member

Response to Comment

Thank you for your comments and for your perspectives on, and preferences among, the various potential Chehalis flood hazard mitigation projects and approaches. The report attempts to fully communicate the impact of flooding in terms of human suffering, damaged property and livelihoods, and efforts were made to amplify this further in the final report.

The final report recognizes that this hydraulic model, while an improvement over past efforts, still has areas of uncertainty and potential inaccuracy, and that additional improvements should be considered for the future. The final report also recognizes that the model predicts potential outcomes and reinforces this point by more consistently stating model results using terms such as probable, anticipated, and possible.

The final report has also been edited to more completely describe the changes in flood elevations that are predicted in different types of storm events, and reinforces the overall point that flood elevations in the Basin can vary significantly based on the type of storm event.

References to the 100 year event or 100 year floodway or floodplain are now referred to as the "adopted FEMA flood maps", "adopted 100 year floodplain" or "adopted 100 year flood level."

The final report continues to acknowledge the diversity of concerns and perspectives on the dam, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions.

The report has been edited to more adequately cover issues related to future governance over flood hazard mitigation in the Chehalis River Basin.

The report now better reflects concerns that if the Twin Cities project is terminated, the Basin may no longer have as ready access to that form of federal funding, and acknowledges that there are potentially enough cost-effective parts of the existing project or appropriate revisions to reformulate it under a General Reevaluation Report.

With respect to the WSDOT alternatives, the legislative purpose of the WSDOT report was, as the commenter notes, only to evaluate alternative projects that could protect I-5. The full Chehalis Basin Flood Mitigation Alternatives Report addresses other potential projects, including a dam on the upper mainstem Chehalis, in detail. The final WSDOT report more clearly defines its intent and context and more clearly reference the full alternatives report for more information. It also more clearly describes the potential effects of a dam relative to I-5 protection alternatives, including a clear statement that a dam would lower flood elevations throughout the Basin and would, therefore, reduce the amount of effort needed to fully protect I-5 during major flooding and the costs of I-5 protection.

WSDOT acknowledges the conditional support for the walls and levees alternative as preferable to other alternatives discussed; although WSDOT's charge and the purpose of WSDOT's analysis is to evaluate potential project to protect I-5, the Department did attempt to optimize preliminary project design wherever possible to provide collateral protection of communities and infrastructure. Additional actions will be needed for community protection, and I-5 protection alone is not a path forward that is supported in the community. WSDOT recognizes the significant support, expressed by this and other commenters, for water retention as part of a package of protective efforts. WSDOT agrees that it is extremely important to identify the right measurement for freeboard. The right amount of freeboard will provide confidence that, no matter what flood protection measures the legislature directs WSDOT to build, they provide protection for predicted floods in the project area.

The primary reason the Walls and Levees alternative do not show as large an increase in downstream elevation as the Corps Twin Cities project is that the Walls and Levees alternative does not include all of the levees in the Corps Twin Cities project. In particular, the Walls and Levees project does not include the Galvin Road levee. The Walls and Levees along I-5 alternative would restrict flow from passing to the east side of I-5 and into the Twin City area during significant flood events. Under the current conditions, (i.e., without the walls and levees), Chehalis River flows are stored and conveyed along the east side of I-5 during large storm events such as the one that occurred in December 2007. By placing walls and levees along I-5, the amount of water flowing from the Chehalis River to the east side of I-5 would be reduced; a greater portion of floodwater would stay between I-5 and the western valley wall. This water does eventually pass downstream, although some of the flow is temporarily backed up behind the Mellen Street Bridge, a narrow point (constriction) in the floodplain. When the airport levee is raised in conjunction with the I-5 Walls and Levees alternative, an additional location of floodplain narrowing occurs, further backing up flood waters. Under these scenarios, the flood elevations along the Chehalis River are predicted to increase up to 1-2 feet for the December 2007 event at some locations between I-5 and the western valley wall. The increase in water surface elevation is predicted to be on the order of 1 foot for the 100-year event.

The predicted change in water surface elevations downstream of Mellen Street and the Chehalis River/Skookumchuck River confluence caused by the Walls and Levees alternative is significantly less during events such as the December 2007 and 100-year floods when compared to the change upstream of Mellen Street. This is due, in part, to the narrow opening at Mellen Street which limits downstream discharges. The timing of flows in the Chehalis River and their coincidence with Skookumchuck River flow is also affected. Simulations indicate that the change in downstream water surface elevations are on the order of plus or minus 0.1 feet. Larger changes in water surface elevations are seen in the area downstream of the Chehalis River/Skookumchuck River confluence with other combinations of flood protection features, such as the Corps Flood Reduction Project. Part of the reason that the Walls and Levees alternative does not cause much of a rise downstream of the Skookumchuck is that the proposal does not include any physical changes to the floodplain in this area and as such, the flood flows are free to spread across the entire floodplain as they currently do.

Helen Holloway 8/31/12

① Aug. 29, 2012

Melissa Kuehne -

I have been asked to write about our experiences during the 1996 flood. My typewriter drowned and I have resorted to longhand since then.

My name is Helen Holloway - 823 J St. Centralia, Wa 98531 - 360-736-2296 and I am 87 years old.

The weather was horrible for days - cold, windy and very heavy rain. We awakened on Feb. 8, 1996 to very high winds and heavy rain and I noticed the ceiling was leaking just above the dinette windows. I called the roofer who would come the next day. The rain was unrelenting.

Just after lunch I called the fire department to inquire about the condition of the Skookumchuck and Chehalis rivers, just blocks away from our house. I was told to leave immediately and go to the shelter at the Edison School two blocks from our home. The dike - four blocks north of us on the Skookumchuck River was giving way.

That night about 7 P.M. the dike broke and the water washed out the ground under the railroad tracks two blocks north of us and we flooded. The tracks

saved us on several occasions from possible flooding.
We spent Feb. 8 & 9 at the shelter and decided to check on our house. Our house was a half block from our Pastor's which was higher & only had his basement flooded and the sump pump took care of that.
Our house was at the lowest section of "J" street and had a foot of water, sewage, petroleum products, garbage and who knows what else. The smell was awful!
Our garage and a small storage building out back each had 2½ feet of water. We could not get to our house on the 10th and just stood and looked on in horror. We were invited to stay with the Pastor and his family the 10th & 11th. Our cars were safe parked at the center so they were saved.
Our grandson-in-law came back on the 11th and tore out all the carpet and it was taken to the space between the sidewalk and the street. The pile of debris got about five feet tall. We had just had insulation installed under our house we had to tear it out so we could have the floor start drying. It joined the carpet. Later that pile was about six feet high with all that flooded along with appliances. Later the city came with dump trucks and removed all the trash.
It took about 2 weeks before the wate

(2)

went down in the back yard. Only then could we begin to clean the garage and the storage shed which held several generations of treasures and pictures.

On the 12th we decided to go home. We were able to turn on the furnace and start drying out the house. Our furnace ran day & night for three months. Then the night-mare of clean-up started in earnest. The dump trucks would remove piles of debris and we would continue to make more piles - it was endless.

Unless you have lived through a flood you can't imagine what it does to your home, health, - mental & physical and your life savings. The cost to us was over $50,000 plus the funds we received from FEMA. We had NO FLOOD INSURANCE. We bought insurance in July of '96. We have been insured since then - I have been paying premiums that went from $300 per year to over $1550 for the past 10 years. My husband died three years ago and those premiums are harder and harder to pay.

We worked for 13 months - cleaning, sanitizing, replacing and repairing. All our floors were replaced. Our first job was to put in all new windows as only two could be opened. Wall paper paste became moldy and the paper fell off the walls. Our floors never got dry enough until Sept. to start replacing the floors.

My husband and I lost weight - there were days that we couldn't eat because we both cried over all the irreplacable keepsakes we had to take to the pile. For months we started our day by not even knowing what to do next. Family helped carry out garbage to the pile, Church helped clear and sanitize garage floor. We finally decided to work alone It was easier than directing help who didn't know where to start or what to do.

We dried furniture and though it didn't look as nice as before we had to make do. We used gallons of Purex. Every thing had to be sanitized. Every room - nook + cranny had to be cleaned, sanitized and repacked

After months of just plain back-breaking work and sadness - came the workmen who replaced floors - walls and began the actual putting the house back together. There was endless furniture moving from one room to another. Each room had to be absolutely empty as we floored painted or cleaned and returned furniture.

After 13 months we began to see some return to normalcy. I was in my 70s and

(3)

my husband was in his 80s when we flooded. We only had a foot of water in the house - and I know that doesn't sound like much! One cannot believe what damage a foot of water did & cost us.

Why can't the rivers be dredged and retention dams be built? They did it in Oregon - it worked! We live in the same country. Let's keep spending years, and millions for studies, planning and arguing while the flooding increases and the damage is astronomical. Please somebody Help!!!

I left my home 3 times in the past 7 years fearing flooding. Thank God when I got back all was well — other's weren't that lucky.

Helen Holloway

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. The final report acknowledges the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. Dredging as a alternative to mitigate future flood damages is discussed in Appendix A.

Michael Smell 8/31/12

21 August 2012

Vickie Raines
PO Box 2007
Cosmopolis, WA 98537

Hello:
Congratulations on being appointed to the Governor's Flood Advisory Group. This is the best address I found to contact you. I have attached my reply to The William D. Ruckelshaus Center draft report dated 16 July 2012 to share with you.

BY, ON AND IN THE NEWAUKUM RIVER
Michael L. Smell
470 Hamilton Rd
Chehalis, WA. 98532
360-748-1918 9 AUGUST 2012

COMMENTS ON YOUR DRAFT REPORT DATED 16 JULY 2012

I WOULD LIKE TO MAKE SOME OBSERVATIONS:

As [HAVE STATED AT MEETINGS AND IN WRITING BEFORE, I FEEL A DAM ON THE UPPER CHEHALIS RIVER IS NOT THE CORRECT CHOICE BECAUSE IT WOULD BE STATIONARY ON THE UPPER CHEHALIS RIVER. You OWN DRAFT LISTS 3 EXAMPLES AND LARRY KARPACK'S PRESENTATION AT YOUR MEETING ON 14-15 JUNE 2012 SHOWED 10 EXAMPLES OF MAJOR RAIN EVENTS. THEY SHOW THAT MAJOR RAIN EVENTS ARE SCATTERED ALL OVER THE CHEHALIS RIVER BASIN. DAM PROPONENTS HAVE NOT ADDRESSED THIS ISSUE. EVEN IF THE MAJORITY OF THE RAIN EVENT OCCURRED BEHIND THE DAM SITE, THE DAM WOULD BE LESS EFFECTIVE THE HIGHER THE RETAINED WATER LEVEL WAS AT THE BEGINNING OF THE RAIN EVENT. THE DAM WOULD BE USELESS IF THE RAIN EVENT WAS BELOW THE LOCATION. THIS IS MY MAJOR OBJECTION. THE COST IS VERY HIGH WITH OR WITHOUT HYDRO AND AS STATED ABOVE: IT MAY OR MAY NOT HAVE ANY EFFECT ON FLOODING DOWNSTREAM. You MUST ALSO ADD TO THE COST ANY MITIGATION PROJECTS THAT WOULD HAVE TO BE ACCOMPLISHED SUCH AS FOR FISH HABITAT AS A DAM WOULD PERMANENTLY ALTER THE LAND AND RIVER DOWNSTREAM. NOW ADD THE FACT THAT THE TOWN OF PEEL!.. IS ONLY 2 MILES DOWNRIVER WHICH MEANS ANY BREACH ON THE DAM WOULD GIVE THE TOWN NO TIME TO EVACUATE. THE CHEHALIS RIVER BASIN FLOOD AUTHORITY HAS OVER A HUNDRED VARIED PROJECTS ON THEIR LIST THAT ARE SCATTERED THROUGHOUT THE BASIN. IWOULD RATHER SEE ALL OF THEM COMPLETED FIRST. NATURAL PROJECTS LIKE THE HORSESHOE BEND (OXBOW) THAT THE CHEHALIS TRIBE FUNDED ON THE NEWAUKUM RIVER IN 2000 TO TEMPORARILY STORE FLOOD WATER WOULD BE MY FIRST CHOICE. ANOTHER NATURAL PROJECT NOT EVEN LIST-ED .BUT THAT USED TO SE THE PET PROJECT FOR THE LEWIS COUNTY GOVERNMENT WHEN THE COE TWIN CITIES PROJECT WAS PROPOSED IS THE HAMILTON MEADOWS PROJECT. UNLIKE THE SCHEUBER ROAD BYPASS, THIS PROJECT WOULD TEMPORARILY STORE FLOOD WATER NEXT TO STATE ROUTE 6 AND THEN RELEASE IT AFTER THE RIVER LEVEL WENT BACK DOWN. IWOULD LIKE TO SEE ANY PROJECT THAT WORKS WITH NATURE INSTEAD OF TRYING TO CONQUER IT. ANYONE CAN LOOK AT OUR LAND AT 470 HAMILTON RD. CHEHALIS, WA TO SEE NATURAL WAYS TO TEMPORARILY STORE. FLOOD WATERS. I ALSO HOPE THAT MORE WETLANDS WILL BE ESTABLISHED THROUGHOUT THE BASIN AS ANOTHER NATURAL WAY TO ABSORB THE FLOOD WATERS.

BY, ON, AND IN THE NEWAUKUM RIVER
MICHAEL L. SMELL

Response to Comment

Thank you for your comments and for your perspectives on, and preferences among, the various potential flood hazard mitigation alternatives. The final report acknowledges the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach that includes a balance between the potential for large-scale capital projects, such as a dam and/or I-5 improvements, smaller more localized projects, and programmatic actions. Recommendations with the final report call for moving forward with a number of actions including work to better understand how projects that improve floodplain function might mitigate potential future flood damages.

Brenda Boardman 8/31/12

I was in the flood of 2007. I suffered all the anxieties and hard work that everyone else experienced at that time. I was out of my home for seven months and my vacation rental business was closed for one year. I did not have flood insurance as my home was not designated to be in a flood zone. I have taken $40,000 of my retirement money and have acquired an $87,000 loan to put my property back in order. If you include that landscaping and cleaning of my 25 acres that means about five years of my time, money and effort.

I oppose the building of the dam above PeEll for several reasons. I do not think it will solve the problem. The rains come to many places in the hills and to build a dam in only one place more that likely will not always be the solution. I also think that the proposed site of the dam, two miles above PeEll, would not give sufficient time for the town to be evacuated in a flood event. I feel that the study about the location should be completed before anything else in done concerning the dam.

It is my very strong feeling that the FLOOD PLAIN BELONGS TO THE RIVER. There should be NO building and NO filling in the flood plain! I think money should be spent to remove homes and business from harms way. This may take many years but it would solve the problem for good.

Equally important, I think every effort should be made to protect the river so it can help with flooding waters. I feel that logging practices need to be much more stringent when logging hills, riparian area and building logging roads. Though I know some of this has been done I do not feel it is enforced strictly enough nor is it strong enough. These improved practices would help the salmon and wildlife immensely as well as reduce flooding.

I think everything should be done to accomplish the above before anything is done to dam the rivers or build structures to redirect water. This will take time but I feel it will be a much better, safer, natural and long lasting solution to this difficult problem.

Many thanks,

Brenda Boardman
Doty/Dryad area fo the Chehalis River Basin
PO Box 258
Doty, WA 98539

Response to Comment

Thank you for taking the time to respond to the request for stories that show the human perspective of flooding on homes and businesses in the Chehalis Basin and for your perspectives on, and preferences among, the various potential flood hazard mitigation alternatives. All your comments were taken into consideration and your story was included in Appendix B, a compilation of personal stories and reflections on flooding in the basin. The final report describes the diversity of concerns and perspectives on the dam and other flood hazard mitigation alternatives, and highlights the importance of a Basin-wide approach. Recommendations in the final report include moving forward with programmatic and other efforts to preserve and enhance natural floodplain function.

Stefanie Wahl, 8/23/12

Chehalis West is a 65 bed assisted living facility that employs 42 people. The facility is located on the west side directly on the Tacoma rail line. The noise, exhaust, and visual asthetics would be devastating to our business if the express or temporary bypass options were implemented. The center of the track is 12.5' from our property line.

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Edna Fund, 8/23/12

Our council is in favor of a basinwide solution and sent a letter to Congresswoman Butler; agrees with Merlin MacReynold comment

Response to Comment

Thank you for your comment. The final report on Chehalis flood hazard mitigation alternatives emphasizes the need for a Basin-wide approach for people and communities. The WSDOT report was written to address only Section 1033 (2) (c) of ESHB 2020. This section states "evaluate alternative projects that could protect the interstate highway and municipal airport at Centralia and Chehalis, and ensure access to medical facilities …". The WSDOT report was not intended to address other potential projects or components that may be considered as part of a basin wide solution(s).

The final report more clearly describes the context for the I-5 protection analysis – it is but one component of a broader effort to summarize existing information on alternatives to mitigate flood damage in the Chehalis Basin. The alternatives described are focused on I-5 protection because that is the focus of the report; however the final report more clearly describes protection of I-5 as only one potential component of a broader set of flood hazard mitigation efforts needed in the Basin and refers more clearly to the larger effort to determine a path forward for flood hazard mitigation in the Basin, of which protection of I-5 is only a part.

Merlin McReynold, 8/23/12

City Council of Chehalis opposed to all alternatives. Official position is that this has to be a basinwide solution; how these alternatives could fit into that is critical, but City Council thinks none are viable as individual alternatives without basin wide solution

Response to Comment

Thank you for your comment. The final report on Chehalis flood hazard mitigation alternatives emphasizes the need for a Basin-wide approach for people and communities.

The WSDOT report was written to address only Section 1033 (2) (c) of ESHB 2020. This section states “evaluate alternative projects that could protect the interstate highway and municipal airport at Centralia and Chehalis, and ensure access to medical facilities …”. The WSDOT report was not intended to address other potential projects or components that may be considered as part of a basin wide solution(s).

The final report more clearly describes the context for the I-5 protection analysis – it is but one component of a broader effort to summarize existing information on alternatives to mitigate flood damage in the Chehalis Basin. The alternatives described are focused on I-5 protection because that is the focus of the report; however the final report more clearly describes protection of I-5 as only one potential component of a broader set of flood hazard mitigation efforts needed in the Basin and refers more clearly to the larger effort to determine a path forward for flood hazard mitigation in the Basin, of which protection of I-5 is only a part.

Ron Averill, 8/23/12

Flood relief maps of the Walls and Levees are misleading. In all alternatives, Miracle Mile is still under water, so a 1.4 foot drop doesn't mean it's dry. The Yardbirds, Sunbirds, and Lewis County Mall are not protected by airport levee, even though Town Center and Airport are protected

Response to Comment

The flood relief maps were provided to show representative changes in peak Water Surface Elevation (WSEL) throughout the project area in a 2007 and simulated 100-year flood event, and were not meant to imply that a reduction in WSEL equates to full flood protection for all residences and businesses in that particular cross-section.

The report does not state that any particular businesses, such as Yardbirds, Sunbirds, or Lewis County Mall, would be completely protected from flooding.

Anonymous, 8/23/12

Consider the property value impacts on businesses and residences in the express/bypass lanes project area that would be affected.

Express and bypass lanes don’t allow for non-commercial traffic, so folks that need to access the hospital during floods may not be able to due to the backups.

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Anonymous, 8/23/12

Our company leases property from Tacoma Rail, so if express/bypass lanes are built we will have nowhere to park

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Anonymous, 8/23/12

Express/bypass lanes would have impact on our company because we would have to relocate our storage facility and its difficult to get ability to store hazardous material in places; this would impact our business and other residents and businesses in the area who get their propane from us

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Anonymous, 8/23/12

The bypass and express lanes when going through urban area of Chehalis from West to Main street are going to have to be elevated with a ~22ft high wall through Chehalis. This is important when considering the impact on the quality of life of for the community on historic West side, as it bisects the community and would it make it difficult to traverse from one side to the other. So very objectionable by community. Impacts quality of life throughout the city

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Anonymous, 8/23/12

Options 3-4 just protects I-5 and does nothing for flood control so community won't see any help

Response to Comment

Thank you for your comment. The final report on Chehalis flood hazard mitigation alternatives emphasizes the need for a Basin-wide approach for people and communities.

Deanna Ziskey, 8/23/12

I respect commercial interests in bypass and express lanes and know businesses are important; in area described where express lanes come through it is described as industrial, but it's also an area where residences are, partially from main street to prindle and definitely from prindle to west there are homes and property goes close to tracks; and division street and hawthonre too, so huge impact. Not just looking out window and seeing structure and breathing in fumes, but exremeley damaging to people there who own homes and their property value; we appreciate being part of the discussion and being able to comment

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Anonymous, 8/23/12

Our business would be affected by express/bypass lanes. Our business provides the local and surrounding areas with fertilizer. Taking the Tacoma rail tracks away would not allow us to have product flow.

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in the report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

J. Vander Stoep, 8/23/12

Think Bart's presentation does an excellent job on saying what we know and don't know. The report, however, doesn't. It is written as a govt. agency selling a specific project, which emphasizes the positive of the walls and levees option. It only says "a dam alone will not protect I-5" and needs to be more balanced.

The report moves goal post on protecting I-5. Now says 3ft of freeboard of 100 yr flood. And no differentiation of I-5 being closed for four days or a minute.

Response to Comment

The legislative purpose of this report was to evaluate alternative projects that could protect I-5. The full Chehalis Basin Flood Mitigation Alternatives Report addresses other potential projects, including a dam on the upper mainstem Chehalis, in detail. The final WSDOT report more clearly defines its intent and context and more clearly references the full alternatives report for more information. It also more clearly describes the potential effects of a dam relative to I-5 protection alternatives, including a clear statement that a dam would lower flood elevations throughout the Basin and would, therefore, reduce the amount of effort needed to fully protect I-5 during major flooding and the costs of I-5 protection.

WSDOT agrees that it is extremely important to identify the right measurement for freeboard. The right amount of freeboard will provide confidence that, no matter what flood protection measures the legislature directs WSDOT to build, they provide protection for predicted floods in the project area.

As described in an Appendix to the draft report, WSDOT determined that freeboard must be three feet above the 100-year flood level. This amount of freeboard is in alignment with the freeboard the Army Corps of Engineers has been using for the Twin City project including the protection of I-5 for the past decade. It equates to a minimum of one foot above the 2007 flood level in the Chehalis-Centralia area. This measurement was established through analysis by WSDOT's State Hydraulic Office as sufficient to cover a potential future water flow increase of 25 percent. This issue is addressed further in the final report.

Regarding the comment on no differentiation of I-5 being closed for four days or a minute, as noted in an Appendix to the draft report, closing I-5 in the Centralia-Chehalis area is a resource intensive, complex, and challenging undertaking, regardless of the length of time the freeway is ultimately closed for. When I-5 is anticipated to be flooded between 13th and Mellen streets, (exits 76 and 81), WSDOT closes I-5 at the US 12 interchanges (exits 68 and 88). WSDOT then uses US 12 as the major detour route. Closing I-5 at the US 12 interchanges means WSDOT must block off the main interstate lanes and 10 separate interchanges at exits 68, 71, 72, 74, 76, 77, 79, 81, 82 and 88 to prevent traffic from entering I-5 in the closed area. This must be accomplished well before I-5 is inundated by floodwaters to ensure WSDOT's ability to safely evacuate drivers and move personnel and equipment into the affected area.

Department of Ecology 8/31/12

Ecology comments: WSDOT Draft Report: I-5 protection from 13th Street to Mellen Street near Centralia and Chehalis

General comments

1. Mitigation for flood impacts appears to be included, but not environmental mitigation. The report mentions that there will be wetland impacts. The report states that impacts could be mitigated by using the North Fork Newaukum mitigation site. Has the cost of wetland mitigation been considered in developing the different alternatives? In some of the alternatives that are presented, the costs could be quite substantial. Potential mitigation costs for wetlands, fisheries, or other environmental impacts should be discussed, recognizing this is still at a preliminary planning stage.

   Federal and State 404/401Water quality certification may be necessary.

2. When you are evaluating the different alternatives, you should consider impact avoidance. Which project is the least environmentally damaging solution? An analysis should be done in order to follow the mitigation sequence. (Also please see Specific Comment #1 below.)

3. Portions of the project may be in shoreline jurisdiction and will need to be consistent with the Shoreline Management Act and the local Shoreline Master Programs. There may be more than one jurisdiction involved with this project and so there may be multijurisdictional review.

4. The term “miracle mile” may not be clear to all readers. Consider defining this term the first time it is used.

Project Alternatives

1. Could some hybrid of Alternative 1, with some limited use of viaducts from Alternative 5, provide environmental benefits? In particular I would picture this as a benefit in an area like Dillenbaugh Creek, where a viaduct could reopen flood plain connectivity. There may also be areas where improving the movement of water with a viaduct would have more flood hazard mitigation benefits to the community than blocking the water with a levee or well. In general, to focus on transportation benefits with community and environmental impacts as secondary considerations may be missing an opportunity to look for solutions in the valley the optimize benefits for transportation, the community, and the environment. (This comment relates to Specific Comment #3 below).

2. Alt. 2 includes raising I-5. There is discussion in the report about how much this alternative would result in new flooding or increased water surface elevations. It is not clear HOW this would be caused - is it from the added fill that would be necessary to raise the road? Some brief explanations like this would improve the readability of the document and help decision makers better understand the effects of and differences between the alternatives.

3. At meetings, Twin Cities staff and residents voiced significant concerns with the aesthetics and social issues surrounding alternatives 3 and 4. There are vague references to the concerns on pages 21 and 27, but this could be emphasized more and perhaps earlier in the report.

4. It's not clear how the natural resource impacts of alternative 3 (or alt. 4) are the same as widening I-5 to six lanes. Is this because the extent of impacted areas would be the same? Because these alternatives occur away from the existing I-5 footprint, it is hard to see how they could be the same. Consider qualifying or clarifying what is meant by this statement.

5. For alternatives 3 and 4, it seems the sentences about access to the hospital may be oversimplified. Both say access to the hospital would be improved if drivers can reach I-5 from the south or from the north.

   While on the surface this is probably true, my reading of alternative 3 is that from the express lanes one would not have access to the freeway between 13th and Mellen Street. So is this only true if the freeway is open (not inundated) both the north and south of the express lanes, or would the current Mellen to Blakely improvement project play a role?

6. Similarly alternative 4 would not provide local access to the freeway between 13th and Mellen, so I have the same question. What if downtown Centralia is flooded from Salzer Creek or the Skookumchuck and people can't get to Mellen Street or north of it on I-5, is there access to the hospital? A better explanation of the conditions and scenarios under which drivers would be able to access the hospital under these two alternatives would be more meaningful, since access to the hospital is cited as a key piece to the evaluation of each alternative.

Specific Comments

1. Executive Summary: This section notes the need to consider the proposed projects in conjunction with other flood hazard mitigation projects. It also notes the potential impact to the community, measured in terms of improved conditions or negative impacts for "buildings." However no mention is made of environmental impacts or benefits, or opportunities to develop a project that has both transportation and environmental benefits.

   a. Some mention should be made of potential environmental impacts for each alternative.
   b. The Executive Summary notes that funds for flood impact mitigation are included in the cost estimates, but it's not clear if costs for environmental mitigation are included.
   c. It's possible that there are locations where a combined highway/environmental project could result in greater benefits than a highway project alone. For example, raising the freeway could result in greater floodplain connectivity, enhanced wetlands, and fish passage or rearing areas. The possibility of projects with environmental benefits should be given some consideration and noted in the Executive Summary.

2. Page 7: The discussion of a potential dam should clarify that these are modeled estimates of a dam that has only been conceptually proposed. For example, the sentence "If a dam were constructed…it would not fully protect I-5" should be reworded to something like "If a dam as proposed were

constructed…model simulations show that it would not fully protect I-5". Another example: Instead of "In 2007, a dam would not have prevented flooding…", say "In 2007, model simulations show that the dam as proposed would not have prevented flooding…"

3. Page 13, "What are the potential impacts to natural resources?": Impacts can be negative or positive. It would be good to see more discussion here of potential positive impacts, such as through improved fish passage, flood plan connectivity, wetland enhancement, or water quality treatment improvements. Improved stormwater retention and treatment would be a positive benefit in terms of compliance with TMDLs in the Chehalis River and tributaries. WSDOT might consult with WDFW to see if there are opportunities for fish and wildlife habitat enhancement in the footprint of the project, beyond the mitigation of negative impacts.

4. Page 24 of the report describes how alternative 3 may 'change' a flood. How? Is it from the fill necessary to expand the Tacoma Rail ROW to a typical road section as shown on page 20?

5. Page 34, Table 7: This table should also include a summary of environmental mitigation costs and potential enhancements.

   Also, consider adding an asterisk to the Alternative 3 and 4 stating that these estimates do not include the costs or ability to acquire the Tacoma Rail ROW.

6. Page 35, "Conclusions…" same comments as #1 for executive summary.

7. Page 39, "Difficulty Precisely Predicting…": In this discussion you might also note that the Hydraulic model, whose results you show in Appendix D, shows a calibration error on high water marks in the area of I-5 ranging from -1.24 feet to +1.0 feet (Appendix F of Ruckelshaus Center report; page 215, 219, 221; Tables 3, 5, 7). Model uncertainty is another reason to include freeboard in your estimates.

   In addition, the Hydraulic model evaluated 3 historic events and one 100-year design flood. These four scenarios do not encompass the full range of possible future events, such as a 2007-scale atmospheric river event concentrated in the Cascade foothills, or a 100-year event focused in the Cascade foothills. This is another source of uncertainty in the hydraulic modeling and also justifies a margin of safety in the freeboard calculation.

   Given the issues raised in Casey's memo in Appendix A.1 along with these other sources of model uncertainty, you may want to review whether a freeboard of more than 3 feet might be appropriate.

Response to Comment

Thank you for your comments. Numerous technical clarifications and corrections were made in the final report as the result of comments and review by the state technical team.

General Comments

1 - The cost of wetland mitigation was factored into cost estimates for each of the alternatives. However, because the alternatives identified in the report are still in a preliminary design phase, the report does not include specifics on mitigation for wetlands, fisheries, or other environmental impacts. Further consideration of any of the alternatives will entail additional analysis related to environmental mitigation and the necessary environmental permitting. WSDOT's process is to avoid, minimize and mitigate impacts in that order.
2 – See response to General Comment 1
3 – See response to General Comment 1
4 – Miracle mile is now defined the first time it is used in the report

Project Alternatives

1. The alternatives described in the report are in a preliminary design phase; WSDOT did not explore hybrid alternatives for combined highway/environmental benefit in this preliminary assessment. Future analysis could include hybrid options.
2 - Raising I-5 on fill material creates a barrier impeding flow downstream. This is the primary reason for the modeled increase in water surface elevations in the areas shown in Appendix C. A lesser cause of the increase in water surface elevations is due to the fill (reducing water storage) but it is not nearly as significant.
3 - New language has been added to the final report that describes the potential impacts alternatives 3 and 4 could have on homes and businesses in the Westside Chehalis neighborhood.
4 - At this preliminary design phase, the impacts on natural resources was determined to be relatively the same due to the close proximity of the location of the Tacoma Rail Line to I-5 and the similar amount and types of impact areas. Further consideration of any of the alternatives will entail additional analysis related to environmental impacts.
5 - Alternative 3: I-5 Express Lanes and Alternative 4: I-5 Temporary Bypass both provide a viable route around the portions of I-5 that are inundated during a flood event. With either of these Alternatives, I-5 will still be inundated and closed during a flood event. The report is attempting to communicate that if drivers can access I-5 north or south of the inundation area, then they can access express lanes or temporary bypass and can then reach the hospital. Moreover, these alternatives do not necessarily provide access to the hospital from portions of inundated local streets. A driver must be able to reach non-inundated portions of I-5 to access the hospital. This is clarified in the final report.

Specific Comments

1a – see response to General Comment 1
1b – see response to General Comment 1
1c – see response to Project Alternatives 1
2 – text was edited to better reflect model estimates of dam
3 – see response to General Comment 1
4 - The modeled 'change' in a flood event due to Alternative 3 is primarily due to the barrier created by the placing a road above the railroad tracks. Water would not flow over the existing railroad bed as it has in the past major floods. A lesser cause of the increase in the water surface is due to the fill reducing the amount of water storage, but it is not nearly as significant.
5 - an asterisk was included to the table to better reflect cost estimates for Alternative 3 and 4
6 – see response to General Comment 1
7 - as discussed in Appendix 1 to the report, WSDOT's analysis is that 3 feet of freeboard are sufficient to address uncertainties and protect I5 under a variety of current and potential future conditions.

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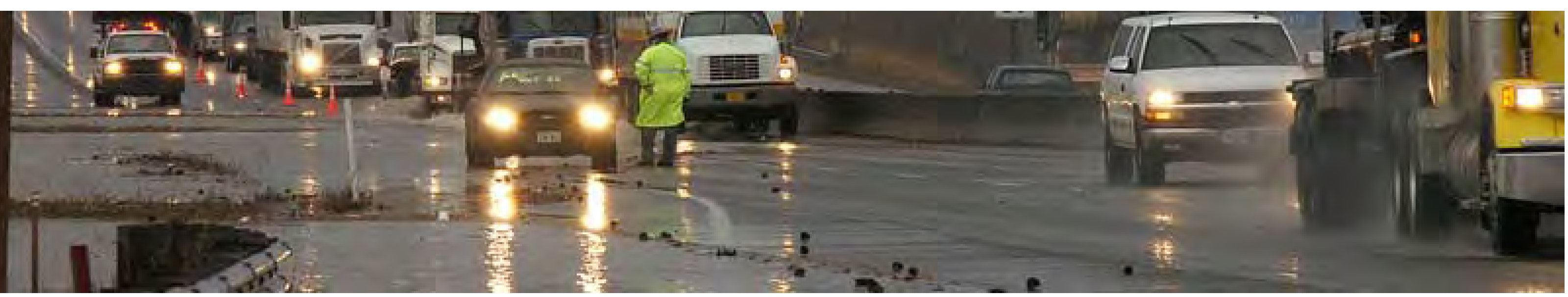
Appendix F: WSDOT Report: I-5 protection from 13th Street to Mellen Street near Centralia and Chehalis



WSDOT Report:

I-5 protection from 13th Street to Mellen Street near Centralia and Chehalis

December 19, 2012

Table of Contents

Executive Summary

This report summarizes work by the Washington State Department of Transportation (WSDOT) to evaluate projects to protect Interstate 5 (I-5), the Chehalis-Centralia Airport and improve access to medical and other critical facilities during flood events.

This work is part of a larger effort to identify potential flood hazard mitigation projects in the Chehalis River Basin. In 2011, as part of the capital budget (ESHB 2020, Section 1033) 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, state and federal agencies – to recommend priority flood hazard mitigation projects in the Chehalis River Basin for continued feasibility and design work. The OFM report looks at a full range of alternatives to protect people and communities from flooding, including water retention in the upper Chehalis, smaller scale infrastructure protection, floodplain management and other projects to improve ecological and natural floodplain function, and land use management approaches to reduce potential flood damages.

As part of the OFM report, WSDOT was tasked with evaluating alternatives that could be used to protect I-5 from flooding. This is only one part of the work needed to determine how best to reduce flood damages in the Chehalis Basin. WSDOT evaluated six alternatives that could be used to protect I-5 from flooding. Due to time and funding constraints, WSDOT has done a limited amount of design work to define and evaluate these alternatives.

- **Alternative 1: I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee** – Provides protection of I-5 and the Chehalis-Centralia Airport in flood events up to the 2007 or simulated 100-year flood level. It improves conditions for approximately 1,030 buildings, but has a negative impact for approximately 140 buildings on the west side of I-5 near the Chehalis River and along the Newaukum River and Dillenbaugh Creek. These negative impacts can be mitigated and funding for flood impact and environmental mitigation is included in the cost estimates for this alternative. Alternative 1 does not address the need to widen I-5 in the future. Alternative 1 appears to warrant further consideration as an independent project or in combination with other flood hazard mitigation efforts in the Chehalis Basin.

- **Alternative 2: I-5 Raise and Widen Only** – Provides protection of I-5 in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 840 buildings, but has a negative impact for approximately 300 buildings on the west side of I-5 near the Chehalis River and along the Newaukum River and Dillenbaugh Creek. These negative impacts can be mitigated and funding for flood impact and environmental mitigation is included in the cost estimates for this alternative. Alternative 2 does address the need to widen I-5 in the future. Alternative 2 appears to warrant further consideration as an independent project or in combination with other flood hazard mitigation efforts in the Chehalis Basin.

- **Alternative 3: I-5 Express Lanes** - Provides a viable route around the portions of I-5 that are inundated during a flood event. This alternative route would be protected in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 890 buildings, but has a negative impact for approximately 170 buildings on the west side of I-5 near the Chehalis River and along the Newaukum River and Dillenbaugh Creek. These negative impacts can be mitigated and funding for flood impact and environmental mitigation is included in the cost estimates for this alternative. There are significant uncertainties with Alternative 3, including whether the City of Tacoma would sell the right-of-way to the Tacoma Rail line and, if so, at what cost, and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. However, Alternative 3 does address the future need to widen I-5 at a significant cost savings. If Alternative 3 is to warrant further consideration, more work is required to determine feasibility.

- **Alternative 4: I-5 Temporary Bypass** - Provides a viable route around the portions of I-5 that are inundated during a flood event. This alternative route would be protected in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 900 buildings, but has a negative impact for approximately 170 buildings on the west side of I-5 near the Chehalis River and along the Newaukum River and Dillenbaugh Creek. These negative impacts can be mitigated and funding for flood impact and environmental mitigation is included in the cost estimates for this alternative. There are significant uncertainties with this alternative, including whether the City of Tacoma would sell the right-of-way to the Tacoma Rail line and, if so, at what cost, and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. Alternative 4 does not address the future need to widen I-5. If Alternative 4 is to warrant further consideration, more work is required to determine feasibility.

- **Alternative 5: I-5 Viaduct -** WSDOT does not consider this a viable alternative due to high costs and increased flood elevations in the urban areas of Centralia.

- **Alternative 6: I-5 Relocation** - WSDOT does not consider this a viable alternative due to high costs and impacts to the built and natural environment surrounding Chehalis and Centralia.

Alternatives for protecting I-5 cannot be considered in a vacuum. They are part of the comprehensive solution to protecting people and communities in the basin, and will be affected by the selection and implementation of the basin-wide solution.

A dam on the upper Chehalis will reduce the likelihood of I-5 flooding, and the extent of flooding if it does occur. The dam also has substantial benefits for downstream communities. However, in a 100-year scenario and during the 2007 flood, a dam as proposed would not have kept I-5 open.

A dam could potentially change which alternative could be chosen to protect I-5, and the design of that alternative. The selection and construction of an alternative is further complicated by the need to widen five miles of I-5 in Chehalis in the same location that has been flooded multiple times in the past. At this time, WSDOT does not have funds to widen this section of I-5, and it may be several years before funds could become available to begin the environmental process necessary for widening of this section of the interstate.

There are many unknowns at this time, and a basin-wide solution is still being discussed. As this report is completed and next steps are being considered, WSDOT proposes identifying a recommended solution to protect I-5 with and without a dam.

Public comments on the draft report

A draft of WSDOT's I-5 protection alternatives report was made available for public comment August 17-31, 2012. Thirteen written comments were received and additional oral comments were taken at a public meeting in Chehalis on August 23, 2012.

Of the 13 written comments received, eight were from local residents of the Westside Chehalis neighborhood expressing opposition to the Express Lane and Temporary Bypass project alternatives. These commenters are concerned that, if constructed, either of these alternatives could decrease their property value and business revenue, increase air pollution, noise levels, and traffic volume adjacent to and through the project area, and increase the flow of water in and through the neighborhood during major flood events. Other comments expressed concern over the estimates of flood level elevation changes and flood damage reductions in the report , and concerns that the WSDOT report did not adequately describe the flood damage reductions that may be associated with a potential water retention facility on the upper Chehalis. The report has been modified to better address these concerns.

In November 2012, a small group of Chehalis Basin leaders convened by Governor Gregoire recommended a series of actions that, taken together, will represent a $28.5 million investment to reduce flood damages in the short term, enhance natural floodplain function and fisheries, and put the Basin on firm footing to make critical decisions about large scale projects. This includes a recommendation to finish the analysis necessary to determine the best option for large-scale capital projects, and make a decision whether to move into project permitting by December 2014. The large capital projects under consideration include upstream water retention and I-5 protection alternatives.

If funded by the legislature WSDOT anticipates that further evaluation of I-5 protection alternatives would include additional effort to define and refine the alternatives, additional work to refine the analysis of potential flood damage reduction benefits including potential impacts to buildings in the floodplain and potential environmental and community impacts or benefits, and work to better understand how other flood damage reduction alternatives such as water retention might affect the amount of effort needed to protect I-5.

Introduction and Background

This report summarizes work by the Washington State Department of Transportation (WSDOT) to evaluate projects to protect Interstate-5 (I-5), the Chehalis-Centralia Airport, and improve access to medical and other critical facilities during flood events.

This report on alternatives to protect I-5 is part of a larger effort to identify potential flood hazard mitigation projects to protect people and communities in the Chehalis River Basin from flooding. In 2011, as part of the capital budget (ESHB 2020, Section 1033) 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, state and federal agencies — to recommend priority flood hazard mitigation projects in the Chehalis River Basin for continued feasibility and design work. The OFM report looks at a full range of alternatives to protect people and communities from flooding including water retention in the upper Chehalis, smaller scale infrastructure protection, floodplain management and other projects to improve ecological and natural floodplain function, and land use management approaches to reduce potential flood damages. It is important to emphasize that the evaluation of projects to protect I-5 is just one small piece of the ongoing work to identify a package of flood damage reduction efforts in the Chehalis. WSDOT anticipates that, if they were to move forward, projects to protect I-5 would be carried out in coordination with other projects focused on providing additional protection from flood damages to people and communities throughout the Basin.

Some of the potential projects WSDOT evaluated to protect I-5 have the potential to also reduce the negative effects of flooding on nearby people and communities. Where possible, those potential benefits have been optimized. On the other hand, some of the potential I-5 projects could potentially increase the negative effects of flooding on people and communities, particularly on the west side of I-5 near the Chehalis River and along the Newaukum River and Dillenbaugh Creek. Where possible, these effects have been avoided and minimized. Where negative effects are still anticipated, project cost estimates include funding for flood impact and environmental mitigation efforts, such as raising buildings, moving buildings, fully purchasing impacted properties, wetland mitigation, and other measures.

Six I-5 protection project alternatives were evaluated:

1. I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee;
2. I-5 Raise and Widen Only;
3. I-5 Express Lanes;
4. I-5 Temporary Bypass;
5. I-5 Viaduct; and,
6. I-5 Relocation.

Project Area and History of Flooding

The project area is in Lewis County and the cities of Chehalis and Centralia, Washington, along a five-mile stretch of I-5 that begins near the 13th Street interchange at milepost 76 and extends north to the Mellen Street interchange at milepost 81.

This stretch of I-5 is a midpoint between Seattle, Washington and Portland, Oregon, connecting two of the West Coast's major population and industrial centers. I-5 is vital to the state's economy and acts as the West Coast's major north-south transportation corridor. The uninterrupted movement of cars, trucks, freight, and recreational vehicles along I-5 is essential to the quality of life and economic vitality in the region.

Chehalis Basin floods in February 1996 and December 2007 closed I-5 at Chehalis and Centralia for four days each, and flooding in January 2009 closed the same stretch for two days. WSDOT estimates the total cost of the closure and delays in 2007 alone in the tens of millions of dollars. The major costs come from limited freight movement through the area, including costs incurred by private companies as a result of that limited movement. WSDOT has a detour route that takes drivers around I-5 using SR 7 and US 12, but this route is limited to critical freight only. It can handle only about 25 percent of the freight that typically travels this section of I-5. A more efficient, longer-term solution during flood events is still needed.

Photo courtesy of *The Chronicle*, Centralia, Washington

Other Flood Hazard Mitigation Projects Under Consideration in the Basin

The William D. Ruckelshaus Center, a joint effort of the University of Washington and Washington State University (more information available at www.ruckelshauscenter.edu), is under contract with OFM to coordinate development of a report using technical information provided by other agencies and organizations. The report is intended to provide the Washington State Legislature and other decision makers with information to aid their decisions and set the course for effective solutions that reduce negative impacts of flooding while supporting the economic prosperity of communities in the Basin and protection/restoration of fish and other natural resources.

Review and Comments on the Draft Report

A draft of WSDOT's I-5 flood protection alternatives report was made available for public comment August 17-31, 2012. Thirteen written comments were received and additional oral comments were taken at a public meeting in Chehalis on August 23, 2012.

Of the 13 written comments received, eight were from local residents of the Westside Chehalis neighborhood expressing opposition to the Express Lane and Temporary Bypass project alternatives. These commenters are concerned that, if constructed, either of these alternatives would decrease their property value and business revenue, increase air pollution, noise levels, and traffic volume adjacent to and through the project area, and increase the flow of water in and through the neighborhood during major flood events. Other comments expressed concern over the estimates of flood level elevation changes and flood damage reductions in the report , and concerns that the WSDOT report did not adequately describe the flood damage reductions that may be associated with a potential water retention facility on the upper Chehalis. The report has been modified to better address these concerns and a full discussion of comments and changes made to address them is available as Appendix F.

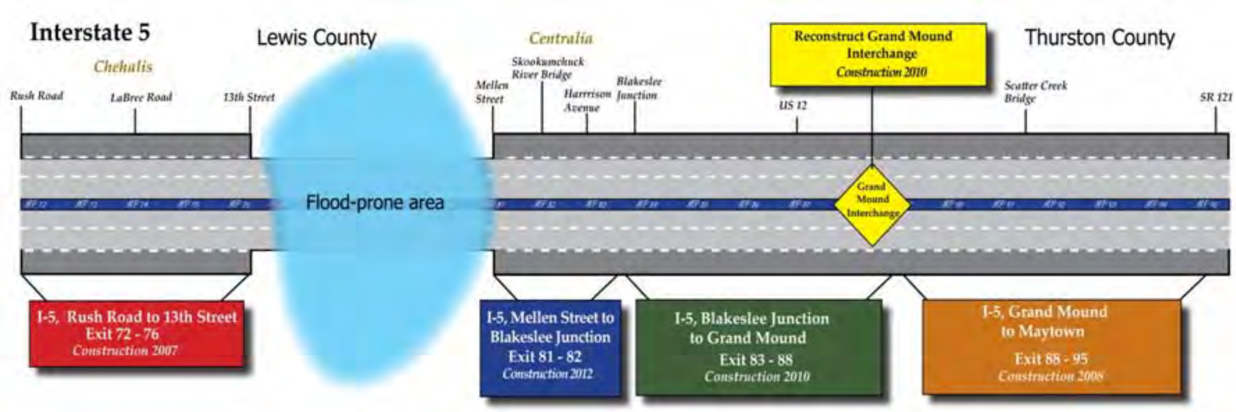
Project Context

This section provides background information on recent and ongoing projects along I-5 at Chehalis and Centralia, and each of the flood hazard mitigation projects considered.

Recent and Ongoing Improvements to I-5 in the Chehalis and Centralia Area

Since 2007, Washington State has invested $365 million in improving I-5 in the Chehalis-Centralia area. Between Exit 72 and Exit 95, 18 miles of I-5 have been or are being widened from four to six lanes.

Figure 1: Overview of I-5 Improvements between Exit 72 and Exit 95



The I-5 Mellen Street to Blakeslee Junction (MTB) project is currently under construction and scheduled for completion in fall 2014. The project improves access to the hospital from Centralia during flood events and will also reduce flood levels at some homes and businesses in the nearby area to a limited degree. The MTB project improves but does not completely resolve the issue of hospital access during flooding. Residents in Chehalis and Centralia who are able to reach the I-5, Mellen Street interchange area during flooding will have improved ability to reach the hospital in Centralia. This access depends on getting to the Mellen Street interchange area, so residents who are unable to reach the area will not have improved access to the hospital.

The Future Need to Widen I-5 from 13th Street to Mellen Street

In addition to being susceptible to flooding, the stretch of I-5 from 13th Street to Mellen Street has not yet been widened to six lanes. WSDOT plans to widen this section of I-5 to six lanes; however, it is unlikely widening will happen without a broader solution to flooding along this corridor. A widening project for this stretch of I-5 by itself would cost $250-350 million, and with the potential future flood damage reduction efforts also under consideration, it would not make sense to move ahead with this investment until a determination is made about protection of I-5 from flooding so the flood damage reduction and widening projects can be coordinated. To ensure funds are invested properly and minimize the potential for “re-work” when I-5 widening along this stretch occurs, WSDOT evaluated whether each flood hazard mitigation project alternative addresses the need for future widening of this stretch of I-5, and considered future widening needs in project design.

Potential for a Dam on the Chehalis River

Following the major flood in 2007, the Chehalis Basin Flood Authority began to evaluate whether water retention structures in the Chehalis River Basin might be a solution to basin-wide flooding. The primary water retention alternative still under consideration in the Chehalis Basin is a multi-purpose dam located upstream of Pe Ell on the Upper Chehalis River. At an estimated cost of $245 million, the dam would be 288 feet high with 80,000 ac-ft of dedicated flood control storage, and a flow augmentation/hydropower storage capacity of 65,000 ac-ft.[3]

If the proposed dam were constructed, model simulations show that it would reduce flood elevations throughout much of the upper Chehalis Basin and in the Centralia and Chehalis area. Because it lowers flood elevations, a dam on the upper Chehalis would reduce the amount of effort needed to fully protect I-5 during major flooding and the costs of I-5 protection, but as currently modeled, a dam would not fully protect I-5 in flood events like those in 1996, 2007, or 2009. Therefore, some additional investment in I-5 protection will be needed even with a dam.

Model simulations show that the proposed dam would not have prevented flooding in the 2007 flood event in the areas where Salzer and Dillenbaugh creeks flow under I-5, and at the State Route 6 on-ramp to I-5. In the 2009 flood, water inundated the I-5 area through the Newaukum River and Dillenbaugh Creek rather than the main Chehalis River channel. Model simulations show that in the 2009 flood event the proposed dam would not have prevented I-5 from being flooded in at least one location on the west side of I-5, north of the 13th Street interchange.

In addition, in several other locations, models show that even with flood elevation reductions brought about by the dam as proposed floodwaters would be within several inches of the road surface, likely requiring the closure of I-5 to ensure safety. In particular, I-5 near the Chehalis-Centralia Airport levee (and Chamber Way) is a low spot in the area. The interstate is at least six to seven feet below the top of the levee, and significantly lower than other portions of I-5 and the surrounding area. It can easily and quickly accumulate deep floodwaters if any nearby part of the interstate is inundated, presenting obvious and significant safety concerns for drivers. With or without the construction of a dam, this risk of rapid and deep inundation of I-5 from overtopping of the Airport levee or due to a structural failure of the levee, has and will continue to prompt WSDOT to take a conservative approach to ensuring that I-5 is fully and effectively closed whenever there is serious potential for inundation and well before there is any water actually on or across the interstate.

[3] EES Consulting. 2011. Chehalis River Flood Water Retention Project: Phase IIB Feasibility Study Report. Final Submitted April 14, 2011.

Project Goals

Photo courtesy of *The Chronicle*, Centralia, Washington

The goal for all projects is the full protection of I-5 from 13th Street to Mellen Street, protection of the Chehalis-Centralia Airport, improved access to infrastructure, and optimization of any potential ensuing benefits to people, communities, and the environment. Completion of any of the I-5 protection projects would require a significant investment. It is only appropriate to invest hundreds of millions of dollars in a project if it will provide full and robust protection for a significant period of time. Therefore, WSDOT has chosen a conservative measure of performance for I-5 protection alternatives. This measure of performance looks at the distance between the potential flood water surface and the top of the flood protection element. For example, it might look at the difference in elevation between the potential flood water surface and the top of a flood wall or levee. This measurement is called “freeboard.” WSDOT has chosen a measurement for freeboard similar to that used by the US Army Corps of Engineers: three feet above the projected 100-year flood level. Any modification or new construction of dikes or levees should be built at this level to ensure robust, reliable protection for I-5 and the Chehalis-Centralia Airport. Appendix A provides a more detailed technical description on how WSDOT determined freeboard.

Project Alternatives

WSDOT considered six alternatives to protect I-5, the airport, and infrastructure in the Centralia and Chehalis area.

1. I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee;
2. I-5 Raise and Widen Only;
3. I-5 Express Lanes;
4. I-5 Temporary Bypass;
5. I-5 Viaduct; and,
6. I-5 Relocation.

For each alternative, this section describes the project details, potential costs and implementation issues, and potential impacts to nearby people and communities, major infrastructure, and the environment. A side-by-side project comparison table is provided at the end of this section. As discussed earlier, the I-5 protection alternatives are only a part of a larger effort to identify potential flood hazard mitigation projects in the Chehalis River Basin. A comprehensive solution will protect people and communities throughout the Basin from flood damages. In a related effort, OFM is evaluating a full range of alternatives to protect people and communities from flooding including water retention in the upper Chehalis, smaller scale infrastructure protection, floodplain management and other projects to improve ecological and natural floodplain function, and land use management approaches to reduce potential flood damages.

ALTERNATIVE 1: I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee

Alternative 1 would protect I-5 with a combination of five miles of earthen levees and structural walls along I-5, two miles of improvements to the existing Chehalis-Centralia Airport levee, and a new one-mile-long levee in southwest Chehalis.

Alternative 1 includes replacing five bridges (four over Dillenbaugh Creek and one over Salzer Creek) with bottomless box culverts, and construction of stormwater treatment areas to store and treat stormwater runoff from I-5. Stormwater treatment is necessary because the water that flows during storm events need to be collected and stored until flood waters recede to prevent pooling on I-5. Treatment of runoff is also required to address water quality concerns.

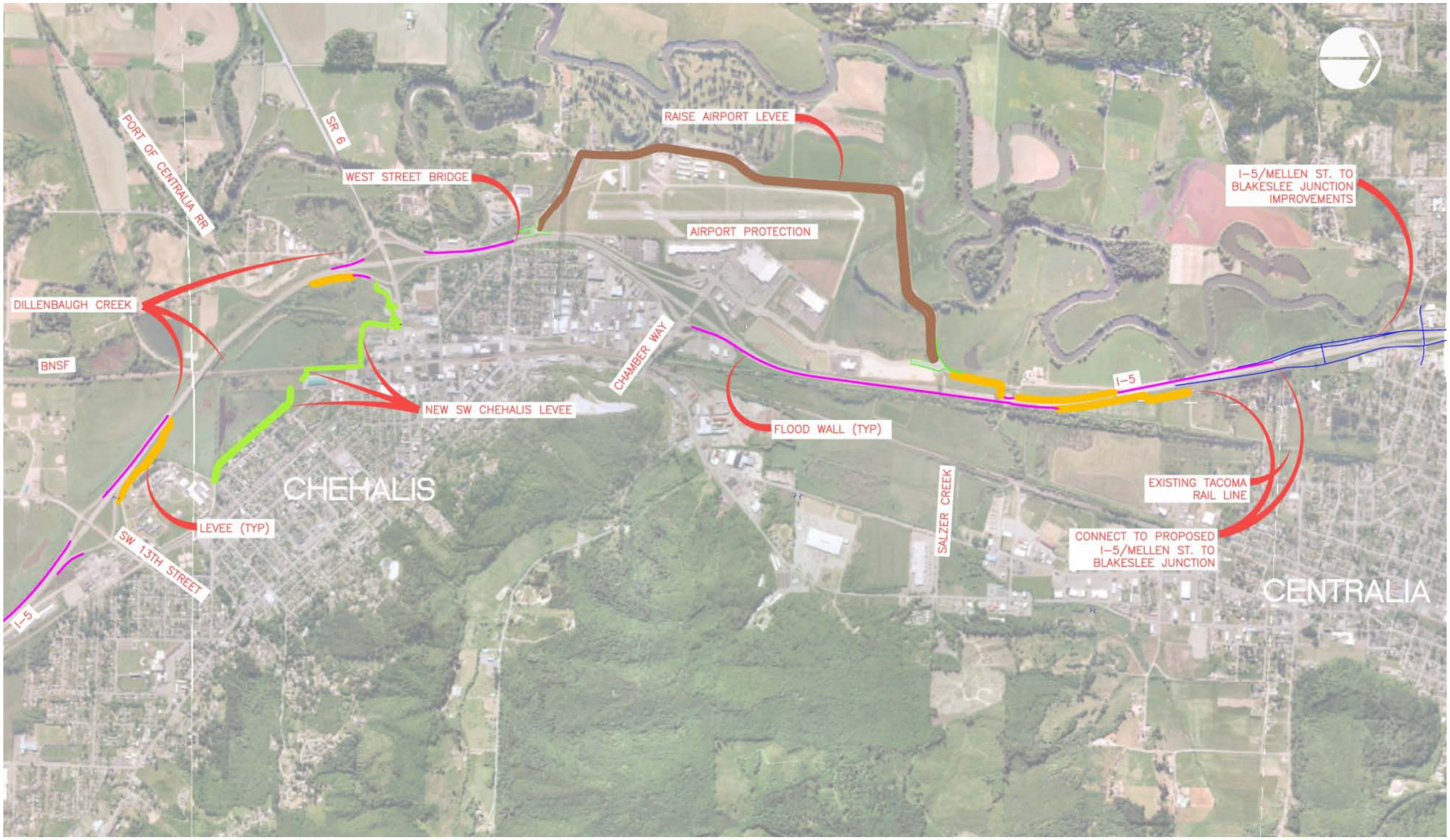
Table 1: Alternative 1 – Location and Length of Levees

Alternative 1: Levees and Walls, No Dam on Upper Chehalis	
Protective Measure	**Length (Miles)**
Airport Levee	2
SW Chehalis Levee	1
I-5 Levees and Walls	5
Total Cost: $80 to 100 million	

Levees would be used away from I-5, where impacts to property would be minimized and levees could utilize existing high ground topography. Walls would only be used in areas where levees are not possible, such as areas with space constraints.

A detailed map showing the layout of the walls and levees is provided in Figure 2.

Figure 2: Alternative 1 - I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee



How does the project increase or decrease flood levels in nearby areas?

In a 2007 flood event, model simulations show that Alternative 1 would decrease water surface elevations (the height of floodwaters) east of I-5, particularly the developed area in Centralia and along the Miracle Mile, generally between 1.4 and 1.8 feet. In the area west of I-5, which is more rural, water surface elevations are predicted to generally increase between 0.2 and 1.8 feet, but by as much as 2.0 feet in some locations. Increases in water elevations are largely because walls and levees would prevent floodwater from crossing over (or under) I-5 from west to east, resulting in more water staying to the west of I-5.

In a simulated 100-year flood event, model simulations show that Alternative 1 would decrease water surface elevations east of I-5, particularly the developed area in Centralia and along the Miracle Mile (a stretch of Kresky Avenue in Centralia containing many businesses that is susceptible to damage from flooding in the basin), generally between 0.5 and 0.8 feet. The drop in water surface elevations would be more than 11 feet in some places protected by the raised Airport levee. In the area west of I-5 and west of the Airport levee, which is closer to the river and more rural, water surface elevations are predicted to increase between 0.2 and 1.2 feet in most areas, and by as much as 1.3 feet in some locations. Increases in water surface elevations are largely because walls and levees would prevent floodwater from crossing over (or under) I-5 and over the Airport levee from west to east, resulting in more water staying on the west side of I-5 and the Airport levee closest to the river.

Appendix B provides a detailed map showing representative changes in the predicted peak water surface elevations throughout the project area in a 2007 and simulated 100-year flood event. The model simulations for determining the water surface elevations were conducted in July 2012.

How does the project impact surrounding residences and commercial buildings?

Based on a preliminary analysis, in events such as the 2007 flood Alternative 1 would lower flood elevations at 760 residences and 280 commercial buildings, generally east of I-5. Of these, 460 residences and 140 commercial buildings would no longer be flooded. Alternative 1 would raise flood levels at a total of 120 residences and 30 commercial buildings located mostly west of I-5, but no new structures would be flooded. Increases in flood elevation would need to be addressed through mitigation efforts such as raising buildings, moving buildings, buyouts, and other measures. Project cost estimates include funding for these mitigation efforts. Table 2 summarizes and rounds the results of the structure analysis conducted in August 2012. Please note that these are very rough estimates prepared using water surface elevation predictions and a standard set of assumptions about building locations within parcels. They are intended to provide a consistent way to begin to understand and compare potential community benefits and adverse impacts from I-5 protection alternatives. If alternatives move forward, additional analysis will be needed to better understand their potential impacts and benefits.

Table 2: Flood Mitigation in Twin Cities Area by Alternative 1

	I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
<-2	70	80	**150**
-2 to -1	480	130	**600**
-1 to 0	210	70	**280**

	I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
Sum Decreased Flooding	**760**	**280**	**1030**
0 to 1	90	20	**100**
1 to 2	30	10	**40**
>2	0	0	**0**
Sum Increased Flooding	**120**	**30**	**140**

	I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee, Dec 07 Event		
	Residence	**Commercial**	**Total**
Newly Flooded Buildings	0	0	**0**
Buildings No Longer Flooded	460	140	**600**

What are the potential impacts to natural resources?

Alternative 1 would create impacts to wetlands and cultural resources due to the excavation and fill necessary to build the floodwalls, levees, and stormwater treatment. Most wetland impacts would likely be mitigated at WSDOT's North Fork Newaukum Mitigation Bank. Any adverse affects to cultural resources would be addressed through consultation with interested parties.

There are no Endangered Species present in Dillenbaugh Creek or Salzer Creek. Alternative 1 may impact fish passage at these crossings due to the length of culverts needed to protect I-5, but there are mitigation opportunities nearby. WSDOT would continue to work with the Washington Department of Fish and Wildlife (WDFW) to determine how to address and minimize any impacts to fish passage at these locations.

Based on WSDOT's initial investigation, there appear to be no fatal flaws that would prevent Alternative 1 from moving forward. In addition, the natural resource impacts anticipated for Alternative 1 are essentially the same as those that would occur from anticipated (pending funding) future widening of I-5 to six lanes; therefore, these environmental impacts likely will occur regardless of whether Alternative 1 is constructed.

How much does the project cost?

Alternative 1 has an estimated cost of $80-100 million. This cost estimate includes funding for mitigation for affected properties and environmental mitigation that may be needed, as described above.

Does the project protect the Chehalis-Centralia Airport?

Yes, Alternative 1 includes improvements to the Chehalis-Centralia Airport levee that would protect the airport in a flood up to the 2007 level.

Does the project address future widening of I-5?

Yes. While it does not actually widen I-5, the improvements built as part of Alternative 1 will be needed when I-5 is widened in the future. Building these elements now avoids additional costs to build them at a later date. Additionally, elements of Alternative 1 would be designed to continue to provide flood protection when widening occurs. These include:

- Airport Levee – The levee would not be impacted by widening of I-5.
- Protection of SW Chehalis Ave. – Any wall or levee constructed to protect southwestern Chehalis between Main Street and the Green Hill School would not be impacted by widening I-5 to six lanes.
- Bridges – The project includes replacing five bridges (four over Dillenbaugh Creek and one over Salzer Creek) with culverts. These culverts will be designed to remain in place when I-5 is widened, although the Salzer Creek culvert may need to be lengthened for the widening project. Because the bridge crossings will be improved as part of the flood protection effort, WSDOT would save $15-$20 million on bridges in a future widening project.
- Right of Way acquisition – Any property acquired for the protection of I-5 would also serve the needs of any future widening project.
- Stormwater collection, conveyance, and treatment – The facilities constructed to collect, convey, store and treat stormwater runoff from I-5 will be preserved where possible. Treatment facilities are designed so they can be expanded if needed when I-5 is widened. If stormwater collection, conveyance, and treatment facilities are built as part of I-5 flood protection, they will be sized adequately where possible to serve any future widening project.
- Chamber Way Pump Station – This facility has been sited to accommodate future widening and can be preserved for continued use after widening.
- Levees – Levees have been designed and located to accommodate I-5 widening and would not need to be moved or reconstructed.
- Walls – Walls can be preserved in sections where widening will occur solely on the opposite side of I-5 (for example, adjacent to the railroad tracks).

Does the project improve access to the hospital in Centralia?

Yes. In a flood event up to the 2007 level, Alternative 1 improves access to the hospital if drivers can reach I-5 from the south or from the north of flooded areas. If drivers cannot access I-5 due to flooding on local roads in Chehalis or Centralia, they will not have improved access to the hospital under this alternative.

Would the project change if a dam were to be built on the upper Chehalis?

Yes. Because model simulations show that a dam would lower flood levels in the project area, walls and levees along I-5 could be smaller in some places and would not be needed in other places if a dam were built. The total cost of the project would be reduced by $20 million. Table 3 shows the differences in the length of walls and levees, and total costs, with and without a dam .

Table 3: Difference in Length of Levees and Total Costs in a With and Without Dam Scenario

Alternative: Levees, No Dam on Upper Chehalis	
Protective Measure	**Length (Miles)**
Airport Levee	2
SW Chehalis Levee	1
I-5 Walls and Levees	5
Total Cost: $80 to 100 million	

Alternative: Levees with Dam on Upper Chehalis	
Protective Measure	**Length (Miles)**
Airport Levee	2
SW Chehalis Levee	1
I-5 Walls and Levees	4
Total Cost: $60 to 80 million	

ALTERNATIVE 2: I-5 Raise and Widen Only

Alternative 2 would raise I-5 using fill material in areas where the interstate falls below the desired flood protection elevation, and widen I-5 from four to six lanes. It also would raise bridges within the project to above the flood elevation.

Raising I-5 using fill material would require reconstruction of all pavement, stormwater systems, illumination systems, and guardrail in the project area. In addition, because raising I-5 would reduce clearance for existing ramps and overpasses, it would require reconstruction of all aspects of the 13th Street, State Route 6, and Chamber Way interchanges and the West Street bridge.

Alternative 2 does not include raising the Chehalis-Centralia Airport Levee or building a new SW Chehalis Levee. However, these elements could be added to the project or constructed independently to provide additional protection in those areas.

How does the project increase or decrease flood levels in the nearby areas?

In a 2007 flood event, Alternative 2 would decrease water surface elevations east of I-5, particularly the developed area in Centralia and along the Miracle Mile (a stretch of Kresky Avenue in Centralia containing many businesses that is susceptible to damage from flooding in the basin), generally from 1.4 to 1.9 feet. In the area west of I-5, which is more rural, water surface elevations are predicted to generally increase between 0.2 to 0.9 feet, but by as much as 1.2 feet in some locations. Increases in water elevation are largely because raising I-5 on fill material creates a barrier, impeding flow of flood waters downstream.

In a simulated 100-year flood event, Alternative 2 would decrease water surface elevations east of I-5, particularly the developed area in Centralia and along the Miracle Mile, generally from 0.6 to 0.9 feet, but by as much as 1.9 feet lower in some locations. In the area west of I-5, which is closer to the river and more rural, water surface elevations are predicted to generally increase between 0.1 to 0.6 feet, but by as much as 0.8 feet in some locations. Increases in water elevation are largely because raising I-5 on fill material creates a barrier impeding flow of flood waters downstream.

Appendix C provides a detailed map showing representative changes in peak water surface elevations throughout the project area in a 2007 and simulated 100-year flood event. The model simulations for determining the water surface elevations were conducted in July 2012.

How does the project impact surrounding residences and commercial buildings?

Based on a preliminary analysis, in events such as the 2007 flood Alternative 2 would lower flood elevations at 660 residences and 180 commercial buildings, generally east of I-5. Of these, 360 residences and 40 commercial buildings would no longer be flooded. Alternative 2 would raise flood levels at a total of 170 residences and 130 commercial buildings located mostly west of I-5. Fewer than 10 additional buildings would be newly flooded (i.e., would experience flooding under this scenario when they have not been flooded before). Increases in flood elevation would need to be addressed through mitigation measures such as raising buildings, moving buildings, buyouts, and other measures. Project cost estimates include funding for these mitigation measures. Table 4 summarizes and rounds the results of the structure analysis conducted in August 2012. Please note that these are very rough estimates prepared using water surface elevation predictions and a standard set of assumptions about building locations within parcels. They are intended to provide a consistent way to begin to understand and compare potential community benefits and adverse impacts from I-5 protection alternatives. If alternatives move forward, additional analysis will be needed to better understand their potential impacts and benefits.

Table 4: Flood Mitigation in Twin Cities Area by Alternative 2

	I-5 Raise and Widen Only, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
<-2	30	0	**30**
-2 to -1	440	120	**560**
-1 to 0	190	60	**250**
Sum Decreased Flooding	**660**	**180**	**840**
0 to 1	170	130	**300**
1 to 2	0	0	**0**
>2	0	0	**0**
Sum Increased Flooding	**170**	**130**	**300**

	I-5 Raise and Widen only, Dec 07 Event		
	Residence	**Commercial**	**Total**
Newly Flooded Buildings	0	0	**0**
Buildings No Longer Flooded	360	40	**400**

What are the potential impacts to natural resources?

Alternative 2 would impact wetlands and cultural resources due to the excavation and fill necessary to raise I-5, and build stormwater treatment. Most wetland impacts would likely be mitigated for at WSDOT's North Fork Newaukum Mitigation Bank. Any adverse effects to cultural resources would be addressed through consultation with interested parties.

There are no Endangered Species present in Dillenbaugh Creek or Salzer Creek. Alternative 2 may impact fish passage at these crossings due to the length of culverts needed to protect I-5, but there are mitigation opportunities nearby. WSDOT would continue to work with the Washington Department of Fish and Wildlife (WDFW) to determine how to address and minimize any impacts to fish passage at these locations.

Noise analysis may show there would be an increase in noise levels in surrounding neighborhoods. This would only be slightly more of an increase than if I-5 were only widened and not raised. A noise analysis would determine if any noise mitigation (such as noise walls) would be appropriate.

Based on WSDOT's initial investigation, there appear to be no fatal flaws that would prevent this alternative from moving forward. In addition, as with Alternative 1, the natural resource impacts anticipated for Alternative 2 are essentially the same as those that would occur from anticipated (pending funding) future widening of I-5 to six lanes; therefore, these impacts likely will occur regardless of whether Alternative 2 is constructed.

How much does the project cost?

Alternative 2 has an estimated total cost of $450-550 million. To widen I-5 only would cost $250-350 million; to raise I-5 only would cost $350-$450 million. The cost estimates include funding for mitigation for affected properties and environmental mitigation that may be needed, as described above.

Does the project protect the Chehalis-Centralia Airport?

No, Alternative 2 does not include raising the Chehalis-Centralia Airport levee or building a new SW Chehalis levee. These elements could be added to the project or constructed independently to provide additional flood protection, but they were not included in cost estimates for this alternative.

Does the project address future widening of I-5?

Yes. Alternative 2 includes both raising and widening I-5 because WSDOT determined that it is not cost effective to only raise I-5 and defer widening. Both raising and widening I-5 would require reconstruction of the 13th Street, State Route 6, and Chamber Way interchanges, and West Street bridge. Raising and widening at the same time prevents rework in these areas and avoids associated increased costs.

The cost range to only raise I-5 as part of one project (i.e. rebuild four lanes at higher level) is $350-450 million. The cost range to raise and widen I-5 (i.e. rebuild six lanes at higher level) is $450-550 million.

The cost range to widen I-5 through a separate future project, after I-5 had been raised, is $120-170 million. The total cost of raising I-5, then widening I-5 as a separate project is $470-620 million. It would cost an additional $20-70 million to raise and widen separately.

Raising I-5 requires a complete rebuild of the interstate for the full width of 88 feet (four lanes and four shoulders). This includes stormwater treatment, illumination, pavement, concrete barrier, and all other elements of the interstate. Although a raise-only project would not widen I-5 to six lanes, where possible it would likely construct various elements to accommodate future widening to six lanes. For example, the bridges over I-5 at SR 6 and Chamber Way would be built long enough to accommodate a six lane I-5. Overbuilding these structures as part of raising I-5 would require more upfront costs. However, it would avoid costly demolition and reconstruction as part of a future widening project.

Raising and widening I-5 at the same time also requires a complete rebuild of the interstate to a width of 112 feet (six lanes and four shoulders). It also requires stormwater treatment, illumination, pavement, concrete barrier, and all other elements of the interstate. Since all of these facilities must be rebuilt whether I-5 is four lanes or six, widening adds only the costs associated with the additional 24 feet of width for two more lanes.

Although various structures (i.e. bridges over I-5 at SR 6 and Chamber Way) would be constructed to accommodate a future six lanes, returning at a later date to widen I-5 to six lanes after only raising it could require the tear out and reconstruction of portions of stormwater facilities, illumination, and various other elements, and would include another round of traffic control costs, temporary walls, temporary water treatment, etc. At each interchange, a portion of all four ramps would need to be constructed to properly tie into the new lanes added on the outside of I-5.

Does the project improve access to the hospital in Centralia?

Yes. In a flood event up to the 2007 level, Alternative 2 improves access to the hospital if drivers can reach I-5 from the south or from the north of flooded areas. If drivers cannot access I-5 due to flooding on local roads in Chehalis or Centralia, they will not have improved access to the hospital under this alternative.

Would the project change if a dam were to be built on the upper Chehalis?

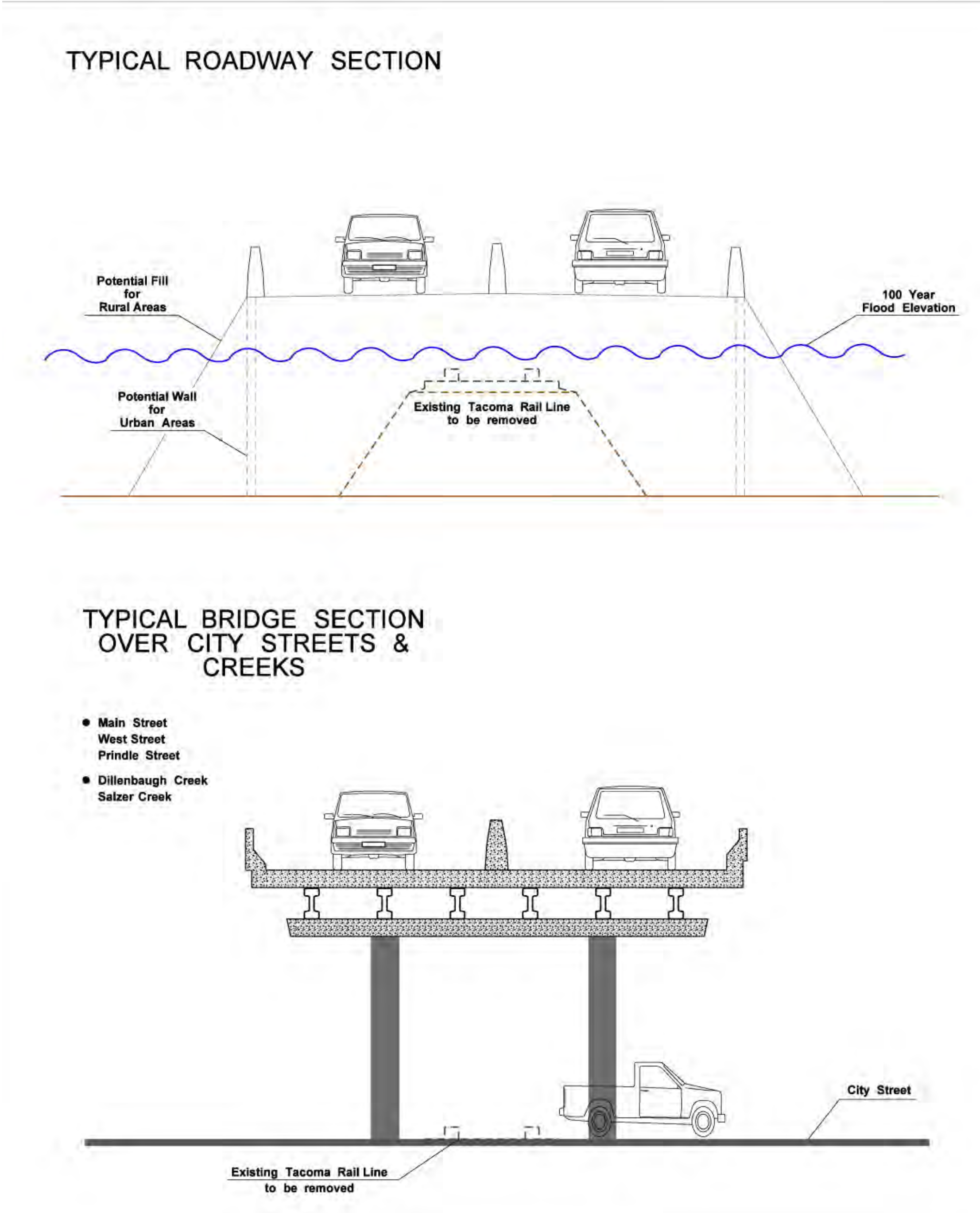
Yes. Because a dam would lower flood levels in the project area, WSDOT would not need to raise I-5 as high, would use less fill material, and would create a smaller overall footprint if a dam were built. The total cost of the project would drop approximately five to 10 percent.

ALTERNATIVE 3: I-5 Express Lanes

Alternative 3 would construct new express lanes adjacent to I-5. Express lanes would be four miles in length and one lane in each direction, constructed a minimum of three feet above the 100-year flood elevations. This would provide traffic the opportunity to bypass I-5 if the main interstate was closed by major floods. Outside of any flood events, express lanes also would be available to traffic 24 hours a day, seven days a week.

The express lanes would diverge from I-5 at 13th Street, and then follow the existing Tacoma Rail line through Chehalis, with bridges over West, Prindle, and Main streets in Chehalis. To minimize right-of-way acquisition and impacts to adjacent properties, the lanes would be built on fill material with side slopes in rural areas and would be built on fill material contained by walls in urban areas. Figure 3 provides a cross-section view of the typical roadway section and typical bridge section over city streets and creeks for Alternative 3.

Figure 3: Cross Section View of I-5 Express Lanes or Temporary Bypass



For the most part, the Tacoma Rail line runs through the industrial area of Chehalis, but also lies adjacent to several homes and businesses in the Westside Chehalis neighborhood. The lanes likely would be visible from some homes on the edge of the Westside neighborhood. A noise study has not been conducted yet, but cost estimates for the project include funding for noise walls in the event they are needed.

There are significant uncertainties with the express lanes. Perhaps most importantly, it is not known whether the City of Tacoma would sell the right-of-way along the Tacoma Rail line, and, if so, at what cost. The express lanes would not provide local access between 13th Street and Mellen Street. The City of Chehalis has expressed strong concerns about the express lanes alternative and its potential effects on the community.

In addition, during the public comment period the Lewis County Public Utility District (PUD) expressed concerns that the express lanes would encroach on a project being built where the Tacoma Rail track borders PUD property at Main and Quincy avenues in Chehalis. Residents of the Westside neighborhood, and businesses such as the Wilco Agricultural Center, CENEX, Chehalis West Assisted Living, and National Frozen Foods also expressed strong concerns about the potential long-term adverse impacts on property value and business revenue, increased air pollution, noise levels, and traffic volume adjacent to and through the project area, and the flow of water in and through the neighborhood during major flood events. WSDOT acknowledges these concerns and that careful evaluation of potential impacts and mitigation measures would be needed if the express lanes option were to proceed.

Alternative 3 does not include raising the Chehalis-Centralia Airport Levee or building a new SW Chehalis Levee. These elements could be added to the project or constructed independently to provide additional flood protection. If express lanes are constructed, they would eliminate the need to widen I-5 in the future, saving $250-350 million.

A detailed map showing an overview and close-up view of the express lanes is provided in Figures 4 and 5.

Figure 4: Alternative 3 – I-5 Express Lanes Overview

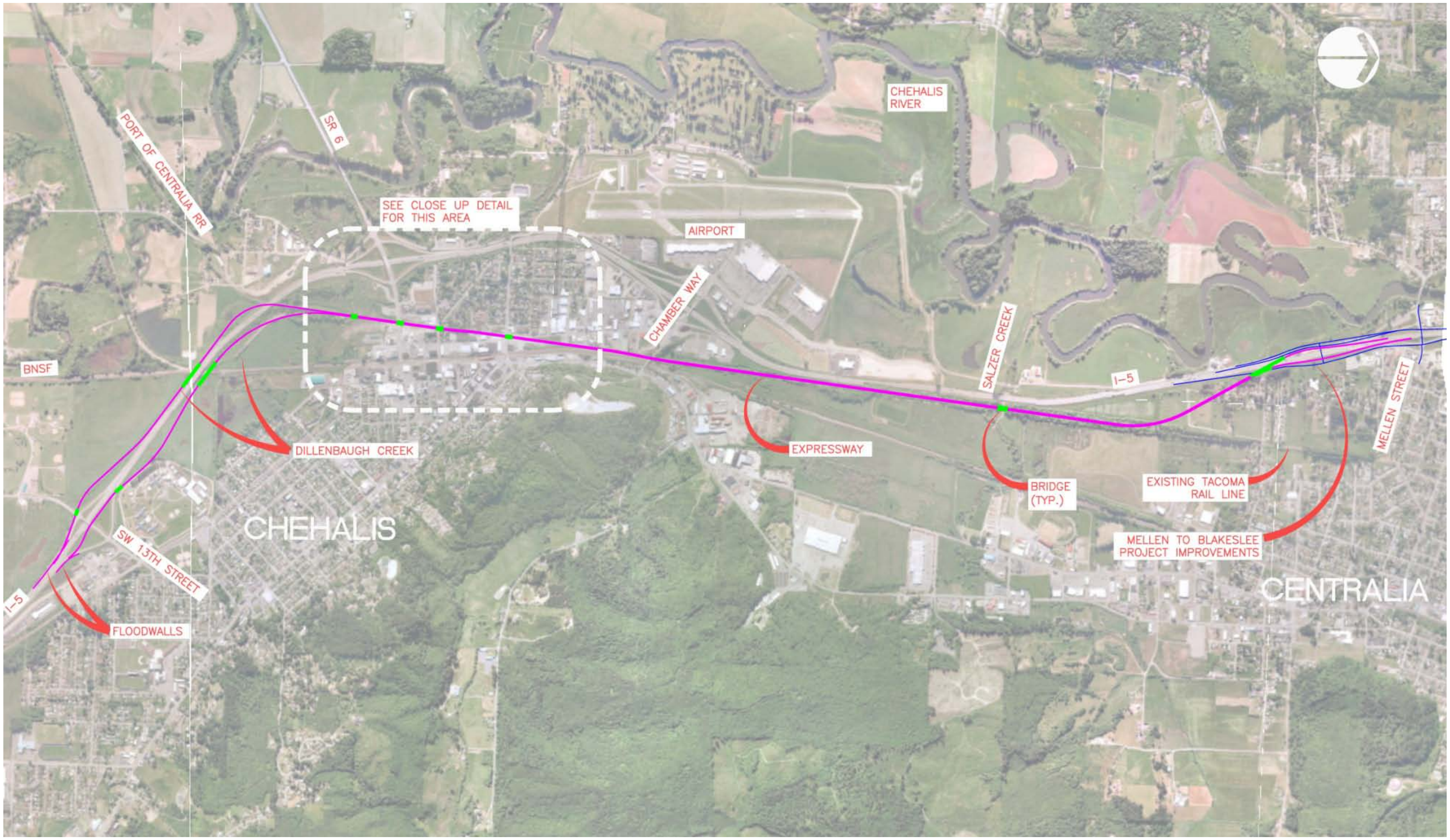
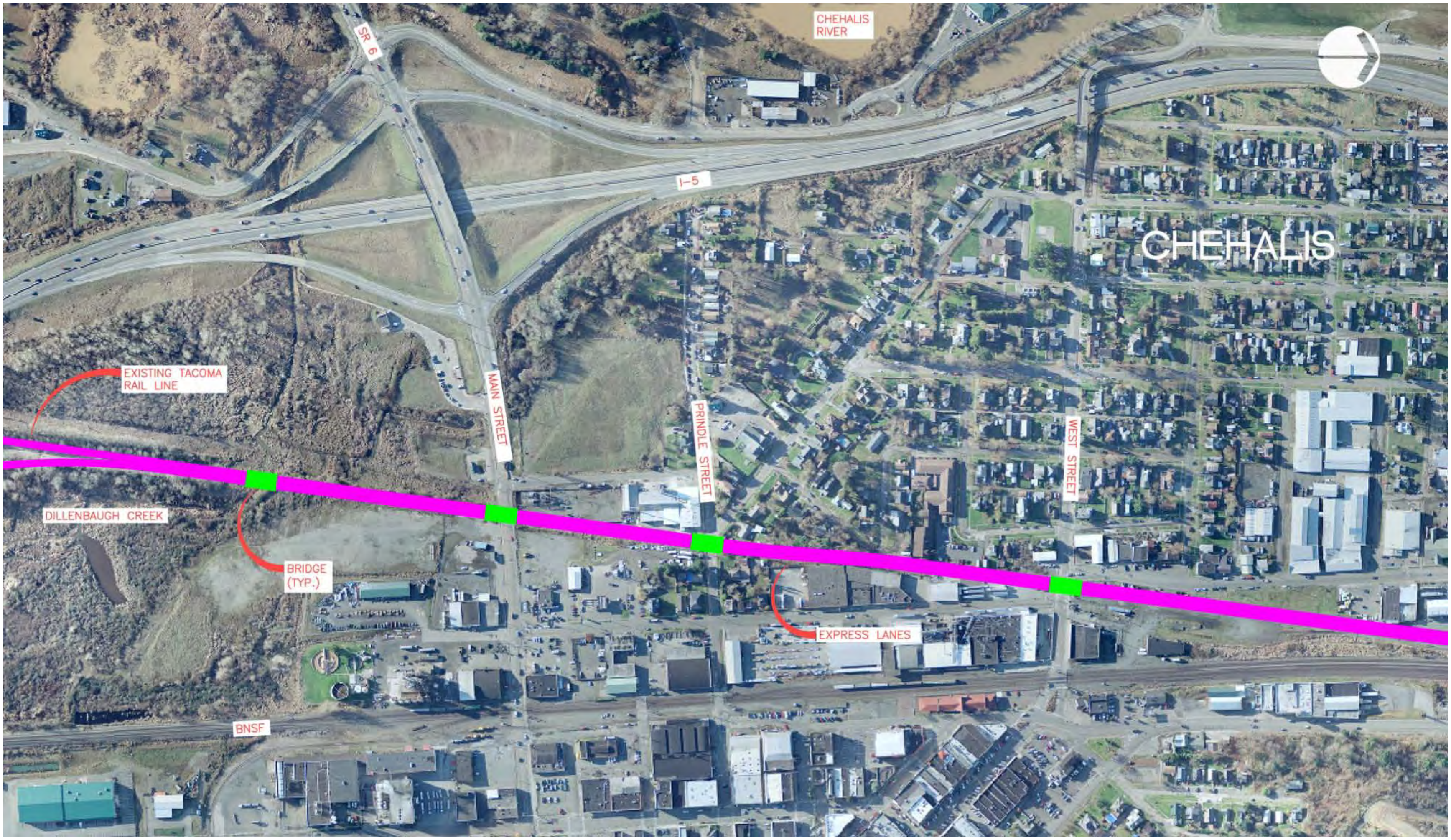


Figure 5: Alternative 3 – I-5 Express Lanes Close-up Detail



How does the project increase or decrease flood levels in the nearby areas?

In a 2007 flood event, Alternative 3 would decrease water surface elevations east of I-5, generally between 0.4 and 1.1 feet. In the area west of I-5, which is more rural, water surface elevations are predicted to increase generally between 0.0 and 0.6 feet. In a simulated 100-year flood event, Alternative 3 would decrease water surface elevations east of I-5, particularly the developed area between Salzer Creek and Mellen Street, generally between 0.6 and 0.9 feet, but by as much as 1.5 feet in some locations. In the area west of I-5, which is closer to the river and more rural, water surface elevations are predicted to increase generally between 0.1 and 0.6 feet. The modeled changes in water surface elevations are primarily due to the barrier created by placing a road above the railroad tracks; water would not flow over the existing railroad bed as it has in the past major floods. A lesser cause of the increases in water surface elevation is fill reducing the amount of flood water storage in the area..

Appendix D provides a detailed map showing representative changes in peak water surface elevation throughout the project area in a 2007 and simulated 100-year flood event. The model simulations for determining the water surface elevation were conducted in July 2012.

How does the project impact surrounding residences and commercial buildings?

Based on a preliminary analysis, in events such as the 2007 flood Alternative 3 would lower flood elevations at 700 residences and 190 commercial buildings generally east of I-5. Of these, 290 residences and 30 commercial buildings would no longer be flooded. Alternative 3 would raise flood levels at a total of 80 residences and 90 commercial buildings located mostly west of I-5, and 10 additional buildings would be newly flooded. Increases in flood elevation would need to be addressed through mitigation measures such as raising buildings, moving buildings, buyouts, and other measures. Project cost estimates include funding for these mitigation measures. Table 5 summarizes and rounds the results of the structure analysis conducted in August 2012. Please note that these are very rough estimates prepared using water surface elevation predictions and a standard set of assumptions about building locations within parcels. They are intended to provide a consistent way to begin to understand and compare potential community benefits and adverse impacts from I-5 protection alternatives. If alternatives move forward, additional analysis will be needed to better understand their potential impacts and benefits.

Table 5: Flood Mitigation in Twin Cities Area by Alternative 3

	I-5 Express Lanes, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
<-2	0	0	**0**
-2 to -1	290	20	**310**
-1 to 0	410	170	**580**
Sum Decreased Flooding	**700**	**190**	**890**

	I-5 Express Lanes, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
0 to 1	80	90	**170**
1 to 2	0	0	**0**
>2	0	0	**0**
Sum Increased Flooding	**80**	**90**	**170**

	I-5 Express Lanes, Dec 07 Event		
	Residence	**Commercial**	**Total**
Newly Flooded Buildings	0	10	**10**
Buildings No Longer Flooded	290	30	**320**

What are the potential impacts to natural resources?

Alternative 3 would impact wetlands and cultural resources due to the excavation and fill necessary to construct the lanes on top of fill, bridges over existing city streets and stormwater treatment. Most wetland impacts would likely be mitigated for at WSDOT's North Fork Newaukum Mitigation Bank. Any adverse affects to cultural resources would be addressed through consultation with interested parties.

There are no Endangered Species present in Dillenbaugh Creek or Salzer Creek. Alternative 3 would construct an additional stream crossing at both creeks. These would be short enough that fish passage should not be compromised. If needed, there are mitigation opportunities in the area. WSDOT would continue to work with the Washington Department of Fish and Wildlife (WDFW) to determine how to address and minimize any impacts to fish at these locations.

Noise analysis may show there would be an increase in noise levels in surrounding neighborhoods. A noise analysis would determine if any noise mitigation (potentially noise walls) would be appropriate.

There may be hazardous materials to address in the industrial area of the Tacoma Rail line. Removal may not be required since the lanes would be built on top of fill material.

Based on WSDOT's initial investigation, there appear to be no fatal flaws that would prevent this alternative from moving forward. As with Alternatives 1 and 2, the natural resource impacts anticipated for Alternative 3 are essentially the same as those that would occur from anticipated (pending funding) future widening of I-5 to six lanes, due to the proximity of the location of the Tacoma Rail line to I-5; therefore, these impacts likely will occur regardless of whether Alternative 3 is constructed.

How much does the project cost?

The estimated cost of Alternative 3 is $120-150 million, not including the cost for the Tacoma Rail line property. This cost estimate includes funding for mitigation for affected properties and environmental mitigation that may be needed, as described above.

Does the project protect the Chehalis-Centralia Airport?

No. Alternative 3 does not include raising the Chehalis-Centralia Airport levee or building a new SW Chehalis levee. Therefore, those areas are not protected. These elements could be added to the project or constructed independently to provide additional flood protection, but they were not included in cost estimates for this alternative.

Does the project address future widening of I-5?

Yes. Alternative 3 would provide the capacity needed to prevent traffic congestion on I-5. Therefore, it would eliminate the need to spend $250-350 million on a future widening project.

Does the project improve access to the hospital in Centralia?

Yes. In a flood event up to the 2007 level, Alternative 3 provides a viable route around the portions of I-5 that are inundated during a flood event and can improve access to the hospital if drivers can reach I-5 from the south or from the north of flooded areas. Drivers must be able to access I-5 north or south of where the express lanes connect to I-5 to be able to reach the hospital, as this alternative does not provide direct connections to local roads.

Would the project change if a dam were to be built on the upper Chehalis?

Yes. Because a dam would lower flood levels in the project area, WSDOT would be able to reduce the height of the express lanes in the floodplain area. The total cost of the project would be reduced by two to five percent.

ALTERNATIVE 4: I-5 Temporary Bypass

Alternative 4 would construct temporary bypass lanes adjacent to I-5. Similar to the express lane alternative, the bypass lanes would diverge from I-5 at 13th Street, and then follow the existing Tacoma Rail line through Chehalis, with a bridge over Main Street. Prindle and West streets would be at-grade intersections; however, flood gates would close these access points during flood events to keep flood waters out of the temporary bypass. The lanes would be built on fill material with side slopes in rural areas and would be built on fill material contained by walls in urban areas to minimize right-of-way acquisition and impacts to adjacent properties.

The bypass lanes would be four miles in length and one lane in each direction, constructed a minimum of three feet above the 100-year flood elevations. This would provide a local bypass opportunity if the main part of I-5 were to be closed by major floods. Because the bypass lanes would only be used during major flood events, they would not eliminate the need to widen I-5 in the future. In addition, the connections to and from I-5 could be built at the ground level (unlike express lanes which would require high speed flyover ramps). See Figure 3 in the Alternative 3 section for a cross-section view of the typical roadway section and typical bridge section over city streets and creeks for temporary bypass lanes.

There are significant uncertainties with the bypass lanes. Perhaps most importantly, it is not known whether the City of Tacoma would sell the right-of-way along the Tacoma Rail line and, if so, at what cost. The temporary bypass would not provide local access between 13th Street and Mellen Street. The City of Chehalis has expressed strong concerns about the bypass alternative and its potential effects on the community.

In addition, as with the express lanes alternative (Alternative 3), during the public comment period the Lewis County Public Utility District (PUD) expressed concerns that the express lanes would encroach on a project being built where the Tacoma Rail track borders PUD property at Main and Quincy Avenues in Chehalis. Residents of the Westside neighborhood, and businesses such as the Wilco Agricultural Center, CENEX, Chehalis West Assisted Living, and National Frozen Foods also expressed strong concerns about the potential long-term impacts on property value and business revenue, increased air pollution, noise levels, and traffic volume adjacent to and through the project area, and the flow of water in and through the neighborhood during major flood events. WSDOT acknowledges these concerns and that careful evaluation of potential impacts and mitigation measures would be needed if the bypass lanes option were to proceed.

Alternative 4 does not include raising the Chehalis-Centralia Airport levee or building a new SW Chehalis levee. These elements could be added to the project or constructed independently to provide additional flood protection.

A detailed map showing an overview and close-up view of the temporary bypass is provided in Figures 6 and 7.

Figure 6: Alternative 4 - I-5 Temporary Bypass Overview

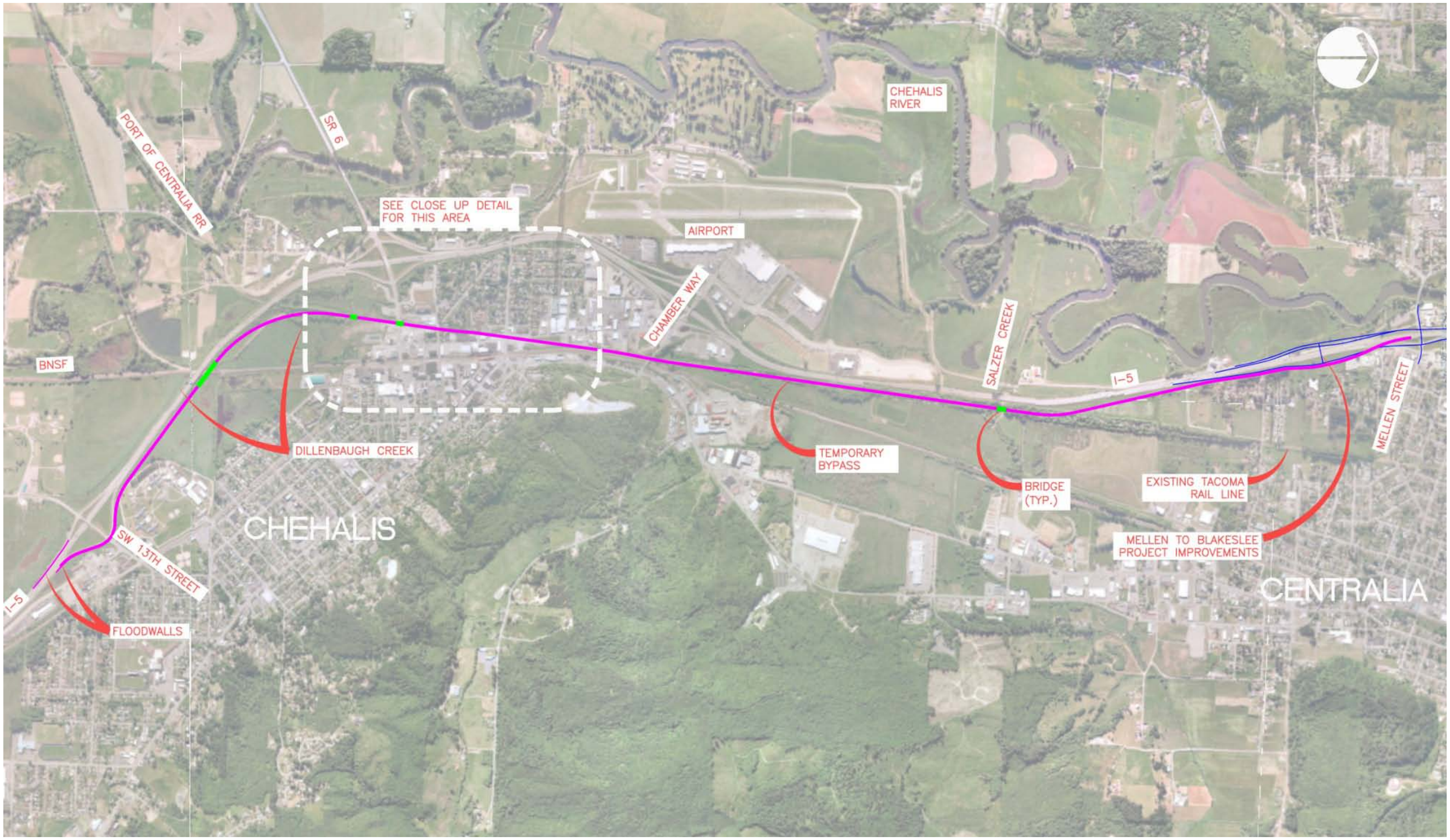


Figure 7: Alternative 4 - I-5 Temporary Bypass Close-up

How does the project increase or decrease flood levels in the nearby areas?

In a 2007 flood event, Alternative 4 would decrease water surface elevations east of I-5, generally between 0.4 and 1.1 feet. In the area west of I-5, which is more rural, water surface elevations are predicted to increase by generally 0.0 and 0.6 feet. In a simulated 100-year flood event, Alternative 4 would decrease water surface elevations east of I-5, particularly the developed area in Centralia and along the Miracle Mile (a stretch of Kresky Avenue in Centralia containing many businesses that is susceptible to damage from flooding in the basin), generally between 0.6 and 0.9 feet, but by as much as 1.5 feet in some locations. In the area west of I-5, which is closer to the river and more rural, water surface elevations are predicted to increase generally between 0.1 and 0.6 feet. The modeled changes in water surface elevations are primarily due to the barrier created by placing a road above the railroad tracks; water would not flow over the existing railroad bed as it has in the past major floods. A lesser cause of the increases in water surface elevation is due to fill reducing the amount of flood water storage in the area.

Appendix E provides a detailed map showing representative changes in peak water surface elevation throughout the project area in a 2007 and simulated 100-year flood event. The model simulations for determining the water surface elevation were conducted in July 2012.

How does the project impact surrounding residences and commercial buildings?

Based on a preliminary analysis, in events such as the 2007 flood Alternative 4 would lower flood elevations at 710 residences and 190 commercial building generally east of I-5. Of these, 290 residences and 30 commercial buildings would no longer be flooded. Alternative 4 would raise flood levels at a total of 80 residences and 90 commercial buildings located mostly west of I-5, and an additional 10 buildings would be newly inundated. Increases in flood elevation would need to be addressed through mitigation measures such as raising buildings, moving buildings, buyouts, and other measures. Project cost estimates include funding for these mitigation measures. Table 6 summarizes and rounds the results of the structure analysis conducted in August 2012. Please note that these are very rough estimates prepared using water surface elevation predictions and a standard set of assumptions about building locations within parcels. They are intended to provide a consistent way to begin to understand and compare potential community benefits and adverse impacts from I-5 protection alternatives. If alternatives move forward, additional analysis will be needed to better understand their potential impacts and benefits.

Table 6: Flood Mitigation in Twin Cities Area by Alternative 4

	I-5 Bypass Lanes, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
<-2	0	0	**0**
-2 to -1	290	20	**310**
-1 to 0	420	170	**590**
Sum Decreased Flooding	**710**	**190**	**900**

	I-5 Bypass Lanes, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
0 to 1	80	90	**170**
1 to 2	0	0	**0**
>2	0	0	**0**
Sum Increased Flooding	**80**	**90**	**170**

	I-5 Bypass Lanes, Dec 07 Event		
	Residence	**Commercial**	**Total**
Newly Flooded Buildings	0	10	**10**
Buildings No Longer Flooded	290	30	**320**

What are the potential impacts to natural resources?

Alternative 4 would impact wetlands and cultural resources due to the excavation and fill necessary to construct the lanes on top of fill, bridges over existing city streets and stormwater treatment. Most wetland impacts would likely be mitigated at WSDOT's North Fork Newaukum Mitigation Bank. Any adverse affects to cultural resources would be addressed through consultation with interested parties.

There are no Endangered Species present in Dillenbaugh Creek or Salzer Creek. Alternative 3 would construct an additional stream crossing at both creeks. These would be short enough that fish passage should not be compromised. If needed, there are mitigation opportunities in the area. WSDOT would continue to work with the Washington Department of Fish and Wildlife (WDFW) to determine how to address and minimize any impacts to fish at these locations.

Since the bypass lanes would be used only during flood events, the increase in noise levels in surrounding neighborhoods would be for such a short duration that a noise analysis would likely determine no noise mitigation was necessary.

There may be hazardous materials to address in the industrial area of the Tacoma Rail line. Removal may not be required since the lanes would be built on top of fill material.

Based on WSDOT's initial investigation, there appear to be no fatal flaws that would prevent this alternative from moving forward. The natural resource impacts anticipated for Alternative 4 are similar to those anticipated for Alternative 3.

How much does the project cost?

The estimated cost of Alternative 4 is $70-90 million, not including the cost for the Tacoma Rail line property. This cost estimate includes funding for mitigation for affected properties and environmental mitigation that may be needed, as described above.

Does the project protect the Chehalis-Centralia Airport?

No, Alternative 4 does not include raising the Chehalis-Centralia Airport levee or building a new SW Chehalis levee. Therefore, those areas are not protected. These elements could be added to the project or constructed independently to provide additional flood protection, but they were not included in cost estimates for this alternative.

Does the project address future widening of I-5?

No, Alternative 4 does not address the need to widen I-5 in the future.

Does the project improve access to the hospital in Centralia?

Yes. In a flood event up to the 2007 level, Alternative 4 provides a viable route around the portions of I-5 that are inundated during a flood event and can improve access to the hospital if drivers can reach I-5 from the south or from the north of flooded areas. Drivers must be able to access I-5 north or south of where the bypass lanes connect to I-5 to be able to reach the hospital, as this alternative does not provide direct connections to local roads.

Would the project change if a dam were to be built on the upper Chehalis?

Yes. Because a dam would lower flood levels in the project area WSDOT would be able to reduce the height of the bypass lanes in the floodplain area. The total cost of the project would be reduced by approximately two to five percent.

ALTERNATIVE 5: I-5 Viaduct

Alternative 5 would construct a viaduct by elevating I-5 on piers from south of State Route 6 to Mellen Street. This project would widen I-5 to six lanes and require reconstruction of all interchanges in the project area. WSDOT determined that widening should be included in any viaduct project because it would be completely ineffective to build only four lanes when six are needed to serve capacity.

The viaduct alternative has an estimated cost of more than $1.5 billion. It would reduce flood elevations west of I-5 along the Chehalis River, but would increase flood elevations east of I-5 in the urban area of Centralia. For these reasons, WSDOT does not consider this project a feasible alternative and did not evaluate the project in further detail.

ALTERNATIVE 6: I-5 Relocation

Alternative 6 would relocate I-5 outside of the flood area. The project would build a six-lane I-5, and would require constructing new interchanges in the project area.

The relocation alternative has an estimated cost of more than $2 billion. Relocating I-5 would diverge outside of the existing interstate and cut through Centralia and Chehalis, splitting neighborhoods and impacting the urban and natural environment in and around both cities. For these reasons, WSDOT does not consider this project a feasible alternative and did not evaluate the project in further detail.

Side by Side Project Comparisons

Table 7: Side-by-side Project Comparison of Alternatives

Alternative	Impacts to Buildings**				Protect Airport & SW Chehalis	Ability to Meet Future I-5 Capacity Needs	Cost of Alternative *(A)*	Cost of Future I-5 Widening After Alternative is Constructed *(B)*	Total Cost of Alternative Plus Cost to Meet Future I-5 Capacity Needs *(C)* *A + B = C*
	100-year Flood Event		2007 Flood Event						
	Positive	*Negative*	*Positive*	*Negative*					
1. I-5 Walls and Levees, Raise Airport Levee, New Chehalis Levee	510	140	1030	140	Y	Future widening required. Allows for widening.	$80 to 100 Million	$225 to 330 Million	$305 to 430 Million
2. I-5 Raise and Widen Only	430	240	840	300	N*	Provides widening of I-5.	$450 to 550 Million	$0	$450 to 550 Million
3. I-5 Express Lanes	390	180	890	170	N*	Provides capacity, future widening unnecessary.	$120 to 150 Million****	$0	$120 to 150 Million
4. I-5 Temporary Bypass	400	150	900	170	N*	Future widening required. Allows for widening.	$70 to 90 Million****	$250 to 350 Million	$320 to 440 Million
5. I-5 Viaduct	***	***	***	***	N*	Replaces I-5 with new facility with sufficient capacity.	Greater than $1.5 Billion	$0	Greater than $1.5 Billion
6. I-5 Relocation	***	***	***	***	N*	Replaces I-5 with new facility with sufficient capacity.	Greater than $2 Billion	$0	Greater than $2 Billion

* Chehalis - Centralia Airport Levee or new SW Chehalis Levee could be added to this alternative or constructed as an independent project.
** The positive or negative '*Impacts to Buildings*' indicates the total predicted number of buildings experiencing decreased (positive) or increased (negative) flood elevations resulting from the alternative.
*** '*Impacts to Buildings*' analysis was not conducted as this Alternative was deemed not viable for further analysis.
**** Estimates do not include the costs to acquire the Tacoma Rail Right of Way

Conclusions and Next Steps

The effort to evaluate options to protect I-5 from flooding is part of a larger effort to protect people and communities in the Chehalis River Basin. While it is important that I-5 protection be part of a basin-wide solution to flooding in the Chehalis, I-5 protection is not the only flood damage reduction need and likely will not move forward without complementary efforts to provide broader protections for people and communities.

In support of the larger effort to identify basin-wide approaches to flood damage reduction in the Chehalis, this report looks only at options to protect I-5. There are a variety of approaches that could be used to protect I-5 from flooding. Some of the alternatives to protect I-5 could be considered in conjunction with other flood protection efforts in the Chehalis Basin, like a dam or flood bypasses. Due to time and funding constraints WSDOT has done a limited amount of design work to define and evaluate these alternatives. More work would be needed to refine and optimize alternatives individually or as part of a larger package of flood damage reduction efforts.

WSDOT considered six alternatives in this report:

- **Alternative 1: I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee** – Provides protection of I-5 and the Chehalis-Centralia Airport in flood events up to the 2007 or simulated 100-year flood level. It improves conditions for approximately 1030 buildings, but has a negative impact for approximately 140 buildings on the west side of I-5 near the Chehalis River and along the Newaukum River and Dillenbaugh Creek. These negative impacts can be mitigated and funding for flood impact and environmental mitigation is included in the cost estimates for this alternative. Alternative 1 does not address the need to widen I-5 in the future. Alternative 1 appears to warrant further consideration as an independent project or in combination with other flood hazard mitigation elements in the Chehalis Basin.
- **Alternative 2: I-5 Raise and Widen Only** – Provides protection of I-5 in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 840 buildings, but has a negative impact for approximately 300 buildings on the west side of I-5 near the Chehalis River and along the Newaukum River and Dillenbaugh Creek. These negative impacts can be mitigated and funding for flood impact and environmental mitigation is included in the cost estimates for this alternative. Alternative 2 does address the need to widen I-5 in the future. Alternative 2 appears to warrant further consideration as an independent project or in combination with other flood hazard mitigation elements in the Chehalis Basin.
- **Alternative 3: I-5 Express Lanes** - Provides a viable route around the portions of I-5 that are inundated during a flood event. This alternative route would be protected in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 890 buildings, but has a negative impact for approximately 170 buildings on the west side of I-5 near the Chehalis River and along the Newaukum River and Dillenbaugh Creek. These negative impacts can be mitigated and funding for flood impact and environmental mitigation is included in the cost estimates for this alternative. There are significant uncertainties with this alternative, such whether the City of Tacoma would sell the right-of-way to the Tacoma Rail line and, if so, at what cost, and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. However, Alternative 3 does address the future need to widen I-5,

and provides a significant cost savings over other widening approaches. If Alternative 3 is to warrant further consideration, more work is required to determine feasibility.

- **Alternative 4: I-5 Temporary Bypass** - Provides a viable route around the portions of I-5 that are inundated during a flood event. This alternative route would be protected in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 900 buildings, but has a negative impact for approximately 170 buildings on the west side of I-5 near the Chehalis River and along the Newaukum River and Dillenbaugh Creek. These negative impacts can be mitigated and funding for flood impact and environmental mitigation is included in the cost estimates for this alternative. There are significant uncertainties with this alternative, such whether the City of Tacoma would sell the right-of-way to the Tacoma Rail line and, if so, at what cost, and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. Alternative 4 does not address the future need to widen I-5. If Alternative 4 is to warrant further consideration, more work is required to determine feasibility.
- **Alternative 5: I-5 Viaduct** - WSDOT does not consider this a viable alternative due to high costs and increased flood elevations in the urban areas of Centralia.
- **Alternative 6: I-5 Relocation** - WSDOT does not consider this a viable alternative due to high costs and impacts to the built and natural environment surrounding Chehalis and Centralia.

In late 2012, Governor Gregoire convened a small group of leaders in the Chehalis Basin to develop a plan of action to reduce damages from major flooding from the Chehalis River. The group recommends a series of actions that, taken together, will represent a significant investment to reduce flood damages in the short term, enhance natural floodplain function and fisheries, and put the Basin on firm footing to make critical decisions about large scale projects. Recommended actions include:

- Large-scale capital projects affecting a broad geographic area like a water retention, and/or improvements to protect Interstate 5
- Smaller-scale capital projects with more localized benefits
- Environmental projects to enhance overall conditions, aquatic habitat, and abundance of fish in the Basin
- Land use management to help people already in the floodplain and reduce the potential that new development will increase flood damage
- An effective system of flood warning and emergency response

Relative to I-5 protection, the group recommended funding be provided to determine the best combination of walls, levees, pumps, bypasses and other structures needed to protect Interstate 5 traffic, the airport and key urban areas of Centralia and Chehalis, if a dam is in place, to evaluate changes to the project that would be needed to secure comparable protection without a retention facility, to improve damage estimates to residential and commercial structures, and to improve the economic impact estimate from I-5 closures.

Appendix A:

Determining the right measurement for I-5 flood protection

Any major investment in flood protection must ensure that it will actually be effective in avoiding flooding and an I-5 closure under a wide range of events and potential future conditions (development, land use, climate change, etc.).

To accomplish this, WSDOT determined the distance needed from the calculated water surface during a flood to the top of the flood hazard mitigation element (e.g., levee or flood wall) to provide robust, reliable protection for I-5 and the Chehalis-Centralia Airport. This measurement is called "freeboard."

It is extremely important to identify the right amount of freeboard. The right amount of freeboard will provide confidence that, no matter what flood protection measures the legislature directs WSDOT to build, they provide protection for predicted floods in the project area.

WSDOT determined that freeboard must be three feet above the 100-year flood level. This level of protection equates to a minimum of one foot above the 2007 flood level in the Chehalis-Centralia area. This measurement was established through analysis by WSDOT's State Hydraulic Office as sufficient to cover a potential future water flow increase of 25 percent, which could be due to changes in the Chehalis River Basin such as development, land use, climate change, etc. This measurement would have protected I-5 in the 2007 flood, which was in excess of a 100-year flood event. See Appendix A.1 for a technical memorandum on WSDOT's hydrologic and hydraulic analysis to determine freeboard.

The following factors contributed to WSDOT's determination of freeboard:

- *Safety and economic risks* – In particular, there are significant safety risks if I-5 were to be inundated;
- *The size of the investment* – Any investment to protect I-5 will be substantial and there should be confidence that it will reliably prevent I-5 closures;
- *Frequency and variability of flood events in the Chehalis River Basin* – Each flood event is different, and I-5 protection must work across the full range of event types;
- *Difficulty precisely predicting flood levels and complexity of flood hydrology* – Because of its landscape and proximity to multiple water sources, there is significant variability in how flooding occurs in the Centralia-Chehalis area. When flooding predictions raise a serious risk that I-5 may be overtopped, safety concerns prompt a conservative decision about closing I-5. In addition to the threat of overtopping, serious concerns over the structural integrity of the Airport levee have contributed to decisions to close I-5. During the last flood events there have been significant boils developing near the levee; these can cause the levee to breach instantly which would fully inundate I-5 very quickly, posing a serious safety risk; and,
- *Time required to close I-5* – Because it takes time to safely and effectively close I-5, decisions to close the interstate must be made well in advance of potential flooding impacts.

Safety and Economic Risks

I-5 is vital to the state's economy and acts as the West Coast's major north-south transportation corridor. The uninterrupted movement of cars, trucks, freight, and recreational vehicles along I-5 is essential to the quality of life and economic vitality in the region. Interruption of I-5 significantly affects the economy of Washington State and the West Coast.

The stretch of I-5 at Centralia-Chehalis is a midpoint between Seattle, Washington and Portland, Oregon. It connects two of the West Coast's major population and industrial centers, making it the most crucial transportation link in the area.

I-5 near the Chehalis-Centralia Airport levee (and Chamber Way fill) is a low spot in the area. The Interstate is at least six to seven feet below the top of the levee, and significantly lower than other portions of I-5 and the surrounding area. It can easily and quickly accumulate deep floodwaters if any nearby part of the interstate is inundated, presenting obvious and significant safety challenges to drivers. This risk of rapid and deep inundation of I-5, from overtopping of the Airport levee or due to a structural failure of the levee, prompts WSDOT to take a conservative approach to ensuring that I-5 is fully and effectively closed whenever there is serious potential for inundation and well before there is any water actually on or across the interstate.

The Size of the Investment

Any investment to protect I-5 will be substantial and there should be confidence that it will reliably prevent I-5 closures. Therefore, WSDOT must determine a measurement for freeboard that ensures robust protection.

Frequency and Variability of Flood Events in the Chehalis River Basin

Over the past 25 years, the stretch of I-5 from 13th Street to Mellen Street has closed four times due to flooding. The 1990 flood event in the Chehalis Basin closed I-5 for one day; the February 1996 and December 2007 flood events closed I-5 for four days each; and the January 2009 flood event closed this stretch of I-5 for two days. Each flood event has been unique and their effects difficult to predict with precision.

In February 1996 the flood was the result of a large frontal storm with very broad rainfall from north of Seattle to southern Oregon; in December 2007 the storm was concentrated in the Willapa Hills in the upper Chehalis Basin; and in January 2009 the storm focused on the eastern and northern portions of the Chehalis Basin. Each of these storms was different in how it contributed to the flooding of I-5, and the uncertainties of development, land use, and climate change and how that may affect future flood events, require WSDOT to be conservative when determining freeboard (see Appendix A.1). The factor WSDOT uses must be conservative enough to ensure protective measures will remain feasible across the full range of event types and well into the future.

Difficulty Precisely Predicting Flood Levels and Complexity of Flood Hydrology

I-5 protection in Chehalis and Centralia must consider the complex hydrology of the area. I-5 can be reached by floodwaters from multiple sources, and the low spot near Chamber Way accumulates deep floodwaters easily and quickly.

During major flood events, WSDOT follows the National Oceanic and Atmospheric Administration Northwest River Forecast Center (NWRFC) hydrograph predictions to monitor the potential for I-5 to be flooded. Of particular concern are predicted flood levels near the Airport levee, which keeps the low spot near Chamber Way from quickly inundating.

The height of the Airport levee is close to the height of recently predicted flood elevations. NWRFC hydrographs predicted that the levee would be overtopped in the 1996, 2007, and 2009 storm events, and I-5 was closed in each of those instances. However, the levee was actually overtopped in only the 1996 and 2007 events. In 2009, NWRFC hydrographs predicted that the Airport levee would overtop by two feet on January 8, leading WSDOT to close I-5 from January 6 – 9 (43 hours), to ensure drivers would be evacuated before any water reached the interstate. Although a wholesale overtopping did not occur, floodwaters in 2009 did rise to the top of the Airport levee and flowed across the southwest corner of the levee.

As long as the Airport levee remains such a key part of the flood protection system for I-5, it will continue to be necessary to close the interstate whenever there is serious potential for the levee to fail or be overtopped.

It is important to note that, even if the Airport levee were raised, it still would not prevent water from flooding I-5. The levee only protects I-5 from the west, and flood waters can and do encroach on the interstate from the other three directions. In 1996 and 2007, I-5 was covered by floodwaters from the west, over the Airport levee, while at the same time backwater from the Chehalis River via the Salzer Creek Basin flooded I-5 from the east.

Time Required to Close I-5

Closing I-5 in the Centralia-Chehalis area is a complex and challenging undertaking. When I-5 is anticipated to be flooded between 13th and Mellen streets, (exits 76 and 81), WSDOT closes I-5 at the US 12 interchanges (exits 68 and 88). WSDOT then uses US 12 as the major detour route.

The US 12 interchanges were chosen as closure points in part because they are far enough away from Chehalis and Centralia that diverting traffic there minimizes the potential for thousands of interstate drivers to exit onto the limited number of local streets in Chehalis, Centralia, and Lewis County. Limiting congestion on local streets is especially vital during major flood events, as the streets are needed for critical emergency relief and rescue operations.

Closing I-5 at the US 12 interchanges means WSDOT must block off the main interstate lanes and 10 separate interchanges at exits 68, 71, 72, 74, 76, 77, 79, 81, 82 and 88 to prevent traffic from entering I-5 in the closed area. This must be accomplished well before I-5 is inundated by floodwaters to ensure WSDOT's ability to safely evacuate drivers and move personnel and equipment into the affected area. The early flooding of some local streets adds to the difficulty of moving drivers out and resources in.

Figures 1-3 illustrate the comparison of levee heights that meet WSDOT's freeboard requirement in the vicinity of the Chehalis-Centralia Airport, Salzer Creek, and Main Street/SW Chehalis Avenue in a with and without dam scenario.

Figure 1: Comparison of Levee Heights in Vicinity South of Chehalis-Centralia Airport (near West Street) – With and Without Dam

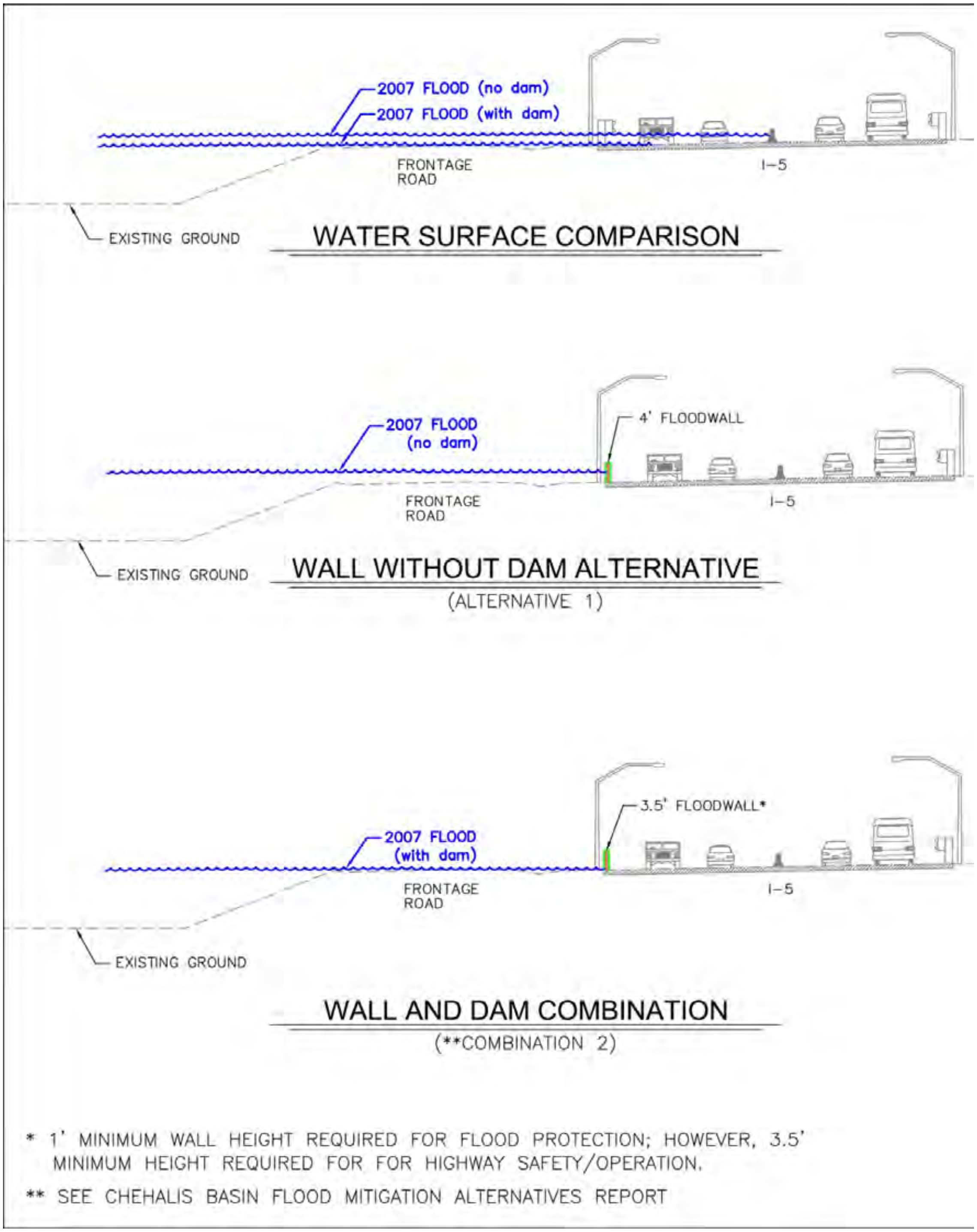


Figure 2: Comparison of Levee Heights in Vicinity of Salzer Creek – With and Without Dam

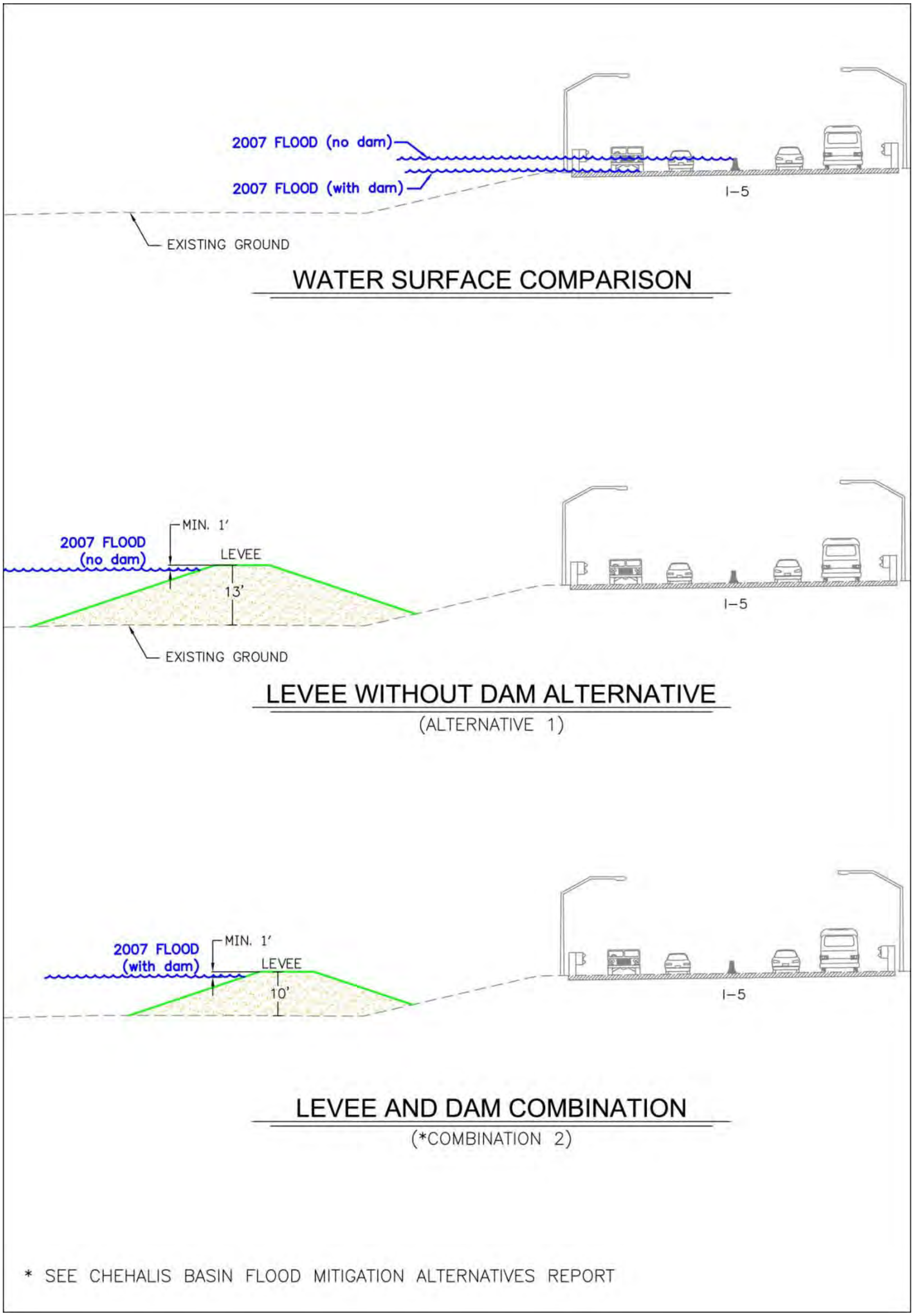
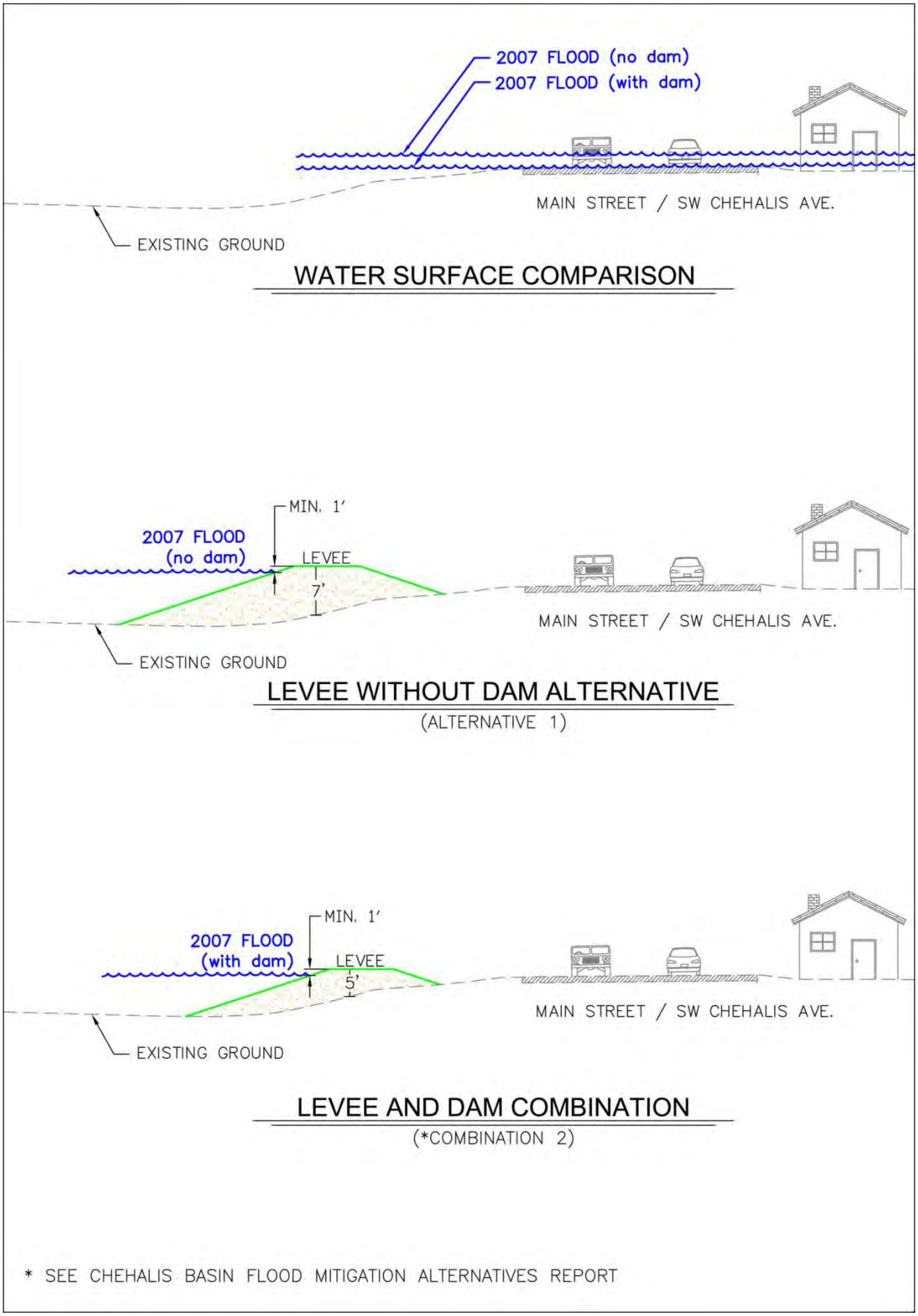


Figure 3: Comparison of Levee Heights in Vicinity of Main Street/SW Chehalis Avenue – With and Without Dam



Appendix A.1:

WSDOT - ESHB 2020 Hydrologic and Hydraulic Analysis

Memorandum

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

To: Bart Gernhart, SWR Assistant Regional Administrator

From: Casey Kramer, State Hydraulic Engineer / Katie Mozes, Hydraulic Designer

Date: 8/8/2012

Re: Engrossed Substitute House Bill 2020 Hydrologic and Hydraulic Analysis

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As requested, a detailed hydrologic and hydraulic analysis was completed to understand how flood frequency events have changed over time in the Chehalis River Basin. In 2011, the Washington State Legislature required the Office of Financial Management (OFM) to provide a report to the governor and legislature that identifies flood hazard mitigation projects in the Chehalis River Basin (Engrossed Substitute House Bill 2020 [ESHB 2020], Section 1033). This memorandum summarizes the analyses conducted by the Washington State Department of Transportation (WSDOT) to determine an acceptable freeboard height for flood hazard mitigation elements within Centralia and Chehalis, in accordance with ESHB2020.

Introduction

In the Chehalis River Basin flooding is a common occurrence often damaging infrastructure in the surrounding cities. ESHB 2020, Section (2) (c) mandates the WSDOT to "evaluate alternative projects that could protect the interstate highway and the municipal airport at Centralia and Chehalis, and ensure access to medical and other critical community facilities during flood events". In order to complete the analysis, it is important for the WSDOT to better understand the hydrology and hydraulics in the basin to determine the amount of freeboard necessary to account for potential increases in flow over time. The analysis included two main tasks, specifically a hydrologic analysis and hydraulic modeling. Each will be discussed separately in the following paragraphs.

Engineering Analysis

Hydrologic Analysis

The hydrologic analysis investigated peak flows at several United States Geological Survey (USGS) stream gages in the project area. The gages considered were the Chehalis River near Doty, WA (USGS 12020000), Chehalis River near Grand Mound, WA (USGS 12027500), Newaukum River near Chehalis, WA (USGS 12025000), and the Skookumchuck River near Bucoda, WA (USGS 12026400). Significant floods have occurred in January 1972, January 1990, November 1990, February 1996, December 2007 and January 2009. Figures 1 through 4 show annual instantaneous peak flows throughout each gage's history.

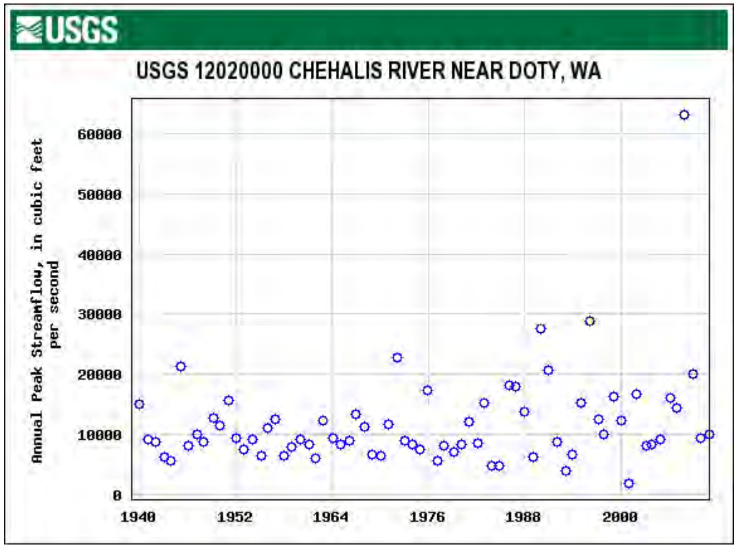


Figure 1. Chehalis River Near Doty Peak Flows

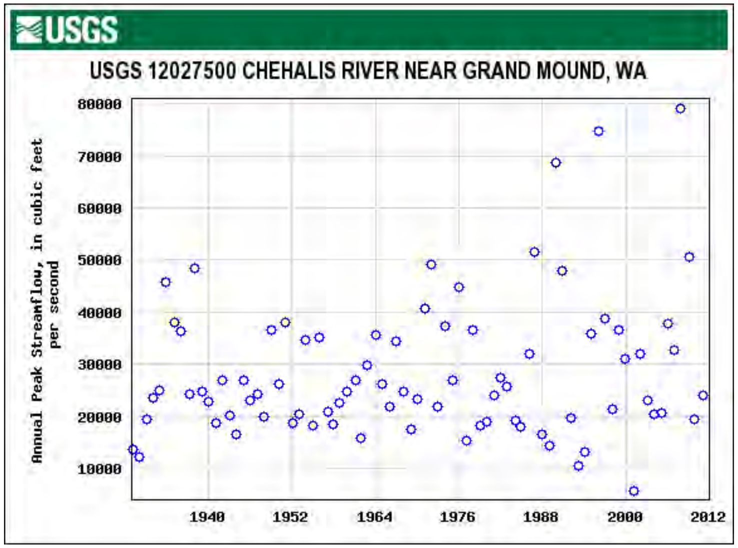


Figure 2. Chehalis River Near Grand Mound Peak Flows

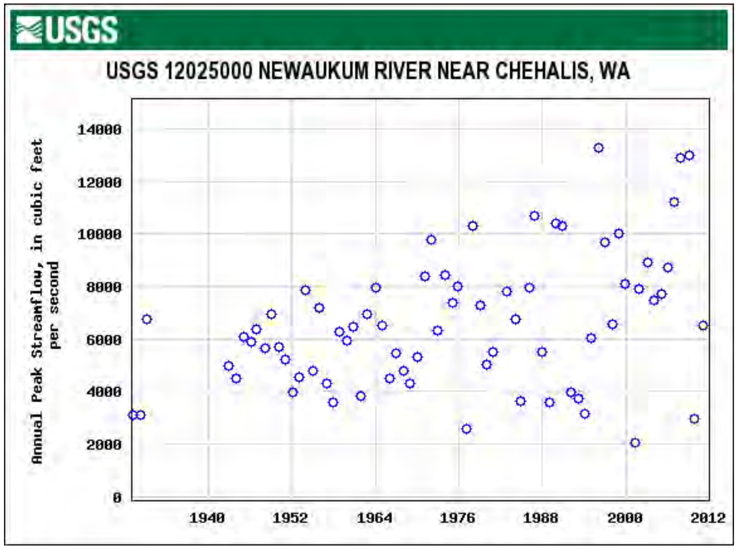


Figure 3. Newaukum River Near Chehalis Peak Flows

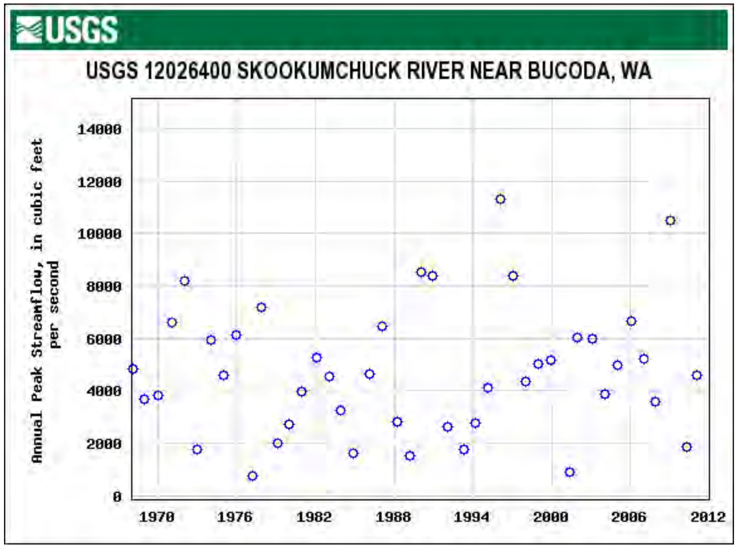


Figure 4. Skookumchuck River Near Bucoda Peak Flows

To understand how flood frequency events have changed over time, a statistical analysis was conducted following procedures outlined in Bulletin 17B of the Interagency Advisory Committee on Water Data. The statistical analysis provided estimates of instantaneous annual-maximum peak flows having recurrence intervals of 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-years. The recurrence interval or return period, is the average interval of time, expressed in years, within which the given flood will be equaled or exceeded once at a specific location, in the case of this analysis at the specific gage location. For example, a flood having a return period of 100-years (i.e. a 100-year flood) has a 1 chance in 100, or a 1-percent probability of occurring in any given year. It is important to understand that the 100-year flood is a statistical computation using as many years of data as possible and does not mean that a flood of this magnitude will only happen once every 100-years.

Peak flow estimates were determined and are plotted for the three following time periods to illustrate how flows have changed over time: 1) Beginning of gage record to 1984, 2) Beginning of gage record to 2006, and 3) Beginning of gage record to present. These time periods were chosen based on when significant floods have occurred in the basin and when other studies have been performed (e.g. 1982 FEMA Flood Insurance Study). Figures 5 through 8 illustrate the three separate flood frequency curves for each gage analyzed. All gages analyzed show that the larger recurrence flows (e.g. return period of 10-yr and greater) have increased within the period of each gage’s record. Note that Skookumchuck River Near Bucoda is regulated therefore changes in recurrence flows are effected by dam operations.

It is difficult to conclude if the increases in flows will continue over time or if we are refining our estimate of a true 100-yr event with each additional year of flow data. It is well understood that flood-frequency values will change, either increasing or decreasing, as more data is collected and a new flood frequency is calculated. It was therefore determined that a flow increase of 25% provides a conservative estimate over the life of the project given uncertainties within the Chehalis River Basin such as development, land use changes, climate change, etc.

Hydraulic Analysis

To determine water surface elevations through the project area for the various flood recurrence events the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center River Analysis System (HEC-RAS) software was utilized. WSDOT together with multiple public and private entities collaborated to develop an unsteady hydraulic model which represents the best available science and information on hydraulic conditions throughout the Chehalis River Basin. This model was utilized to develop rating curves, plots correlating discharge with water surface elevation, for the 100-, 500-year, and 2007 events at several representative sections throughout the basin. The rating curves were utilized with the potential flow increase of 25% to determine flood elevations throughout the project reach (Table 1). The baseline conditions used for this analysis included all of WSDOT’s proposed flood hazard mitigation projects.

Columns 1 and 2 show the river and cross section location, respectively. Column 3 shows the 2007 event flow and the calculated 100- and 500-year flows. Column 5 shows the potential flow including the 25% increase. Column 6 shows the existing water surface elevations for the 100-, 500-year and 2007 events for each specified location. Column 7 shows the potential water surface elevations for the 100- and 500-year events for each specified location.

The difference between the modeled and the potential future flood elevations were analyzed and are shown in Column 8. Based on the analysis it was determined that 3 feet of freeboard above the design 100-year elevation will be adequate to cover a 25% increase in flows. The 3 feet of freeboard was also determined to be sufficient to contain the 2007 flood event (flood of record on Chehalis River) as shown in Column 9.

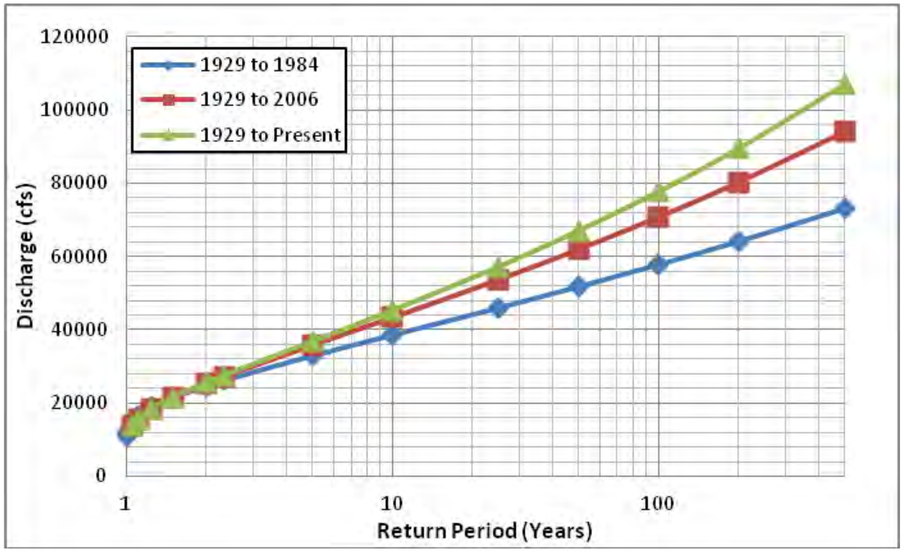


Figure 5. Flood Frequency Plot for Chehalis River Near Grand Mound, WA (12027500)

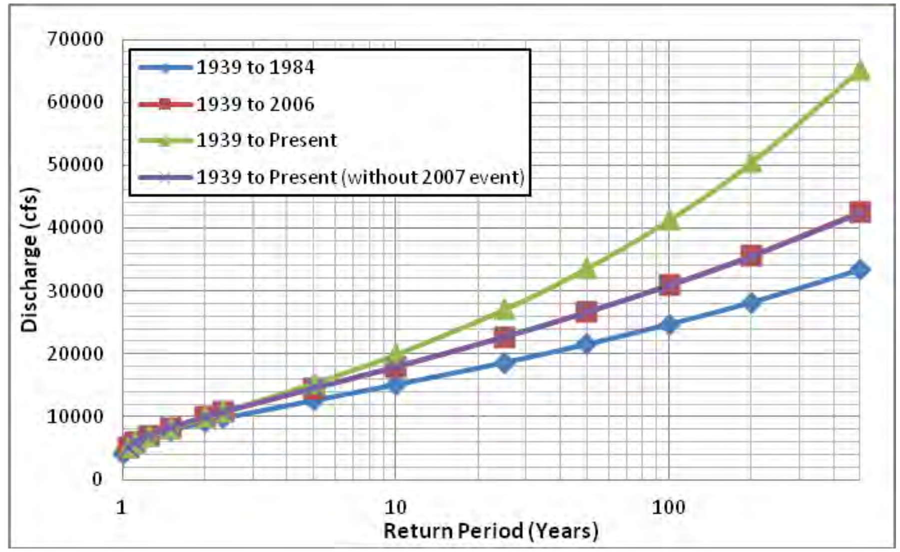


Figure 6. Flood Frequency Plot for Chehalis River Near Doty, WA (12020000)

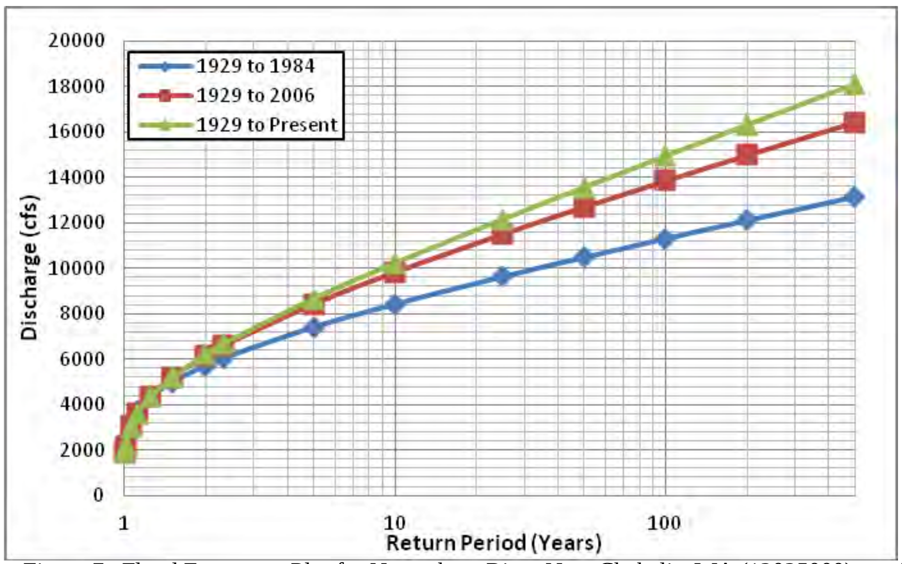


Figure 7. Flood Frequency Plot for Newaukum River Near Chehalis, WA (12025000)

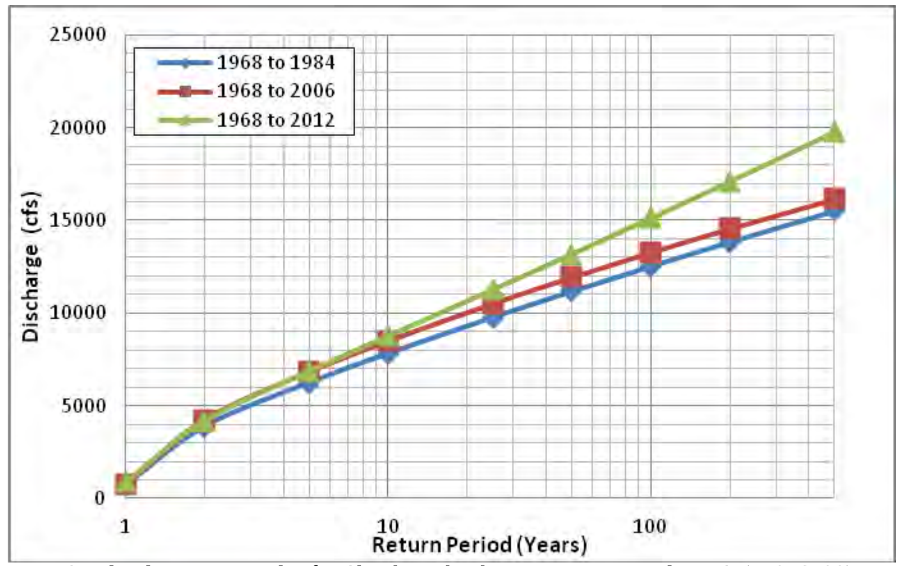


Figure 8. Flood Frequency Plot for Skookumchuck River Near Bucoda, WA (12026400)

Table 1. Hydraulic Characteristics Summary

(1)	(2)	(3)			(4)	(5)		(6)			(7)		(8)	(9)
RIVER	CROSS SECTION (RM)	EXISTING FLOW (CFS)			POTENTIAL FLOW INCREASE (%)	POTENTIAL FLOW (CFS)		EXISTING WATER SURFACE ELEVATION (FEET)			POTENTIAL WATER SURFACE ELEVATION (FEET)		MINIMUM FREEBOARD REQUIRED (FEET)	AMOUNT OF FREEBOARD AVAILABLE ABOVE 2007 ELEVATION (FEET)
		100-YR	500-YR	2007		100-YR	500-YR	100-YR	500-YR	2007	100-YR	500-YR		
Newaukum	2.27	12735	13998	12114	25%	15919	17498	191.0	191.3	190.8	191.6	191.9	0.7	3.2
	1.92	11499	12294	10589	25%	14374	15368	188.1	188.8	188.5	189.5	189.8	1.4	2.6
	1.66	11237	11350	9804	25%	14046	14188	187.4	188.3	188.1	189.7	189.7	2.3	2.3
	0.1	11701	13478	13196	25%	14626	16848	186.4	187.6	187.5	188.0	188.7	1.6	1.9
Chehalis	77.17	52911	56885	57434	25%	66139	71106	187.6	188.6	188.5	189.5	190.0	1.9	2.2
	76.36	45744	49707	49023	25%	57180	62134	186.9	188.0	187.8	188.8	189.3	1.9	2.1
	74.82	60756	67023	67081	25%	75945	83779	184.8	186.3	186.2	187.2	187.8	2.4	1.6
	72.58	45839	54730	54341	25%	57299	68413	183.1	185.0	184.7	185.3	186.4	2.2	1.4
	71.72	46492	55956	55591	25%	58115	69945	181.7	183.8	183.4	184.0	185.0	2.4	1.3
	71.48	70481	86548	85815	25%	88101	108185	181.7	183.8	183.4	183.9	185.0	2.2	1.3
	69.52	69586	85523	85325	25%	86983	106904	180.4	182.7	182.1	182.8	183.9	2.4	1.3
	69.23	65324	79582	79282	25%	81655	99478	180.4	182.7	182.1	182.9	184.2	2.5	1.3
	67.46	65120	79019	79214	25%	81400	98774	177.9	179.9	179.1	180.1	181.0	2.2	1.8

Conclusion

The analysis determined that 3 feet of freeboard above the modeled 100-year flood elevation would be sufficient to cover a potential future flow increase of 25%, given uncertainties within the Chehalis River Basin such as development, land use changes, climate change, etc. This would also provide sufficient clearance during the 2007 flood event which was in excess of a 100-yr event through the project site.

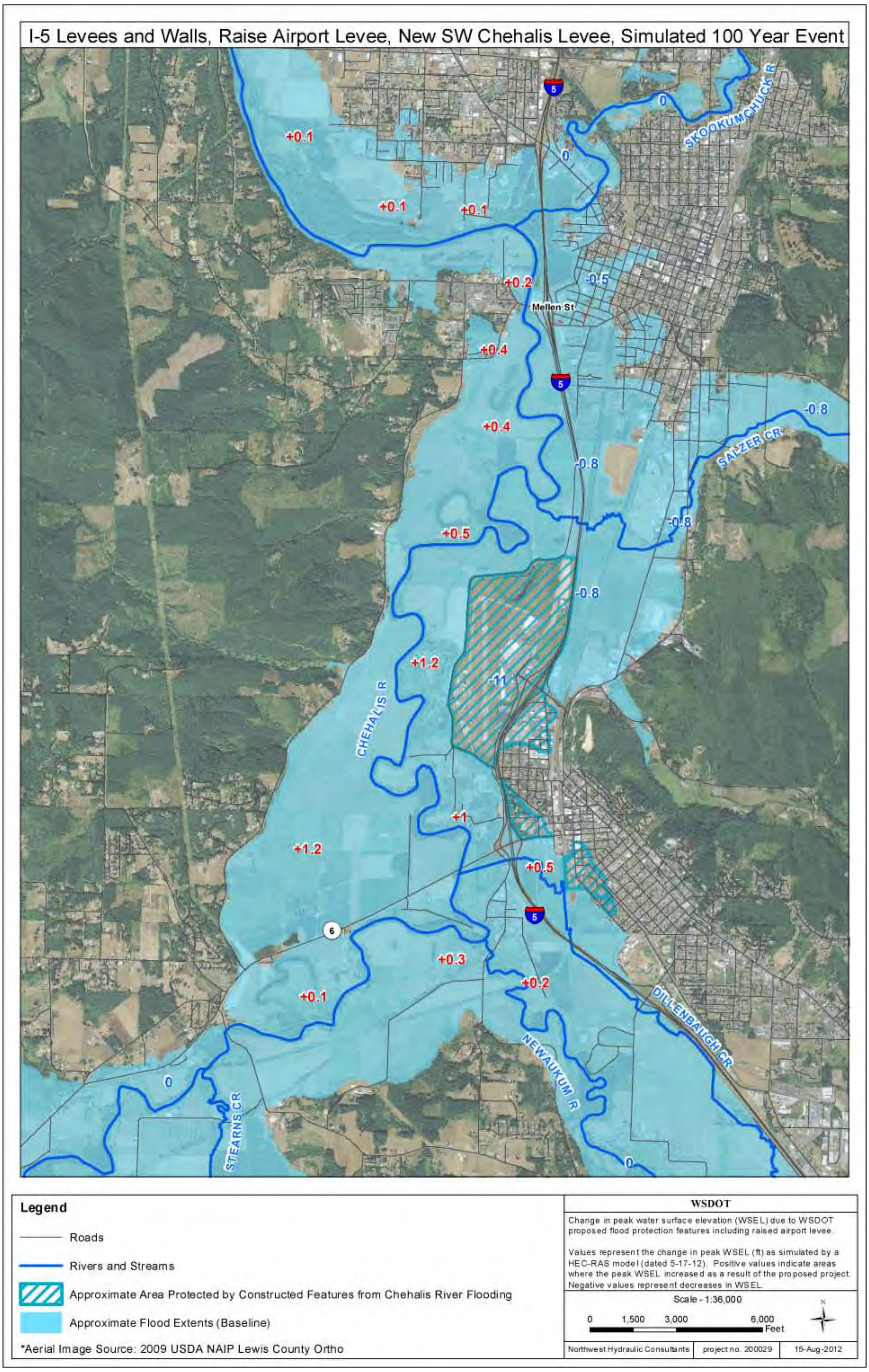
If you have any questions or need further assistance regarding the information included in this memorandum please feel free to contact Katie Mozes at (360) 705-7261 or myself at (360) 705-7262.

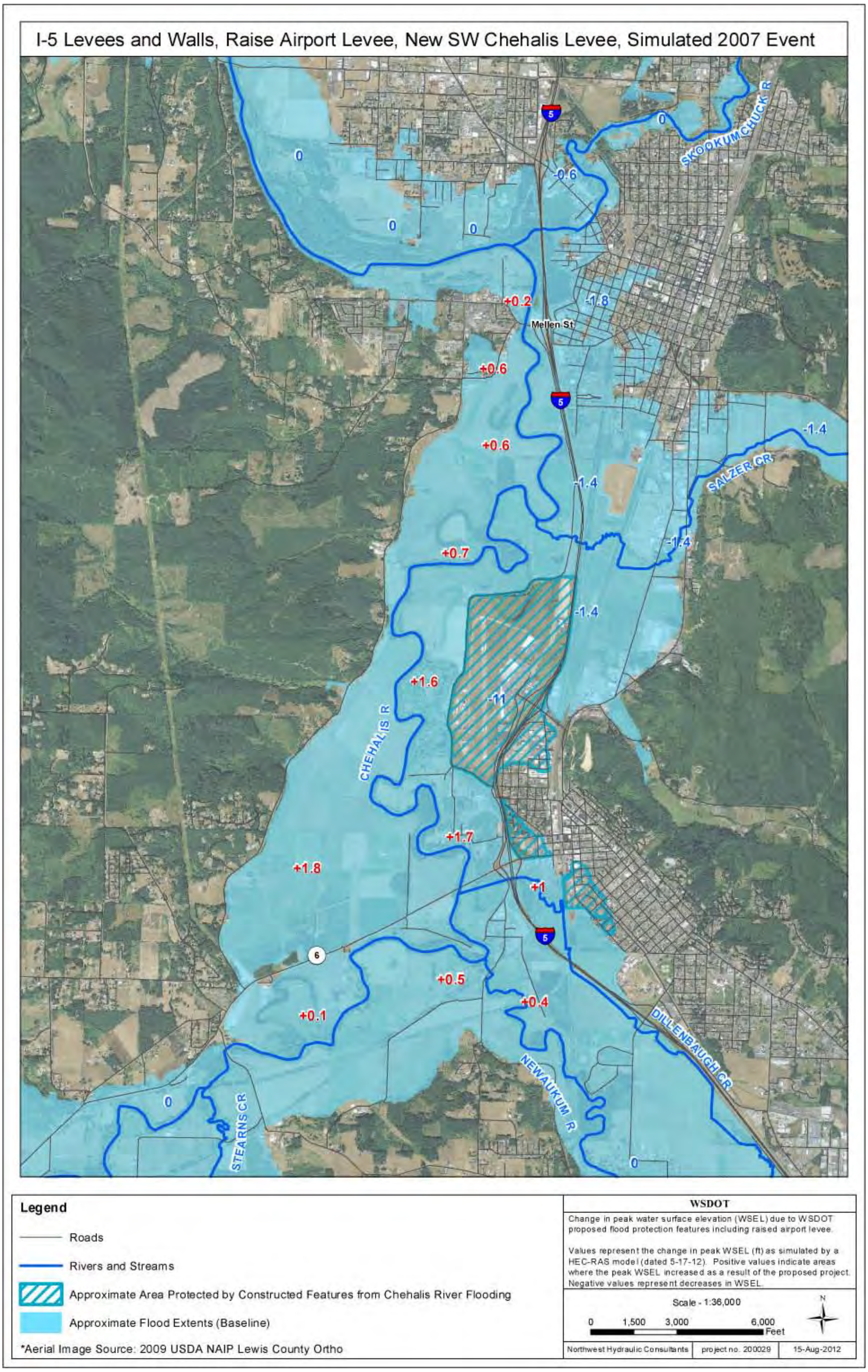
CMK

cc: HQ Hydraulics Project File

Appendix B:

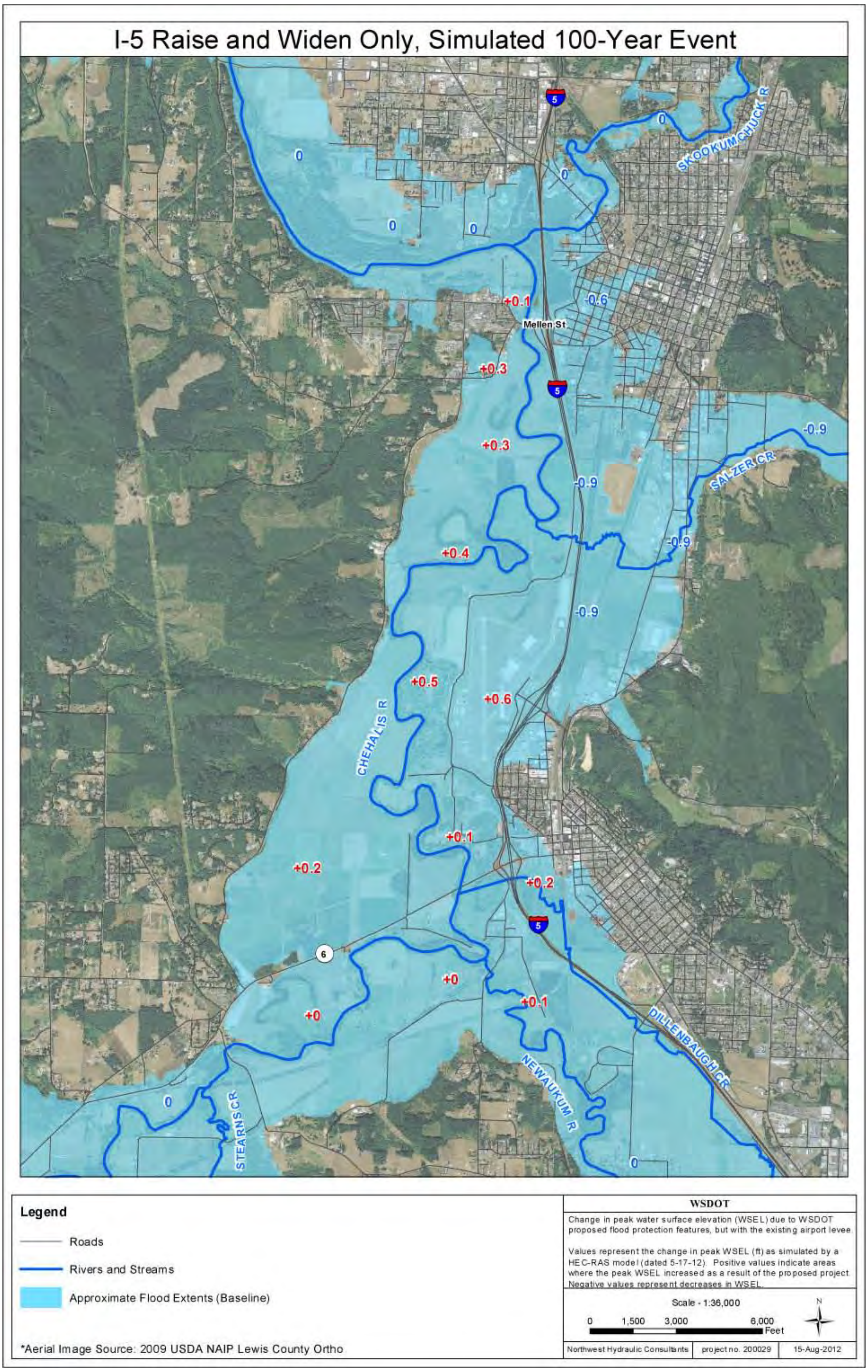
Alternative 1: I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee - Flood Relief Maps



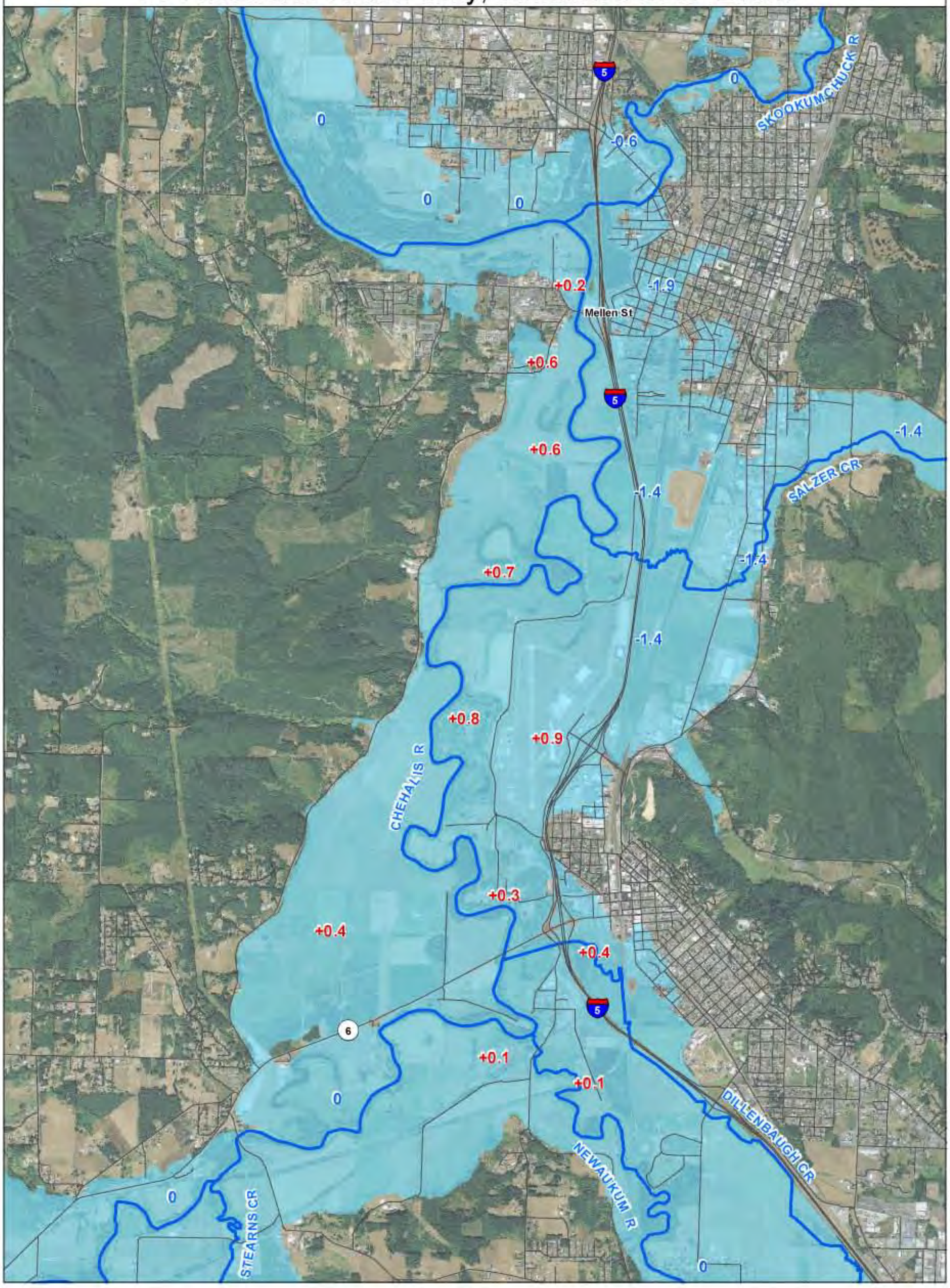

I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee, Simulated 2007 Event
SKOOKUMCHUCK R
Mellen St
SALZER CR
CHEHALIS R
DILLENBAUGH CR
NEWAUKUM R
STEARNS CR
0
-0.6
+0.2
-1.8
+0.6
-1.4
+0.7
+1.6
-11
+1.7
+1.8
+1
+0.5
+0.4
+0.1
Legend
Roads
Rivers and Streams
Approximate Area Protected by Constructed Features from Chehalis River Flooding
Approximate Flood Extents (Baseline)
*Aerial Image Source: 2009 USDA NAIP Lewis County Ortho
WSDOT
Change in peak water surface elevation (WSEL) due to WSDOT proposed flood protection features including raised airport levee.
Values represent the change in peak WSEL (ft) as simulated by a HEC-RAS model (dated 5-17-12). Positive values indicate areas where the peak WSEL increased as a result of the proposed project. Negative values represent decreases in WSEL.
Scale - 1:36,000
0 1,500 3,000 6,000 Feet
N
Northwest Hydraulic Consultants
project no. 200029
15-Aug-2012

Appendix C:

Alternative 2: I-5 Raise and Widen Only - Flood Relief Maps



I-5 Raise and Widen Only, Simulated 2007 Event



Legend

Roads

Rivers and Streams

Approximate Flood Extents (Baseline)

*Aerial Image Source: 2009 USDA NAIP Lewis County Ortho

WSDOT

Change in peak water surface elevation (WSEL) due to WSDOT proposed flood protection features, but with the existing airport levee.

Values represent the change in peak WSEL (ft) as simulated by a HEC-RAS model (dated 5-17-12). Positive values indicate areas where the peak WSEL increased as a result of the proposed project. Negative values represent decreases in WSEL.

Scale - 1:36,000

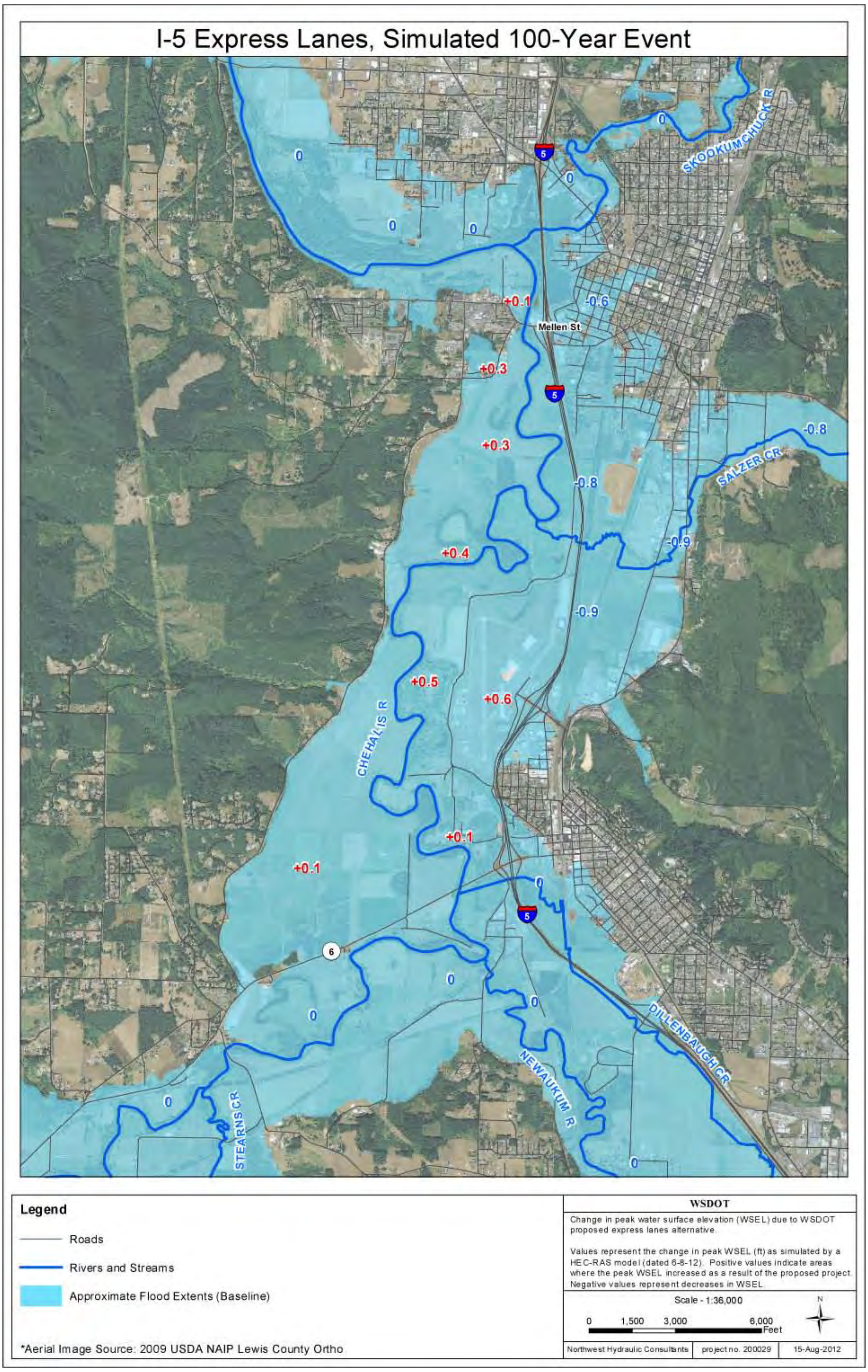
0 1,500 3,000 6,000 Feet

N

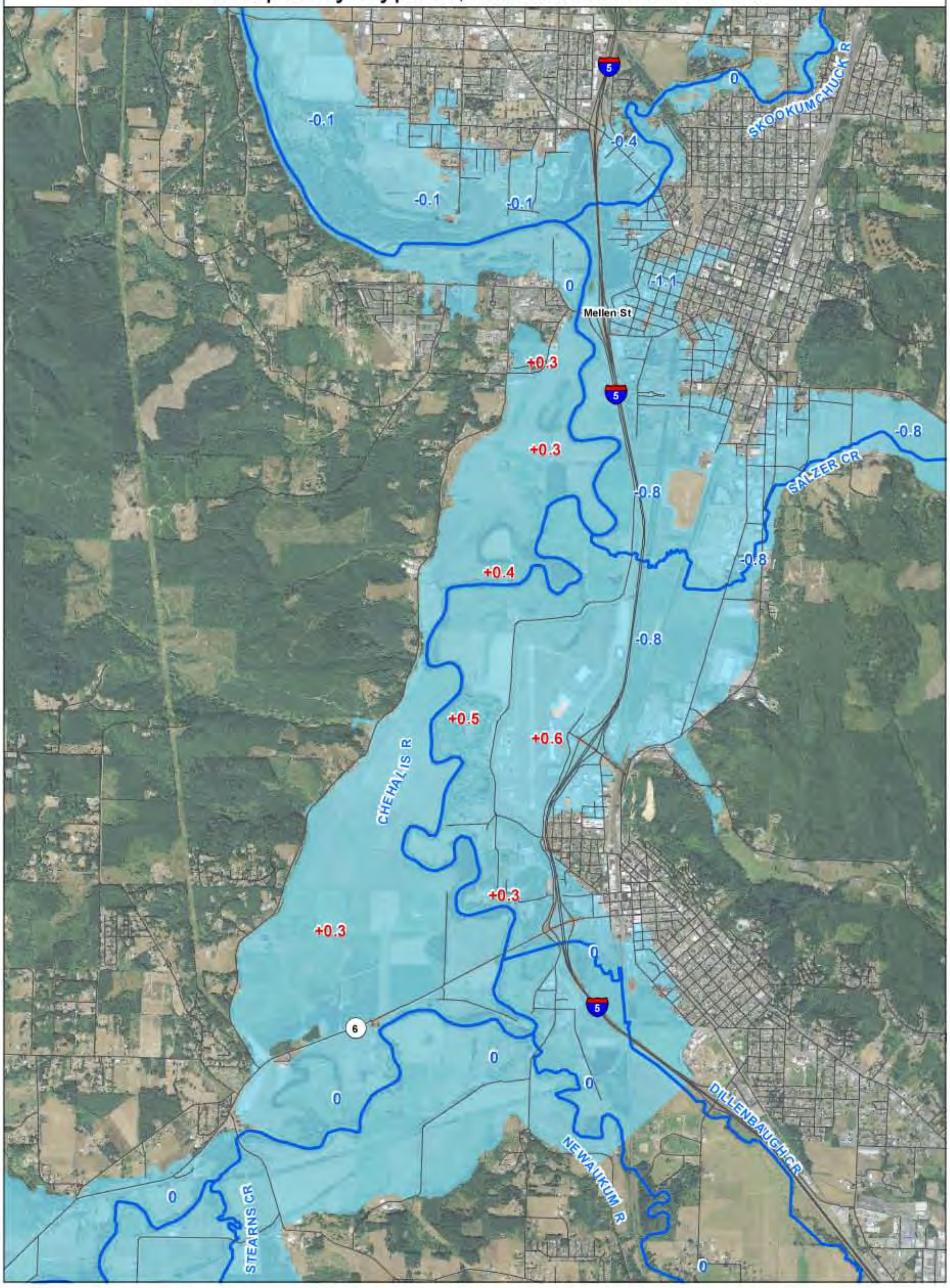
Northwest Hydraulic Consultants	project no. 200029	15-Aug-2012

Appendix D:

Alternative 3: I-5 Express Lanes - Flood Relief Maps



I-5 Temporary Bypass, Simulated 2007 Event



Legend

- Roads
- Rivers and Streams
- Approximate Flood Extents (Baseline)

*Aerial Image Source: 2009 USDA NAIP Lewis County Ortho

WSDOT

Change in peak water surface elevation (WSEL) due to WSDOT proposed temporary bypass alternative.

Values represent the change in peak WSEL (ft) as simulated by a HEC-RAS model (dated 6-8-12). Positive values indicate areas where the peak WSEL increased as a result of the proposed project. Negative values represent decreases in WSEL.

Scale - 1:36,000

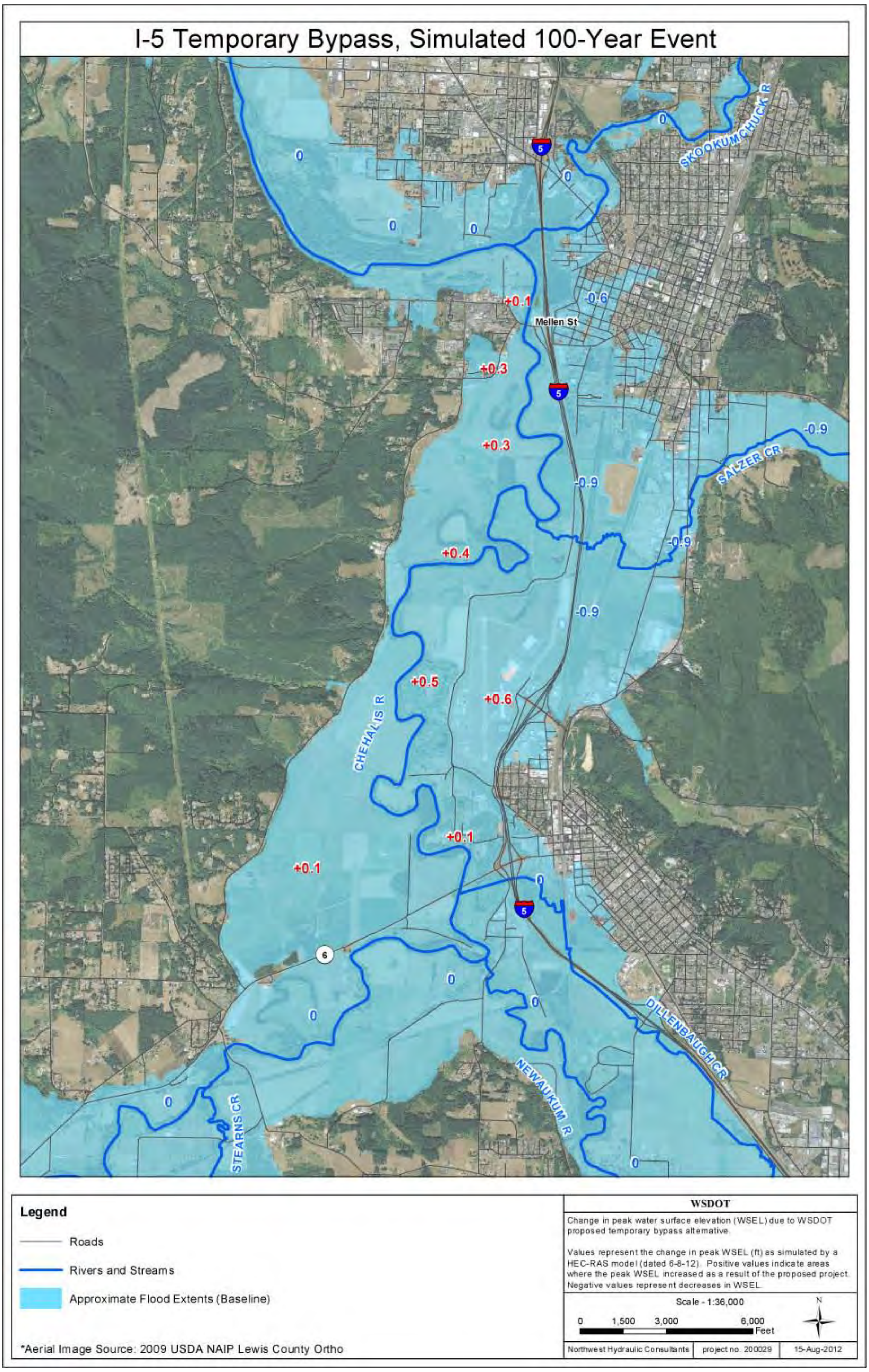
0 1,500 3,000 6,000 Feet

N

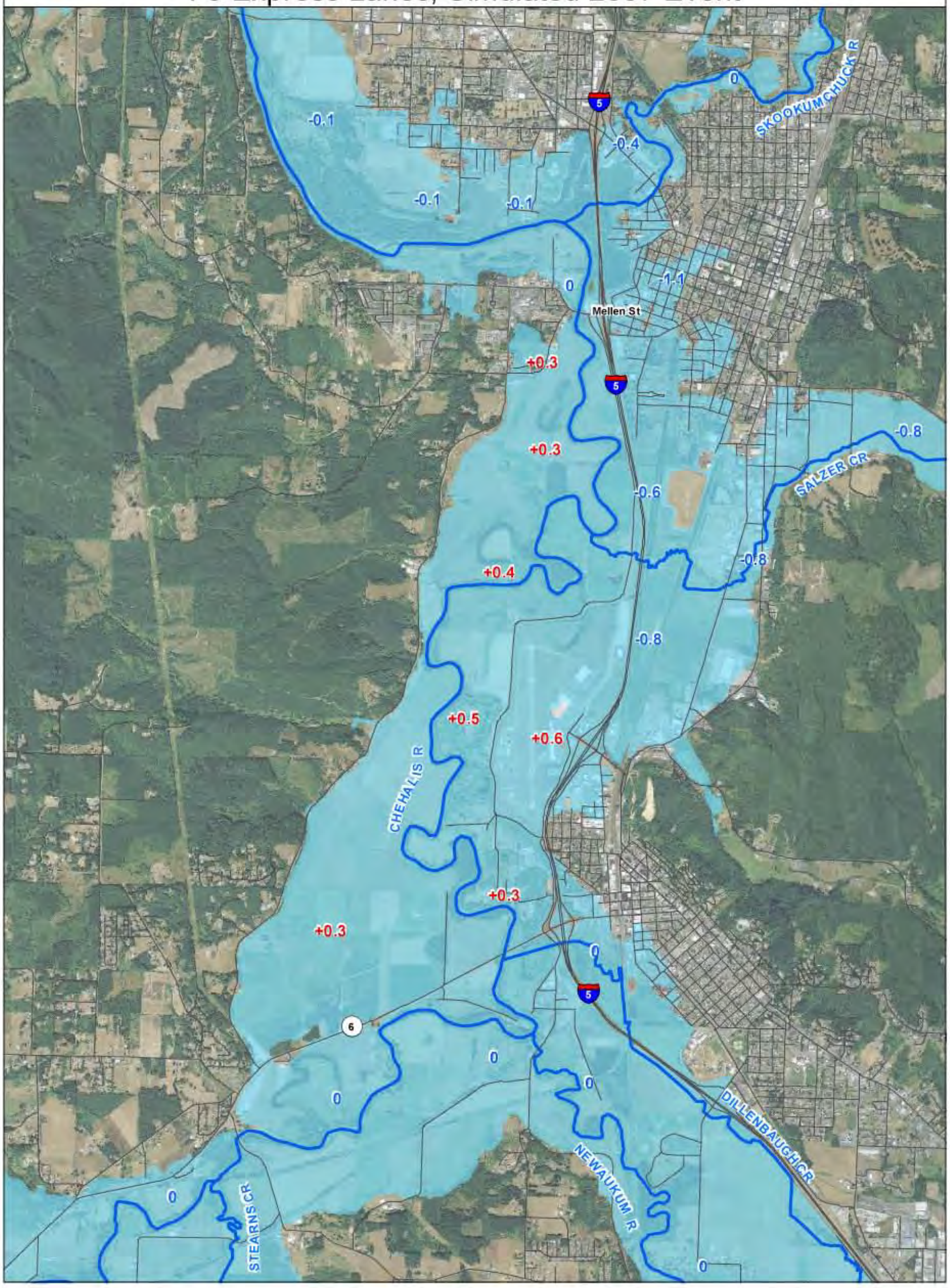
Northwest Hydraulic Consultants	project no. 200029	15-Aug-2012

Appendix E:

Alternative 4: I-5 Temporary Bypass - Flood Relief Maps



I-5 Express Lanes, Simulated 2007 Event



Legend	WSDOT
Roads	Change in peak water surface elevation (WSEL) due to WSDOT proposed express lanes alternative.
Rivers and Streams	Values represent the change in peak WSEL (ft) as simulated by a HEC-RAS model (dated 6-8-12). Positive values indicate areas where the peak WSEL increased as a result of the proposed project. Negative values represent decreases in WSEL.
Approximate Flood Extents (Baseline)	Scale - 1:36,000; 0 1,500 3,000 6,000 Feet; N
*Aerial Image Source: 2009 USDA NAIP Lewis County Ortho	Northwest Hydraulic Consultants · project no. 200029 · 15-Aug-2012

Appendix F:

Public Comment and Response Summary

Stefanie Wahl 8/23/12

Chehalis West is a 65 bed assisted living facility that employs 42 people. The facility is located on the west side directly on the Tacoma rail line. The noise, exhaust, and visual aesthetics would be devastating to our business if the express or temporary bypass options were implemented. The center of the track is 12.5' from our property line.

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Edna Fund 8/23/12

Our council is in favor of a basinwide solution and sent a letter to Congresswoman Butler; agrees with Merlin MacReynold comment

Response to Comment

The WSDOT report was written to address only Section 1033 (2) (c) of ESHB 2020. This section states "evaluate alternative projects that could protect the interstate highway and municipal airport at Centralia and Chehalis, and ensure access to medical facilities …". The WSDOT report was not intended to address other potential projects or components that may be considered as part of a basin wide solution(s).

The final report more clearly describes the context for the I-5 protection analysis – it is but one component of a broader effort to summarize existing information on alternatives to mitigate flood damage in the Chehalis Basin. The alternatives described are focused on I-5 protection because that is the focus of the report; however the final report more clearly describes protection of I-5 as only one potential component of a broader set of flood hazard mitigation efforts needed in the Basin and refer more clearly to the larger effort to determine a path forward for flood hazard mitigation in the Basin, of which protection of I-5 is only a part.

Merlin McReynold 8/23/12

City Council of Chehalis opposed to all alternatives. Official position is that this has to be a basinwide solution; how these alternatives could fit into that is critical, but City Council thinks none are viable as individual alternatives without basin wide solution

Response to Comment

The WSDOT report was written to address only Section 1033 (2) (c) of ESHB 2020. This section states "evaluate alternative projects that could protect the interstate highway and municipal airport at Centralia and Chehalis, and ensure access to medical facilities …". The WSDOT report was not intended to address other potential projects or components that may be considered as part of a basin wide solution(s).

The final report more clearly describes the context for the I-5 protection analysis – it is but one component of a broader effort to summarize existing information on alternatives to mitigate flood damage in the Chehalis Basin. The alternatives described are focused on I-5 protection because that is the focus of the report; however the final report more clearly describes protection of I-5 as only one potential component of a broader set of flood hazard mitigation efforts needed in the Basin and refer more clearly to the larger effort to determine a path forward for flood hazard mitigation in the Basin, of which protection of I-5 is only a part.

Ron Averill 8/23/12

Flood relief maps of the Walls and Levees are misleading. In all alternatives, Miracle Mile is still under water, so a 1.4 foot drop doesn't mean it's dry. The Yardbirds, Sunbirds, and Lewis County Mall are not protected by airport levee, even though Town Center and Airport are protected

Response to Comment

The flood relief maps were provided to show representative changes in peak Water Surface Elevation (WSEL) throughout the project area in a 2007 and simulated 100-year flood event, and were not meant to imply that a reduction in WSEL equates to full flood protection for all residences and businesses in that particular cross-section.

The report does not state that any particular businesses, such as Yardbirds, Sunbirds, or Lewis County Mall, would be completely protected from flooding.

Anonymous 8/23/12

Consider the property value impacts on businesses and residences in the express/bypass lanes project area that would be affected.

Express and bypass lanes don't allow for non-commercial traffic, so folks that need to access the hospital during floods may not be able to due to the backups.

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Anonymous 8/23/12

Our company leases property from Tacoma Rail, so if express/bypass lanes are built we will have nowhere to park

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Anonymous 8/23/12

Express/bypass lanes would have impact on our company because we would have to relocate our storage facility and its difficult to get ability to store hazardous material in places; this would impact our business and other residents and businesses in the area who get their propane from us

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Anonymous 8/23/12

The bypass and express lanes when going through urban area of Chehalis from West to Main street are going to have to be elevated with a ~22ft high wall through Chehalis. This is important when considering the impact on the quality of life of for the community on historic West side, as it bisects the community and would it make it difficult to traverse from one side to the other. So very objectionable by community. Impacts quality of life throughout the city

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Anonymous 8/23/12

Options 3-4 just protects I-5 and does nothing for flood control so community won’t see any help

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Deanna Ziskey 8/23/12

I respect commercial interests in bypass and express lanes and know businesses are important; in area described where express lanes come through it is described as industrial, but it's also an area where residences are, partially from main street to prindle and definitely from prindle to west there are homes and property goes close to tracks; and division street and hawthonre too, so huge impact. Not just looking out window and seeing structure and breathing in fumes, but exremeley damaging to people there who own homes and their property value; we appreciate being part of the discussion and being able to comment

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Anonymous 8/23/12

Our business would be affected by express/bypass lanes. Our business provides the local and surrounding areas with fertilizer. Taking the Tacoma rail tracks away would not allow us to have product flow.

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

J. Vander Stoep 8/23/12

Think Bart's presentation does an excellent job on saying what we know and don't know. The report, however, doesn't. It is written as a govt. agency selling a specific project, which emphasizes the positive of the walls and levees option. It only says "a dam alone will not protect I-5" and needs to be more balanced.

The report moves goal post on protecting I-5. Now says 3ft of freeboard of 100 yr flood. And no differentiation of I-5 being closed for four days or a minute.

Response to Comment

The legislative purpose of this report was to evaluate alternative projects that could protect I-5. The full Chehalis Basin Flood Mitigation Alternatives Report addresses other potential projects, including a dam on the upper mainstem Chehalis, in detail. The final WSDOT report more clearly defines its intent and context and more clearly reference the full alternatives report for more information. It also more clearly describes the potential effects of a dam relative to I-5 protection alternatives, including a clear statement that a dam would lower flood elevations throughout the Basin and would, therefore, reduce the amount of effort needed to fully protect I-5 during major flooding and the costs of I-5 protection.

WSDOT agrees that it is extremely important to identify the right measurement for freeboard. The right amount of freeboard will provide confidence that, no matter what flood protection measures the legislature directs WSDOT to build, they provide protection for predicted floods in the project area.

As described in an Appendix to the draft report, WSDOT determined that freeboard must be three feet above the 100-year flood level. This amount of freeboard is in alignment with the freeboard the Army Corps of Engineers has been using for the Twin City project including the protection of I-5 for the past decade. It equates to a minimum of one foot above the 2007 flood level in the Chehalis-Centralia area. This measurement was established through analysis by WSDOT's State Hydraulic Office as sufficient to cover a potential future water flow increase of 25 percent. This issue is addressed further in the final report.

Regarding the comment on no differentiation of I-5 being closed for four days or a minute, as noted in an Appendix to the draft report, closing I-5 in the Centralia-Chehalis area is a resource intensive, complex, and challenging undertaking, regardless of the length of time the freeway is ultimately closed for. When I-5 is anticipated to be flooded between 13th and Mellen streets, (exits 76 and 81), WSDOT closes I-5 at the US 12 interchanges (exits 68 and 88). WSDOT then uses US 12 as the major detour route. Closing I-5 at the US 12 interchanges means WSDOT must block off the main interstate lanes and 10 separate interchanges at exits 68, 71, 72, 74, 76, 77, 79, 81, 82 and 88 to prevent traffic from entering I-5 in the closed area. This must be accomplished well before I-5 is inundated by floodwaters to ensure WSDOT's ability to safely evacuate drivers and move personnel and equipment into the affected area.

Dan Kay 8/27/12

Melissa,

Good morning. It appears comments from the WSDOT report are to be directed to you. After attending the DOT presentation last week discussing proposed options for I-5 flood protection, I have a few comments regarding options 3 and 4 for the express way and temporary bypass as presented by Bart Gernhart. This was the first time I was aware of these two proposed options. As for the creativity of the options we can certainly appreciate the options; however, the District is challenged with the options as they deal with one of our current projects. The District owns the property at Main and Quincy Avenues in Chehalis. The Tacoma rail track borders our property to the east. This is where the route for Options 3 and 4 were proposed. The District is currently is final stages of construction of a substation construction project on our property. This new DOT proposed route would encroach on our project as it is being built and would cost significant dollars likely well into the 100s of thousands of dollars to relocate electric facilities that would be impacted by such an expressway or bypass construction along the rail corridor. This would be a burdensome cost that should be placed on the District's customers.

Regards,
Daniel E. Kay, P.E.
Chief Engineer
Lewis County PUD
360.740.2435

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Vince Panesko 8/27/12

Comment on WSDOT Report:

Figure 1 on Page 41 depicts 2007 flood water 2-3 feet over I-5 and then depicts the effect of a dam where water is less than a foot over I-5. Page 23 of the draft Ruckelshaus report states that I-5 was covered by over 12 feet of water in places. This depth was consistent with reports in the Chronicle of depths over 10 feet.

If a dam would lower flood water from a future 2007-flood in Chehalis by only 2 feet as shown in Figure 1 on Page 41 in the WSDOT report, that would leave over 10 feet of water over I-5, not the less-than-one-foot shown in Figure 1.

The modeling shows the effect of a dam in a future 2007-flood to lower water approximately 4 feet in Chehalis and 3 feet in Centralia (see Ruckelshaus Report). Therefore, even with a dam, the existing elevation of I-5 would be covered by 8 feet of water in the Chehalis area, not the "less than a foot" shown in Figure 1 on Page 41.

The WSDOT report needs to address the "more than 12 feet of water over I-5," and then explain that if a dam lowered the water 2-3 feet, there would still be 8-9 feet of water over I-5. Figure 1 on Page 41 needs to be modified to be consistent with I-5 covered by 12 feet of water.

Thank you for the opportunity to comment.

Vince Panesko
2132 Harris Ave.
Richland, WA 99354-2021
Phone: (509) 946-1229
e-mail: vince@owt.com

Response to Comment

The water depths acknowledged in this comment appear to be in alignment with water depths witnessed along I-5 at the Chamber Way Interchange. Figure 1 is depicting a representative cross section of I-5, south of the Chehalis-Centralia Airport near the West Street crossing. The final report has been updated to clarify the location of this cross section.

Michael Smell 8/30/12

30 August 2012, Comments on WSDOT meeting 8/23/12

I thought the presentation by Bart Gernhart was very informative and well done. WSDOT should put the Bullseye back on, however. I think the Governor knew this venture was a no-win situation from the get go. I am afraid all the hard work from the WSDOT crew will go for naught. I cannot believe that there were people at the meeting that actually thought that any of the alternatives but the first one were serious. The maps used do need to be updated since there has been development between Prindle St, Main St, and I-5 in Chehalis in the past few years that was not shown and should be taken into consideration on placement of a levee. Also, the Newaukum is a river not a creek. I thought Alternative One had some very good flood protection parts especially for the precious Airport/Strip Mall area as well as the SW Chehalis area. The 600 "Buildings no longer flooded" would be a good result also. But, because I-5 was involved, the powers that be will always object. Any project that would be accomplished in this 5 mile section of I-5 lessens the emphasis for their "basin-wide solution". It was also not their idea and I have found in Lewis County that that usually means a negative opinion on a subject. Good Luck to WSDOT. Alternative one or two may be acceptable in 20 years or so.

By, on, and in the Newaukum River
Michael L. Smell
Chehalis

Response to Comment

The final report has been updated to acknowledge that the Newaukum is a river. Regarding the placement of a levee relative to new developments in Chehalis, if a project moves forward, this will be taken into consideration.

Karen and Raymond Monroe 8/30/12

Date: August 30, 2012

To Whom it Concerns regarding WSDOT Draft and Flood Mitigation Alternatives report

My husband and I have lived in the Westside Neighborhood for 15 years. We were drawn to this neighborhood and staying in Chehalis because it was family friendly, and peaceful. There is a park nearby and also a very friendly daycare that we were using at the time.

I am concerned about some of the suggestions being made in this process of flood protection in the area. I appreciate the draft report saying on page 8 “The goal for all projects is the full protection of I-5 from 13th Street to Mellen Street, protection of the Chehalis-Centralia Airport, improved access to infrastructure, and optimization of any potential ensuing benefits to people, communities, and the environment. It is only appropriate to spend hundreds of millions of dollars on a project if it will provide full protection.” However I am concerned; as I read further it also says “ Any modification or new construction of dikes or levees should be built at this level to ensure robust, reliable protection for I-5 and the Chehalis-Centralia Airport.” On page 9 it says “WSDOT considered six main alternatives to protect I-5, the airport, and infrastructure in the Centralia and Chehalis area.” Only on page 8 does the goal address benefits to the people and communities. Otherwise the concerns seem to be about objects (I-5, airport which could be addressed easily separately, and infrastructure which I take to mean ease of largest portion of Chehalis to get around). I hope in the final deliberations the affect to the people and communities (aka neighborhoods that have not had flood issues) are greatly considered.

Here are my thoughts and concern:

Alternative 1: <u>“I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee”</u> Seems alright. Does not address the issue of needing to expand I-5 which is needed. It also, sadly, creates more of an impact to the wetlands but they all impact the natural habitat of the area so this will not be addressed again.

Alternative 2<u>: “I-5 Raise and Widen Only”</u> Honestly, I already hear I-5 from my house and I’m not interested in hearing more of it. However, that said, I realize it needs to be widened. Regularly, cars are backed up on I-5, especially heading north. If widening improves the transit time for everyone on I-5 AND helps against flooding, then I think this needs serious consideration.

If this alternative is considered, please DO NOT put West Street Bridge back in. As I understand it, in order for cars to cross over the street at West Street once the freeway has been expanded, it will not look anything like the current bridge due to codes. Due to these codes, it will be much larger and will seriously cut into the neighborhood, park and many homes. This in turn will lower the value of homes in this neighborhood and cause immense deterioration. This is the neighborhood where the history of Chehalis is seen by the homes and property that have been lived in for a long time. In these past 15 years living here, our girls have started in the school system and graduated from the Chehalis School District. I run a piano studio and have students that take the bus here on occasion. I believe this is the only neighborhood that is so family friendly it takes the bus two trips from the schools to get the kids back and forth both in the morning and in the afternoon. This neighborhood will not be conducive to families if a large road/bridge (encouraging even more traffic than has already been encouraged in last 2-3 years) is next to the park and possibly even reducing the park's size-let alone make it difficult for residents to maneuver their own neighborhood.

I am a bicyclist and have felt a shortage of safe bicycle routes in the area. Every time I visit my parents on Seattle and Mercer Island I admire their network for bicycle routes. Instead of putting a bridge back in for cars, please consider a bridge that is just for pedestrians and bicyclists. This would make it much safer for kids to bicycle to the other side of the freeway and to some of the stores up the road to the north. I believe there is room to put a bicycle path paralleling the freeway which would increase safety if that road becomes busier due to more people choosing to go over the freeway at mainstreet. Putting a bike path over the freeway would be attractive to STP riders and those that do the Lewis County Historical bicycle tour. Making this bike path would seem to me a way to relieve some traffic congestion. This path would be one more step closer to connect a healthy (yes, pun intended) network of pathways in the county for people to exercise on, go do their errands by (I've spent time in Holland and its is incredible what they do on their bicycles) and increase their health, like they have in Seattle and other areas. Keep in mind there are 2 other bridges cars can use very close by.

Alternative 3: "I-5 Express Lanes" It does not address it in the Draft but this option also really negatively affects the community in Chehalis in Westside Neighborhood (East of the freeway) as well as many others. It will greatly lower the values of homes, it will cause many homes to be destroyed and it will change the appearance of Chehalis greatly making it seem more like we are in Chicago with the expressway running so close to downtown and homes in this small, quiet town.

Alternative 4: "I-5 Temporary Bypass": Does not address the I-5 clogging issue. Forget it.

In summary I consider Alternative 1 and 2 are only viable options and only ones that really address the I-5 crowding condition. As stated earlier one of the goals is to protect the people and community. By tearing up a long-standing historical neighborhood in Chehalis via express lanes (alt 3) or a new West street bridge you are protecting traffic on I-5 on occasion there is a flood as well as businesses (which if I had a say would not have been allowed to be built in the floodplains). If express lanes are allowed via alternative 3 you ARE INSTEAD damaging a major neighborhood and many homes that have been safe from floods (and we chose to live where we did to avoid risk of flooding and don't feel we should be penalized for this). You would be breaking up a peaceful rural community and history for this community.

My recommendations is Alternative 1 (short of seeing impact of what the levees might do to the environment) and/or 2 and turn the west Street bridge into a pedestrian/bicycle pathway instead of cars. No express lanes! (I've never heard of any other town our size or even somewhat bigger getting an expressway put in the middle of their neighborhoods to relieve congestion of I-5.).

Thank you for your consideration,
Sincerely,
Karen and Raymond Monroe

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Lewis County Commissioners 8/31/12

LEWIS COUNTY COMMENTS
THE RUCKELSHAUS CENTER CHEHALIS BASIN FLOOD MITIGATION ALTERNATIVES REPORT
PROTECTION OF I-5 AND THE CHEHALIS-CENTRALIA MUNICIPAL AIRPORT:

1. This is probably better identified as the Washington State Department of Transportation (WSDOT) set of six proposed projects, along with improving the Airport levee to 100-year protection, to provide protection against flooding and closing of the Interstate during a flood. Two of the proposals were thrown out as being too expensive. However all of the projects were without benefit of water retention and while protecting the freeway, they did not provide substantial protection to the population living in the corridor. Protecting the freeway and not the population is just plain NOT ACCEPTABLE!
2. Of the six alternatives, the only one in our perspective which has any merit is Alternative 1: <u>I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee</u>; however, we do not believe it can be a standalone project. We believe that a water retention project needs to be included and then the scale and location of levees and walls can be substantially reduced both in size and location. Several of the proposed projects in this alternative, especially those from the south end of the Airport Levee and running south to 13th Street should be looked at in developing a protection plan for the corridor. We think previous plans to divert Dillenbaugh Creek into the Newaukum River further south still are worthy of consideration; however, no plan is workable without including water retention as part of the plan.
3. Alternative 2: <u>I-5 Raise and Widen Only</u>, Alternative 3: <u>I-5 Express Lanes</u>, and Alternative 4: <u>Temporary Bypass</u> are clearly unacceptable because they are only variations of protecting the freeway from flooding without mitigation of the impact to the surrounding residents in the inundation zone. We have said from the very beginning that a solution which leaves the freeway high and dry while leaving our residents in a bathtub below is not our idea of fixing the problem –and Governor Gregoire has promised us that would not happen.
4. We are very skeptical of the accuracy of the hydrology impacts reported by WSDOT, both from the perspective of downstream impact and the inundation maps provided as appendices. There have been extensive studies conducted by the US Army Corps of Engineers (USACE) in their 16 year study of the Twin Cities Levee project that indicate that a levee protecting the I-5 corridor and the Twin Cities would force water through the Mellen Street Choke Point sooner and in greater quantity. For that reason the USACE included additional water retention at the Skookumchuck Dam to provide mitigation against this increased flow.
5. WSDOT's predictions of increases in downstream elevation (from Mellen Street) of 0.1 to 0.2 feet are simply not believable. Furthermore, the inundation maps give an optimistic picture of reductions in flood elevation in the I-5 corridor on the east side of the freeway of 1.4 feet. The fact is that a substantial amount of land on the east side is inundated and some of it substantially. In the 2007 Flood parts of the Fairgrounds were in 12 feet of water so a reduction of 1.4 feet would still leave that area under almost 10 feet of water.

OTHER FLOOD HAZARD MITIGATION ALTERNATIVES:

6. We are aware that there are different problems to be addressed on the river other than our concern about developing water retention and protecting the I-5 corridor. Certainly, solutions that focus on the I-5 corridor alone do not address our concerns in the basin up-river of the corridor; or, for that matter, either impacts down river or other local problems in the middle and lower basin. We believe we should be good neighbors and make sure that our projects mitigate downstream impacts. We also believe that a basin wide solution must address all of the concerns in the basin and that the process of achieving a solution will be long term. For that reason we would be open to investigate any projects that will provide local protection and contribute to the eventual objective of a basin wide solution.
7. Some of the solutions will be more difficult than others. Obviously there are opponents to both dredging and flood water bypasses that will impede and cripple the approval process making pursuit not practical. There may, however, be some level of dredging or "soil modification" in parts of the river that provide mitigation and may be doable.
8. There are many other projects that can be accomplished separately with a net benefit to flood mitigation and we would fully support such projects. We also believe that achieving a basin wide solution is a long term project and that we will have to achieve parts of the solution incrementally. We will support any projects which have been properly planned and for which there is basin wide consensus that the project contributes to a basin wide flood mitigation plan. In other words, we support the Hallmarks of a Basin-wide solution presented in the Ruckelshaus Report.

F LEE GROSE	PW "BILL" SCHULTE	RON AVERILL
Commissioner, District 3	Commissioner, District 2	Commissioner, District 1
Chairman	Vice-Chairman	Member

Response to Comment

The legislative purpose of this report was, as the commenter notes, only to evaluate alternative projects that could protect I-5. The full Chehalis Basin Flood Mitigation Alternatives Report addresses other potential projects, including a dam on the upper mainstem Chehalis, in detail. The final WSDOT report will more clearly define its intent and context and more clearly reference the full alternatives report for more information. It also will more clearly describe the potential effects of a dam relative to I-5 protection alternatives, including a clear statement that a dam would lower flood elevations throughout the Basin and would, therefore, reduce the amount of effort needed to fully protect I-5 during major flooding and the costs of I-5 protection.

WSDOT appreciates the conditional support for the walls and levees alternative as preferable to other alternatives discussed; although WSDOT's charge and the purpose of WSDOT's analysis is to evaluation potential project to protect I-5, the Department did attempt to optimize preliminary project design wherever possible to provide collateral protection of communities and infrastructure. We understand that additional actions will be needed for community protection, and that I-5 protection alone is not a path forward that is supported in the community. We recognize the significant support, expressed by this and other commenters, for water retention as part of a package of protective efforts. WSDOT agrees that it is extremely important to identify the right measurement for freeboard. The right amount of freeboard will provide confidence that, no matter what flood protection measures the legislature directs WSDOT to build, they provide protection for predicted floods in the project area.

The primary reason the Walls and Levees alternative do not show as large of an increase in downstream elevation as the Corps Twin Cities project is that the Walls and Levees alternative does not include all of the levees in the Corps Twin Cities project. In particular, the Walls and Levees project does not include the Galvin Road levee. The Walls and Levees along I-5 alternative would restrict flow from passing to the east side of I-5 and into the Twin City area during significant flood events. Under the current conditions, (i.e., without the walls and levees), Chehalis River flows are stored and conveyed along the east side of I-5 during large storm events such as the one that occurred in December 2007. By placing walls and levees along I-5, the amount of water flowing from the Chehalis River to the east side of I-5 would be reduced; a greater portion of floodwater would stay between I-5 and the western valley wall. This water does eventually pass downstream, although some of the flow is temporarily backed up behind the Mellen Street Bridge, a narrow point (constriction) in the floodplain. When the airport levee is raised in conjunction with the I-5 Walls and Levees alternative, an additional location of floodplain narrowing occurs, further backing up flood waters. Under these scenarios, the flood elevations along the Chehalis River are predicted to increase up to 1-2 feet for the December 2007 event at some locations between I-5 and the western valley wall. The increase in water surface elevation is predicted to be on the order of 1 foot for the 100-year event.

The predicted change in water surface elevations downstream of Mellen Street and the Chehalis River/Skookumchuck River confluence caused by the Walls and Levees alternative is significantly less during events such as the December 2007 and 100-year floods when compared to the change upstream of Mellen Street. This is due, in part, to the narrow opening at Mellen Street which limits downstream discharges. The timing of flows in the Chehalis River and their coincidence with Skookumchuck River flow is also affected. Simulations indicate that the change in downstream water surface elevations are on the order of plus or minus 0.1 feet. Larger changes in water surface elevations are seen in the area downstream of the Chehalis River/Skookumchuck River confluence with other combinations of flood protection features, such as the Corps Flood Reduction Project. Part of the reason that the Walls and Levees alternative does not cause much of a rise downstream of the Skookumchuck is that the proposal does not include any physical changes to the floodplain in this area and as such, the flood flows are free to spread across the entire floodplain as they currently do.

Marlene Hampton 8/31/12

Hello My name is Marlene Hampton. I have lived in Rochester Washington since 1980. I can in no way describe to you what it is like to be flooded to make you understand the trauma a person goes through. It is one of those experiences you have to experience to fully understand. I was very disillusioned when I heard awhile back that our governor was more interested in the commerce of out state than she was the flood victims. I went to a meeting last week hosted by WSDOT which reiterated the states goal not to interrupt commerce at the expense of the people. From what I understand the walls they plan to construct will make flooding on the west side of I-5 worse! What kind of a solution is this? Wouldn't it be great to have a advocate to expedite the Dams process. This would benefit EVERYONE and the money spent on the walls could be put towards the Dam project. The craziest aspect of the whole idea of the walls is that some tax payers will be helping to fund a project that will causing them to be flooded more!!! I honestly don't know how the folks that make these decisions can sleep at night. This is like throwing a drowning victum an anchor!

Response to Comment

Thank you for your comment. The WSDOT report was written to address only Section 1033 (2) (c) of ESHB 2020. This section states "evaluate alternative projects that could protect the interstate highway and municipal airport at Centralia and Chehalis, and ensure access to medical facilities ...". The WSDOT report was not intended to address other potential projects or components that may be considered as part of a basin wide solution(s).

The final report more clearly describes the context for the I-5 protection analysis – it is but one component of a broader effort to summarize existing information on alternatives to mitigate flood damage in the Chehalis Basin. The alternatives described are focused on I-5 protection because that is the focus of the report; however the final report more clearly describes protection of I-5 as only one potential component of a broader set of flood hazard mitigation efforts needed in the Basin and refer more clearly to the larger effort to determine a path forward for flood hazard mitigation in the Basin, of which protection of I-5 is only a part. We recognize the significant support for water retention as part of a set of projects to mitigate flood damages.

Westside Chehalis Neighborhood Association 8/31/12

Chehalis Basin Flood Mitigation Alternatives Report and 1-5 Expansion, 13th Street to Mellen Street
Westside Chehalis Neighborhood Association Comments

August 31, 2012

We value this opportunity that citizens and the Tribes living within the Lewis, Grays Harbor, and Thurston County portions of the Chehalis River Basin have been given to comment on the difficult task Governor Gregoire has assigned the Chehalis Basin Flood Authority with assistance from the Ruckelshaus Center. Developing a basin-wide flood mitigation plan that addresses everyone's interests and concerns is a virtual impossibility. But giving citizens an opportunity like this to provide comments and suggestions at every stage of the planning process offers the best opportunity to achieve something at least approaching a consensus.

We also value the opportunity granted by Jim Kramer, Chehalis Report Project Manager, of the Ruckelshaus Center to favor our request for extending the comment period for its report to allow us and other communities to utilize the contents of the WSDOT Draft Report in our responses.

In November, 2011, the President of the Westside Neighborhood Association, in her capacity as a member of the Scoping Committee for the I-5 Expansion from 13th Street to Mellen Street, presented written information gathered through a series of three local meetings in our neighborhood to help WSDOT understand our views about I-5 expansion during the WSDOT early planning for exEansion ofl-5 through Chehalis. Since then the WSDOT Draft Report on I-

5 Protection from 13 Street to Mellen Street has been completed and made available for comment.

Following receipt ofthe August 17,2012, WSDOT Draft Report and WSDOT's community meeting at the Veteran's Museum the Westside Neighborhood Association met again to address that report's content and to develop additional comments concerning flood mitigation planning in the Chehalis Basin.

For nearly a half-century the residents of the Chehalis Westside have worked together in an organized fashion to improve our neighborhood and foster a friendly, attractive, and safe community. The current version of that organization is a not-for-profit 501(c) corporation called the Westside Chehalis Neighborhood Association working on behalf of the more than 270 residences located on the west side of Chehalis. Our association encompasses all the residences from State Street to I-5 (east to west) and Main Street to Geary Street (south to north). While there are several businesses located within this area, we do not claim to represent them or their interests.

As residents of the Historic Westside Chehalis neighborhood who will be significantly impacted by expansion ofI-5 between 13th Street in Chehalis and Mellen Street in Centralia we on the Westside want our thoughts and recommendations about the I-5 expansion project to be considered. Because of our proximity to I-5, the disruption that will result from construction operations during the expansion work and the long-term impact that I-5 changes and expansion will have on air pollution, noise levels, traffic volume adjacent to and through our neighborhood, and the flow of water in and through our neighborhood during flooding, the Westside Chehalis Neighborhood Association invited all members of the Westside community to prioritize and voice their concerns, to discuss and ask questions, and to offered suggestions to be included within comments made on behalf of the Association to the Ruckelshaus Center and WSDOT.

As a result four significant questions arose and are presented here.

1. Should 1-5 be elevated between Main Street and just passed Chamber Way so that future floods will not cause a closure of that vital transportation route? Yes. Our neighbors expressed a very strong interest in making sure that the freeway is designed to remain open during all floods.
2. Should the planning for 1-5 expansion take into account the impact of the freeway on flood mitigation and floodplain management? Absolutely. Westside residents are very concerned that changes to I-5 should not adversely impact the extent of flooding in our neighborhood and that planning should incorporate responsible flood plain management considerations. Dillenbaugh Creek is the source of our south side flooding.
3. Should dense and oversized sound barriers be installed to reduce noise impact on the Westside neighborhood? Yes. We are very much in favor of adequate noise control measures being included in the I-5 expansion project, including installing oversized sound barriers. Foliage such as trees and plants also would quell some of the sound.
4. Once the West Street Bridge is removed to allow the widening and relocation of1-5,should the West Street Bridge be replaced? No. Not replacing the West Street Bridge was strongly favored. Eliminating that bridge would significantly reduce itinerant traffic speeding through the neighborhood and increase neighborhood cohesiveness. We are not interested in a replacement of West Side Bridge over 1-5 ending in a roundabout at Louisiana, especially one costing more than $6,000,000.

Specific Ideas Put Forth at Neighborhood Meetings

Specific ideas and/or recommendations offered by those attending the neighborhood meetings are listed below.

Designing for Handling Water Flow

- Make a concentrated effort to pursue funding for the elevation of and the I-5 expansion because it surely will flood again and again, continuing to destroy and damage residences and businesses through this corridor.
- Protect and keep the Westside Residential Neighborhood safe from flooding, air and noise pollution. Protect and keep the Chehalis River healthy.
- Elevate I-5 from Main Street to Chamber Way allowing water to collect and flow away from the roadway while protecting the residential neighborhood.
- Planning for I-5 expansion should make use of Preliminary FEMA Maps.
- Homes on Prindle Street near I-5 are the ones that flood in virtually every flood incident. We propose that the State purchase at fair market value all homes on Prindle Street West from Quincy Street to I-5.

- But leave the existing alley to allow access to the City of Chehalis Pump Station and for St. Helens Avenue home owners' access to the back of their property.
- For drainage dedicate the vacated property on Prindle Street for a large retaining pond, not for any further development of or expansion to Liberty Plaza.

Noise Control

- Retest Sound Density levels emanating from I-5 into the Westside neighborhood.
- Build extra tall and dense sound barriers for the residential neighborhood beginning at Main Street and extending to Chamber Way.
- Maintain the elevation of West Street as it currently exists and Dead End West Street at New York Avenue.

West Street Bridge & West Side Park

- Historically this % acre park was part of an elementary school playground. During the
- 1949 earthquake the school suffered extensive damage and as a consequence demolished. What remained became the West Side Park. The present West Street Bridge with the narrow lanes and extreme curve at its western end was constructed in the 1950s.
- Following its removal, do not replace the West Street Bridge with one designed for the use of autos or trucks. Rebuilding and extending West Street and the Bridge will disturb, widen, and invite even more unwanted speeding traffic to cut through our neighborhood. Not replacing the West Street Bridge will eliminate West Street as a dividing barrier in our neighborhood.
- Construct a handicap accessible covered pedestrian/bicycle bridge over 1-5 from West Street to the Airport Loop TraiL
- Don't encroach upon the existing West Side Park. Where homes on New York Avenue are removed for I-5 expansion use the vacated property wherever possible to enlarge West Side Park

Other Suggestions

- Add a cul-de-sac to every dead end street for emergency vehicles access.
- Prindle Street dead ends at I-5 and currently does not have a cul-de-sac as required or any place for emergency vehicles to turn around.
- Several of the homes nearest to I-5 in the areas flooded have been raised as a form of flood mitigation. But the ones closest to I-5 are vulnerable should large vehicles go out of control and veer off the freeway toward the east. Some sort of protective barriers need to be installed to protect those homes.
- Maintain our neighborhood character. It is a National Historic District with a friendly and cohesive neighborhood character.

WSDOT Draft Report: 1-5 Protection from 13th Street to Mellen Street

It is imperative in making progress on this extremely complex and emotional project that we remain calm and explore the options laid out before us and perhaps some that have not been mentioned. We believe one option WSDOT states is not viable because it is cost prohibitive does deserve consideration. That option, elevating I-5 for a limited distance between Main Street and just past Chamber Way is one that could have an impact on flooding because I-5 does cause closure from flooding for that distance. Combine that option with the New SW Chehalis Levee allowing the flood waters to run freely under I-5 while protecting homes and businesses.

While varying opinions regarding flood issue combinations were obvious, there is no doubt that two alternatives provided by WSDOT got resoundingly and unanimously rejected at our neighborhood meeting! Both Alternative 3, I-5 Express Lanes, and Alternative 4, I-5 Temporary Bypass, prompted the most vigorous discussion. The end result of that discussion are the following: No, No, and No!

Either of those alternatives negatively affects our entire community is drastic ways without offering significant benefits to mitigating flooding or protecting I-5. The WSDOT Draft Report at page 20 states, "However, the lanes likely would be visible from some homes on the edge of the West neighborhood in Chehalis. A noise study has not been conducted yet, but cost estimates for the project include funding for noise walls in the event they are needed." That statement comes nowhere near describing the adverse impacts of those two alternatives.

Express Lanes and Temporary Bypass Lanes at 22 feet in height and at least 50 feet width with bridges at Main Street, Prindle Street at St. Helens Avenue, and West Street at State Street would be visible and heard from most Westside streets, not to mention home owners' private property they would invade. Residents of some historic streets directly affected by the ugly sight and sounds of Alternatives 3 and 4 are West Street, Rhode Island, Hawthorne Place, Division Street, Quincy Place, St. Helens Avenue, Prindle Street, State Street, Pennsylvania Avenue, Gertrude Street, Folsom Street, and Westside Park.

Tacoma rail line traverses through the Historic Westside Neighborhood, Historic Downtown Chehalis, some industrial area, and under the Chamber Way Railroad Bridge. Is the rail line wide enough, is the existing Chamber Way railroad bridge high enough, and does it flood there are additional questions not even addressed in the WSDOT Draft Report.

Thinking about Express Lanes, Temporary Bypass Lanes, and a bigger than life West Street Bridge isolating the Historic Westside makes one know how the citizens of Kalama, Washington, must have felt when I-5 bisected their city.

The Lewis County Historic Museum, located in the former Burlington Northern Depot, sits adjacent to the Northern Pacific/Burlington Northern main line at the intersection of Market Boulevard and West Street. The museum offers the Pennsylvania Avenue - West Side, National Historic District A Public Guide, as a walking tour beginning at the downtown

Chehalis Museum crossing the tracks and up West Street into our neighborhood. In part it states, "The National Register of Historic Places is the federal government's official list of cultural resources worthy of preservation. It was authorized by the National Historic Preservation Act of 1966 and is part of a program to encourage public and private efforts to protect historic and archaeological resources. Properties listed in the National Register include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and culture. The National Register of Historic Places is administered by the National Park Service, United States Department of the Interior, Washington, D.C." Why would any Municipality or State authorize interstate express lanes/temporary bypass lanes with unhealthy, unsightly bridges or promote the deterioration of a National Historic District by building an unneeded hulking ugly West Street Bridge through the middle of that Historic District?

To add some perspective to our concerns about the impact that WSDOT Alternatives 3 and 4 have on our community we have included as an attachment to these comments a series of photographs of the area where the bypass or express lanes would traverse.

At our most recent meeting to discuss the flood mitigation planning that is going on participants offered the following specific comments about the WSDOT alternatives contained in its Draft Report.

- There are essentially two issues associated with protecting the Chehalis Basin from flood damage: the issue of flood damage and the issue of keeping transportation and commerce flowing through the area on I-5. The flooding issue may best be addressed through alternatives like a retention dam, but ifWSDOT cannot wait to protect I-5 until after retention dam is completed then the Westside residents of Chehalis would prefer Alternative 1 from the WSDOT Draft Report.

- If Alternative 1 is adopted the residents of the Westside Chehalis Neighborhood recommend that the existing West Street Bridge not be replaced. That opposition arises because replacing that bridge with a higher and wider bridge will result in substantially increased traffic through our neighborhood, particularly by commercial vehicles and large trucks. Construction of approaches to a raised and widened West Street Bridge will also block access to West Street from New York and Ohio Avenues and will likely cause loss of some of the land that is currently occupied by the Westside Park. A bridge blocking New York and Ohio Avenues due to extended ramping will also preclude access from West Street to those two residential streets from either direction by emergency vehicles and residents.
- If either the Express Lanes or Temporary Bypass alternative is adopted residents of the Westside Chehalis neighborhood will have their real estate property values negatively impacted. If this is the direction taken then those property owners would like a "buy out" option under which they can be compensated for the lost value or have their property purchased outright at fair market value. That option should be available to all property owners on the Westside, not only to those whose property is immediately adjacent to the Tacoma Rail right of way or whose land may be used in part for construction of the new roadway.
- We don't like the idea of a being "blocked in" and set apart from our City of Chehalis.
- If the proposal for either express lanes or a temporary bypass is adopted it will lead to extensive litigation by opponents.
- NOISE! NOISE! NOISE! Express lanes will dramatically increase noise and pollution levels in the Westside neighborhood caused by trucks and automobiles. The noise will be coming at us from both the east and the west as we will be surrounded by I-5.
- Look at the west side ofl-5 for solutions to protect that arterial.
- At our most recent neighborhood meeting we also received the following comments associated with Chehalis Basin-wide proposals to mitigate flooding.
- A basin-wide solution to flooding problems is so far off in the future and there is so little agreement about what options for addressing flooding throughout the basin that WSDOT is going to be forced to protect I-5 from flooding before a basin wide plan will ever be agreed upon or funded.

The Proposal for a Retention Dam Near PeEII

If a retention dam near PeEll is to be seriously considered as a basin-wide approach to flood mitigation it is important that the residents of the entire basin, but especially those in the PeEll area, be educated about and involved in the planning process from start to finish.

The cost estimate for the proposed dam near PeEll, an earthen dam, 300 feet high and *Yz* mile long, for water retention is most likely too low. The proposed PeEll Dam site is approximately 2 miles from town and not in sight from town. Warning systems and evacuation plans for the 700 residents and about 300 school age children are concerns.

There are residents of the Chehalis Westside neighborhood who do and those who do not favor a retention dam as a way of reducing flooding below the dam site.

A retention dam may be a good idea and it may help solve flood problems in the basin. But it does not solve the I-5 flooding problem.

Other Comments Offered for Dealing With Potential Flood Damage

Improved timber practices, including management of harvested timber, need to become part of any proposed basin-wide solution to Chehalis Basin flooding.

Any basin-wide solution to flooding must also address flooding that is caused by groundwater levels that have increased during periods of flooding causing flooding from water intruding from beneath the ground's surface in low lying areas not otherwise affected by surface water flooding.

Respectfully submitted on behalf of the Westside Chehalis Neighborhood Association,

Deanna M. Zieske President
P.O. Box 1272
Chehalis, WA 98532
August 31, 2012

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Ted and Darlene Held 8/31/12

I-5 Protection from 13th St. to Mellon Street

My husband and I live in the Chehalis West Side area and belong to the Westside Chehalis Neighborhood Association. We have become very concerned with proposed alternatives being considered for flood protection and have attended the public community meeting hosted by WSDOT at the Veteran's Memorial Building in Chehalis and a meeting at our local neighborhood association on August 28th.

After considering the alternatives with the information presented, we feel we cannot endorse the temporary bypass or the express lanes. The only plan that we feel might be worthy of considering would be the earthen levy as it could keep our neighborhood from suffering from the flooding that has been an issue in the past. While our home has not flooded, we have had many neighbors and friends that have and they still are suffering. Some have not completed restoration of their home and property yet.

The temporary bypass or the express lanes would be an eyesore and a barrier that would cut off this area from the historic downtown shopping area and could create two towns. It would cause lost revenue to the already struggling small businesses. I speak from experience as we sold our business seven years ago, and during the 22 years that we owned it we found that something as minor as a change in the weather would affect our sales. The bypass/express lanes would also cause air pollution, noise and a decrease in our property values.

Please take these issues into consideration. We do not have the answers, but don't feel these are either.

Ted & Darlene Held
451 NW Division St.
Chehalis, WA 9853
August 31, 2012

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Cynthia and William Tahl 8/31/12

Cynthia & William Tahl
616 NW Hawthorne PL Chehalis, WA 98532

August 30, 2012

To whom it may concern:

We are writing this letter regarding the proposed 1-5 Express lanes.

Our home/property is on the Historic Westside of Chehalis, sitting approximately 125 feet west of the Tacoma rail line.

We have been resident homeowners here for 33 years. For many years the rail line was active and busy and was of little disturbance to our neighborhood or our lives. Lately the rail line is used much less and in open to the Historic Steam Train during the tourist season.

The proposed express lanes would turn our quiet historic neighborhood into an unsightly nightmare; our neighborhood would become or at least resemble an industrial area with bridges, concrete walls, noise & pollution. This would without doubt adversely affect the property values in our historic neighborhood.

While we are well aware of the need to improve access through this part of the 1-5 corridor, this

2-lane expressway is not a logical alternative. A two lane expressway would not have useful traffic flow during normal traffic days, and would be a virtual parking Jot during an emergency. Currently, with four lanes available, our area of 1-5 moves at a crawl every weekend. This expressway location is just not a viable option as it will not provide the solution sought.

Regards,
Cynthia Tahl

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Deanna and Lewis Zieske 8/31/12

August 31, 2012
Ruckelshaus Center, WSU West
520 Pike Street, Suite 1101
Seattle, WA 98101

We appreciate this opportunity to provide comments on both the Chehalis Basin Flood Mitigation Alternatives Report prepared by the Ruckelshaus Center as well as upon the WSDOT Draft Report: I-5 protection from 13th Street to Mellen Street near Centralia and Chehalis, both of which address flooding issues in the Chehalis River Basin.

Addressing how to prevent and/or mitigate recurring flood damage in the Chehalis Basin has been a topic of concern and discussion for over 100-years. More recently the interruption of commercial and personal travel along I-5 during major flood events has also come to the fore. Both issues now seem to be coming to a head.

In the more than 22 years that our family has lived in Chehalis we have lived through the largest flood events this basin has experienced during the lifetimes of all but any centenarians residing in our communities- those of 1996, 2007 and 2009. There have been almost constant debates about how to address flooding. And no resolution. Politics, personal interests, economic constraints and a myriad other factors have prevented action. Hopefully the current approaches outlined in the Chehalis Basin Flood Mitigation Alternatives Draft Report will lead to a different result.

It is with that hope, and as a gesture of appreciation for the work that has gone into both the Flood Mitigation Alternatives Report and the WSDOT Draft Report: I-5 protection from 131 Street to Mellen Street near Centralia and Chehalis that we offer the following comments on the two reports.

Comments on Chehalis Basin Flood Mitigation Alternatives Report

Proposals to provide flood protection to I-5 as set forth in alternatives contained within the WSDOT Draft Report are being criticized by some policy makers and local officials because protecting I-5 does not offer basin-wide flood mitigation benefits. The rationale those individuals use in supporting that criticism is that focusing on protecting I-5 will dampen the pressure to undertake other flood protection measures to provide relief to areas outside of the I-5 corridor.

What those criticisms of the I-5 protection alternatives fail to take into account is that there are no proposals under consideration (or to our knowledge that have even been conceived) that,standing alone, protect the entire Chehalis Basin. And there is no politically viable prospect for marshalling local, state and federal funding in an amount sufficient to accomplish a basin-wide approach at one time. Face it, basin wide flood protection and mitigation will have to be phased in and should begin immediately. The surest way to niake a start- and the way that provides the earliest and greatest positive impact - is by securing the I-5 transportation corridor with its accompanying protection to the more heavily populated areas in Chehalis and Centralia. Thus, our later comments on the WSDOT Draft Report will address the specifics of what we believe is the preferred manner for protecting I-5.

Having said that, and not wanting to ignore the balance of the Chehalis Basin, we want to now begin to address the Chehalis Basin Flood Mitigation Alternatives Report.

A large water retention dam near PeEll appears to be a popular alternative for maximizing protection throughout the basin because it is easy for a lay person to understand. But that alternative is very expensive and has drastic ecological and environmental impacts, some of which we believe are unacceptable. Furthermore, it does not preclude flooding. It merely reduces the 2007 flood level by 3 to 4 feet in the Twin Cities. A dam alone, if not augmented by I-5 protections, would still inundate and close I-5 in a flood event comparable to the 2007 flood.

It would also still leave water depths of 5 to 6 feet on Prindle Street in Chehalis and intrude about 2 feet or more into the lower level of the historic round carriage house located on our property.

And should the dam fail (which does happen, as recently as this week in the Southeastern United States) there would be catastrophic damage to property downs.tream and potentially a significant loss of life. A dam failure would also drain the reservoir area creating additional environmental havoc.

Presently, instead of a dam we believe a better basin-wide approach to mitigating flooding is to encourage implementation of programmatic options like those set forth at page 47 of the Chehalis Basin Flood Mitigation Alternatives Report. Land use management, flood plain regulations, limits on fill and development in flood plain, structure modification and raising and other options of that sort can be implemented at the lowest cost to the public at large.

We recognize the great drawback to this approach. It transfers the cost of flood mitigation to landowners through reduced property values and limits on land uses. That runs afoul of the politically conservative residents who comprise the majority of the residents here in the Upper Chehalis Basin. And our experience in trying to enforce the State's Growth Management Act here in Lewis County clearly shows the depth of political and public opposition to such measures that would be faced and would have to be overcome. But in the long run the benefit is well worth the effort.

As a fall-back position if political opposition to programmatic options cannot be overcome and a "big project" approach is undertaken, we prefer some version of Combination 3 outlined in the Flood Mitigation Alternatives Report that includes Option 1 from the WSDOT report. For that reason we now turn to comments on the WSDOT Draft Report: I-5 protection from 13th Street to Mellen Street near Centralia and Chehalis.

Comments on the WSDOT Draft Report: 1-5 protection from 13th Street to Mellen Street near Centralia and Chehalis

As residents of the Historic Chehalis Westside neighborhood and business owners in Chehalis the proposed solutions for protecting I-5 from flooding contained in the WSDOT Draft Report are of particular personal relevance to our family. Our home is located at 647 NW St. Helens Avenue in Chehalis. We travel from home to our downtown law office in Chehalis several times daily. Both our neighborhood on the Westside and the downtown Chehalis business district are National Historic areas about which our community is proud. We have lived in our home on St. Helens Avenue since early 1995. Our property is approximately one acre in size and slopes downward to the alley abutting the residences on Prindle Street. Our property includes a home built in 1910 that is on the National Historic Register and a large round carriage house/ bam built in 1900 that is also on the National Historic register and may well be the largest surviving round carriage house in Washington1

Since we moved into our home in 1995 we have lived through the major floods of 1996, 2007 and 2009, all of which closed I-5 for varying periods of time. The lower part of our property, including the carriage house, was flooded in each of those major floods, with water being more than 5-feet deep in the carriage house and to a depth of 12-feet or more in the lowest part of our yard during each of those floods. During each of these three major floods in sequence the flood waters came closer and closer to the residence itself.

In addition to those three great floods we have seen flood water intrude into our yard several other times, usually with less than 6 inches of water reaching the carriage house on those occasions. Fortunately, because our home is several feet above those flood levels and also because we do not store personal property of high value in the lower level of the carriage house, the flooding has not caused us any significant monetary loss. Our neighbors, though, especially those abutting our property on Prindle Street, have suffered huge losses from flooding.

Nevertheless, we are extremely interested in measures, including protection of I-5, that will mitigate or eliminate flooding in our neighborhood. Thus, our interest in and these comments on the WSDOT Draft Report are offered for consideration in evaluating and/or revising proposals for flood control in our area.

Of the six proposals (four analyzed briefly and two mentioned but dismissed by WSDOT as financially infeasible) discussed in the WSDOT draft report, the one we favor is Alternative 1: I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee, reflecting widening ofl-5 to six lanes and constructing protection assuming no dam being built in the Upper Chehalis basin. Elevating I-5 in some places should be considered as an additional alternative. We favor this approach for the simple reason that protection is needed for the Chehalis/Centralia area immediately. I-5 is not only crucial to the economy of Washington State and the west coast, it is vital to the economy and lives of the people in Lewis County.

Those losses to interstate commerce, as well as to the businesses and home owners whose property is flooded when I-5 is threatened, must not be allowed to be repeated over and over again.

While several years may pass before the improvements in this alternative will be completed, prospects for basin-wide agreement on any plan, let alone an extremely costly dam above PeEll is extremely controversial.

Prospects for construction of a dam are both much more speculative and the timing of construction, if it ever occurs, is likely to be much later in the future.

Frankly, the savings from proceeding with Alternative 1 now regardless of the outcome of a dam proposal will save more in losses from a single flood like that of 1996, 2007 or 2009 than it will cost to construct the levees, walls and I-5 widening.
While Alternative 1 is our preferred option from among those contained in the WSDOT Draft Report, there is one aspect of that alternative we want to see changed. It reflects widening ofl-5 necessitating replacement of the overpasses at Main Street, Chamber Way and West Street. The Main Street and Chamber Way exits are less than a mile apart. A new bridge at West Street would offer no access to I-5 and serves no purpose in easing the flow of traffic on I-5. But it would have two severe impacts upon the Westside Chehalis Neighborhood.

The first is the increased volume and speed of vehicle traffic through the Westside neighborhood, particularly of large trucks. The existing bridge is narrow and has a sharp curve at its western end that makes it difficult for trucks to navigate. Widening and lengthening the bridge and its approaches will make it easy for large trucks to navigate that route allowing trucks going to National Frozen Foods and/or Sorenson Trucking's terminal on State Street to get to their destinations without having to travel by way of either Chamber Way or Main Street. And a new bridge will encourage more cars to use that route through our quiet neighborhood to get to the airport, to the shopping area along Louisiana Avenue and to the Riverside Golf Course. That increases noise in the neighborhood and the potential for children and other pedestrians to be injured.

The second negative impact of replacing the West Street Bridge is its impact upon the Westside Park and the access to homes on New York and Ohio Avenues. New road construction standards will require a replacement bridge to be much wider and higher than the existing bridge. In addition, widening I-5 will push that interstate east toward Maryland Avenue and New York Avenue south of West Street. The bridge approaches for a new bridge will block access to West Street from New York and Ohio Avenues and will either take part of the already small (3/4 of an acre) Westside Park or result in retaining walls eliminating the sidewalk that runs adjacent to the park on West Street and blocking access to the park for those living north of West Street.

Two of the proposals put forth in the WSDOT Draft Report are unacceptable. Alternative 3, the I-5 Express Lanes, and Alternative 4, the I-5 Temporary Bypass, have such a negative impact upon the City of Chehalis and the Westside Chehalis neighborhood that regardless of their costs (which are for all practical purposes unknown since the availability of the Tacoma Rail Line right of way is up in the air) that they should be rejected as politically infeasible.

Both alternatives contemplate using the Tacoma Rail right of way through Chehalis as the route for a single lane of traffic each direction. Both involve construction to a height that places the surface of the express lanes/bypass lanes, including the guardrails, some 22-feet above the existing street surfaces at Main Street, Prindle Street (and St. Helens Avenue as it joins Prindle Street where the Tacoma Rail line crosses Prindle) and West Street at State Street. Depending upon whether the option will be a temporary bypass or express lanes, the roadway through the urban development area of downtown Chehalis will be a 40 to 50 foot wide wall with vehicle and pedestrian access between the Westside and Downtown area only through the three bridge crossings at Main Street, Prindle Street and West Street.

What those two options do is bisect the City of Chehalis, separating the Westside neighborhood, including the businesses located there, from the rest of our community and permanently altering the overall nature of our city. Even worse, they result in the Westside neighborhood being completely surrounded by freeways making the area an isolated island of primarily residential development exposed to even more noise from high speed motor vehicle traffic and accompanying exhaust pollution than currently exists or would exist with a simple widening of I-5 to six lanes.

The homes in the Westside neighborhood include some of the largest, most expensive and historic homes in Chehalis. The history of our community was written by the original owners of these lovely homes - judges, bankers, politicians, prominent business leaders, etc. Evaluating Alternatives 3 and 4 looking only at construction costs, as was done in the WSDOT Draft Report, does not take into account the very real historic, cultural, social and other very important costs associated with building either of those two alternatives.

It ignores the cultural impact that will occur when either alternative severs our community. It ignores the huge impact that removing the rail service to the Wilco Agricultural Center and CENEX has on those major businesses as well as the impact upon the new Lewis County PUD electrical facility that construction of the elevated roadway there will have. It gives no consideration to the negative impact that the increased noise and pollution will have on residents of the Westside, particularly those whose homes are immediately adjacent to the proposed express or bypass lanes and to the elderly and infirm residents living at Chehalis West, a nursing home that abuts the existing Tacoma Rail right of way. And it does not take into account the tremendous loss in real property values to the homeowners living immediately adjacent to the Tacoma Rail right of way on Prindle Street, St. Helens Avenue, Division Street, Hawthorne Place and Rhode Island. Everyone else owning property on the Westside will also be damaged as a result of the inevitably loss in property values occurring because their property will be a much less desirable place in which to live if bounded on all sides by freeways and cut off from downtown Chehalis by Express Lanes or a Temporary Bypass.

We thank you for this opportunity to comment upon the Ruckelshaus and WSDOT Draft Reports. Sincerely,

Deanna M. Zieske Lewis Zieske

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Brain Raymor 8/31/12

08/30/2012

To whom it may concern:

I am writing this letter to express my concern about the proposed changes involving I-5 and the West Side bridge in my neighborhood.

My name is Brian Raymor and I am a 7 year resident of the historic West Side neighborhood. My property is in a constant state of improvement as I attempt to add to the sense of community that is felt in this area. I feel strongly that my neighbors contribute to this end and it is important that this neighborhood remain as unified as possible.

The suggestions proposed by DOT would effectively cut the neighborhood into two distinct areas divided by a larger road. We would also experience increased traffic and noise due to large trucks being free to drive down West street.

Additionally, under this plan home owners in this area will suffer a reduction in property values as some of the equity in our properties is tied to the desire to live in a quiet, family oriented area absent large transit trucks and traffic. Surely there will be those among using the neighborhood that will propose to resolve the various conflicts of interest and damages by litigating the issues in court. This is an expensive option that would best be avoided by finding a way to resolve the DOT flooding concerns without affecting our neighborhood.

Thank you for your considering my opinion.

Brian Raymor
654 St. Helens Ave
Chehalis, WA 98532 (360) 508-6049

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

Department of Ecology 8/31/12

Ecology comments: WSDOT Draft Report: I-5 protection from 13th Street to Mellen Street near Centralia and Chehalis

General comments

5. Mitigation for flood impacts appears to be included, but not environmental mitigation. The report mentions that there will be wetland impacts. The report states that impacts could be mitigated by using the North Fork Newaukum mitigation site. Has the cost of wetland mitigation been considered in developing the different alternatives? In some of the alternatives that are presented, the costs could be quite substantial. Potential mitigation costs for wetlands, fisheries, or other environmental impacts should be discussed, recognizing this is still at a preliminary planning stage.

Federal and State 404/401Water quality certification may be necessary.

6. When you are evaluating the different alternatives, you should consider impact avoidance. Which project is the least environmentally damaging solution? An analysis should be done in order to follow the mitigation sequence. (Also please see Specific Comment #1 below.)

7. Portions of the project may be in shoreline jurisdiction and will need to be consistent with the Shoreline Management Act and the local Shoreline Master Programs. There may be more than one jurisdiction involved with this project and so there may be multijurisdictional review.

8. The term “miracle mile” may not be clear to all readers. Consider defining this term the first time it is used.

Project Alternatives

7. Could some hybrid of Alternative 1, with some limited use of viaducts from Alternative 5, provide environmental benefits? In particular I would picture this as a benefit in an area like Dillenbaugh Creek, where a viaduct could reopen flood plain connectivity. There may also be areas where improving the movement of water with a viaduct would have more flood hazard mitigation benefits to the community than blocking the water with a levee or well. In general, to focus on transportation benefits with community and environmental impacts as secondary considerations may be missing an opportunity to look for solutions in the valley the optimize benefits for transportation, the community, and the environment. (This comment relates to Specific Comment #3 below).

8. Alt. 2 includes raising I-5. There is discussion in the report about how much this alternative would result in new flooding or increased water surface elevations. It is not clear HOW this would be caused - is it from the added fill that would be necessary to raise the road? Some brief explanations like this would improve the readability of the document and help decision makers better understand the effects of and differences between the alternatives.

9. At meetings, Twin Cities staff and residents voiced significant concerns with the aesthetics and social issues surrounding alternatives 3 and 4. There are vague references to the concerns on pages 21 and 27, but this could be emphasized more and perhaps earlier in the report.

10. It’s not clear how the natural resource impacts of alternative 3 (or alt. 4) are the same as widening I-5 to six lanes. Is this because the extent of impacted areas would be the same? Because these alternatives occur away from the existing I-5 footprint, it is hard to see how they could be the same. Consider qualifying or clarifying what is meant by this statement.

11. For alternatives 3 and 4, it seems the sentences about access to the hospital may be oversimplified. Both say access to the hospital would be improved if drivers can reach I-5 from the south or from the north.

    While on the surface this is probably true, my reading of alternative 3 is that from the express lanes one would not have access to the freeway between 13th and Mellen Street. So is this only true if the freeway is open (not inundated) both the north and south of the express lanes, or would the current Mellen to Blakely improvement project play a role?

12. Similarly alternative 4 would not provide local access to the freeway between 13th and Mellen, so I have the same question. What if downtown Centralia is flooded from Salzer Creek or the Skookumchuck and people can't get to Mellen Street or north of it on I-5, is there access to the hospital? A better explanation of the conditions and scenarios under which drivers would be able to access the hospital under these two alternatives would be more meaningful, since access to the hospital is cited as a key piece to the evaluation of each alternative.

Specific Comments

8. Executive Summary: This section notes the need to consider the proposed projects in conjunction with other flood hazard mitigation projects. It also notes the potential impact to the community, measured in terms of improved conditions or negative impacts for "buildings." However no mention is made of environmental impacts or benefits, or opportunities to develop a project that has both transportation and environmental benefits.

    a. Some mention should be made of potential environmental impacts for each alternative.
    b. The Executive Summary notes that funds for flood impact mitigation are included in the cost estimates, but it's not clear if costs for environmental mitigation are included.
    c. It's possible that there are locations where a combined highway/environmental project could result in greater benefits than a highway project alone. For example, raising the freeway could result in greater floodplain connectivity, enhanced wetlands, and fish passage or rearing areas. The possibility of projects with environmental benefits should be given some consideration and noted in the Executive Summary.

9. Page 7: The discussion of a potential dam should clarify that these are modeled estimates of a dam that has only been conceptually proposed. For example, the sentence "If a dam were constructed…it would not fully protect I-5" should be reworded to something like "If a dam as proposed were constructed…model simulations show that it would not fully protect I-5". Another example: Instead of "In 2007, a dam would not have prevented flooding…", say "In 2007, model simulations show that the dam as proposed would not have prevented flooding…"

10. Page 13, "What are the potential impacts to natural resources?": Impacts can be negative or positive. It would be good to see more discussion here of potential positive impacts, such as through improved fish passage, flood plan connectivity, wetland enhancement, or water quality treatment improvements. Improved stormwater retention and treatment would be a positive benefit in terms of compliance with TMDLs in the Chehalis River and tributaries. WSDOT might consult with WDFW to see if there are opportunities for fish and wildlife habitat enhancement in the footprint of the project, beyond the mitigation of negative impacts.

11. Page 24 of the report describes how alternative 3 may 'change' a flood. How? Is it from the fill necessary to expand the Tacoma Rail ROW to a typical road section as shown on page 20?

12. Page 34, Table 7: This table should also include a summary of environmental mitigation costs and potential enhancements.

Also, consider adding an asterisk to the Alternative 3 and 4 stating that these estimates do not include the costs or ability to acquire the Tacoma Rail ROW.

13. Page 35, "Conclusions…" same comments as #1 for executive summary.

14. Page 39, "Difficulty Precisely Predicting…": In this discussion you might also note that the Hydraulic model, whose results you show in Appendix D, shows a calibration error on high water marks in the area of I-5 ranging from -1.24 feet to +1.0 feet (Appendix F of Ruckelshaus Center report; page 215, 219, 221; Tables 3, 5, 7). Model uncertainty is another reason to include freeboard in your estimates.

    In addition, the Hydraulic model evaluated 3 historic events and one 100-year design flood. These four scenarios do not encompass the full range of possible future events, such as a 2007-scale atmospheric river event concentrated in the Cascade foothills, or a 100-year event focused in the Cascade foothills. This is another source of uncertainty in the hydraulic modeling and also justifies a margin of safety in the freeboard calculation.

    Given the issues raised in Casey's memo in Appendix A.1 along with these other sources of model uncertainty, you may want to review whether a freeboard of more than 3 feet might be appropriate.

Response to Comment

General Comments

1 - The cost of wetland mitigation was factored into cost estimates for each of the alternatives. However, because the alternatives identified in the report are still in a preliminary design phase, the report does not include specifics on mitigation for wetlands, fisheries, or other environmental impacts. Further consideration of any of the alternatives will entail additional analysis related to environmental mitigation and the necessary environmental permitting. WSDOT's process is to avoid, minimize and mitigate impacts in that order.
2 – See response to General Comment 1
3 – See response to General Comment 1
4 – Miracle mile is now defined the first time it is used in the report

Project Alternatives

1. The alternatives described in the report are in a preliminary design phase; WSDOT did not explore hybrid alternatives for combined highway/environmental benefit in this preliminary assessment. Future analysis could include hybrid options.
2 - Raising I-5 on fill material creates a barrier impeding flow downstream. This is the primary reason for the modeled increase in water surface elevations in the areas shown in Appendix C. A lesser cause of the increase in water surface elevations is due to the fill (reducing water storage) but it is not nearly as significant.
3 - New language has been added to the final report that describes the potential impacts alternatives 3 and 4 could have on homes and businesses in the Westside Chehalis neighborhood.
4 - At this preliminary design phase, the impacts on natural resources was determined to be

relatively the same due to the close proximity of the location of the Tacoma Rail Line to I-5 and the similar amount and types of impact areas. Further consideration of any of the alternatives will entail additional analysis related to environmental impacts.
5 - Alternative 3: I-5 Express Lanes and Alternative 4: I-5 Temporary Bypass both provide a viable route around the portions of I-5 that are inundated during a flood event. With either of these Alternatives, I-5 will still be inundated and closed during a flood event. The report is attempting to communicate that if drivers can access I-5 north or south of the inundation area, then they can access express lanes or temporary bypass and can then reach the hospital. Moreover, these alternatives do not necessarily provide access to the hospital from portions of inundated local streets. A driver must be able to reach non-inundated portions of I-5 to access the hospital. This will be clarified in teh final report.

Specific Comments

1a – see response to General Comment 1
1b – see response to General Comment 1
1c – see response to Project Alternatives 1
2 – text was edited to better reflect model estimates of dam
3 – see response to General Comment 1
4 - The modeled 'change' in a flood event due to Alternative 3 is primarily due to the barrier created by the placing a road above the railroad tracks. Water would not flow over the existing railroad bed as it has in the past major floods. A lesser cause of the increase in the water surface is due to the fill reducing the amount of water storage, but it is not nearly as significant.
5 - an asterisk was included to the table to better reflect cost estimates for Alternative 3 and 4
6 – see response to General Comment 1
7 - as discussed in Appendix 1 to the report, WSDOT's analysis is that 3 feet of freeboard are sufficient to address uncertainities and protect I5 under a variety of current and potential future conditions.

Marion Ruth 8/31/12

Melissa Kuehne • Ruckelshaus Center WSUWest
520 Pike Street Suite 1101
Seattle WA 98101

Dear Ms Kuehne,

I attended a meeting of the Westside Association regarding the flood mitigation Report A. We did not learn about other options but I wanted to be sure you knew my feelings about the one presented. I had to leave the meeting early but my husband stayed and said the audience when polled were mostly against the I-5

Express lanes or Temporary Bypass. (I have attached the picture we were given.)

In my opinion it would ruin our very nice historic district. The raised two lane expressway would look so poorly with the rest of the neighborhood. The district is made up of three blocks of all maintained homes with tree lined streets. Our property values will really suffer with an elevated expressway as you enter the neighborhood.

We formed our Westside Association years ago in order to maintain the District and improve what we can. Recently we added flowering fruit trees to our playground. We payed for this with money raised at the holiday tour of homes we which we sponsored for several years. When we requested to be on the State register of historic homes the gentleman who came and evaluated the neighborhood told us it was the best in the state because all the homes weretogether in one place and were so well maintained for the period in which they were built. Some go back to the early 1900's.

Please consider other plans and let us keep our district the way it is now.

Sincerely,
Marion A. Ruth

Response to Comment

Thank you for your comment. WSDOT recognizes there are significant uncertainties with both the express lane and temporary bypass alternatives and the final report more clearly reflects your concerns and the potential impacts to homes and businesses in the Westside Chehalis neighborhood. WSDOT understands that many citizens in the Westside neighborhood felt that the express lane and bypass alternatives were proposed unexpectedly and without opportunities for citizens to provide comments and suggestions. Please note that the alternatives described in this report are in a preliminary design phase and WSDOT has not decided to move forward with any particular project. Further consideration of any of the alternatives will entail additional analysis related to potential impacts on surrounding communities and additional opportunities for public input. If projects move forward, WSDOT will provide opportunities for citizens to provide comments and suggestions as part of the planning process.

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Appendix G: Chehalis River Basin – Forest Practices

Contents

Draft Chehalis River Basin Report

Forestland Section

April 30, 2012

(Revised May 25, 2012)

Charlene Rodgers and Carol Walters
Washington State Department of Natural Resources
Forest Practices Program, Forest Practices Division

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

Executive Summary

Forestland and the Chehalis Basin

Forestlands are an extensive and integral part of the Chehalis river basin, comprising approximately 84% of the land base. Approximately 91% of the forestland is subject to the Washington Forest Practices Act and rules, while the remaining forestland is federal or tribal land. The Earth Economics Study commissioned by the Chehalis River Basin Flood Authority (Batker et al. 2010), explains how natural systems, including forestlands, provide flood protection – protection that can be compromised when the natural systems are lost through such actions as conversion to industrial or home sites. Forestland offers protection from flooding through hydrologic processes. For example, trees intercept rainfall and subsequent evaporation from the foliage (forest evapotranspiration) returns some of the rainfall back to the atmosphere. Permeable soils found in forests and understory vegetation absorb water, decreasing the amount of surface water runoff. Forest management activities such as timber harvest or forest road construction have the potential to decrease the natural flood protection of the forests if executed in a way that does not minimize adverse effects to these hydrologic cycle components.

Washington State has a rigorous forest practices regulatory program which prescribes forest management practices in a way that protects public resources such as water, fish and wildlife. The forest practices regulatory program is flexible and responsive to new information, which provides the ability to make changes in protective measures as scientific knowledge evolves. Additionally, lands subject to the Forest Practices Act and rules are covered by the Forest Practices Habitat Conservation Plan, an unprecedented conservation plan, approved by the Federal government, which covers all of the state and private forestland in Washington. The current Forest Practices rules:

- Protect unstable slopes, riparian forests, and wetlands,
- Minimize the impact of even-aged harvest in rain-on-snow zones,
- Limit even-aged harvest size and timing,
- Minimize soil disturbance as a result of harvest methods,
- Ensure well designed, located, constructed, and maintained forest roads,
- Ensure fish passage to upstream habitat,
- Maintain an effective adaptive management program and compliance monitoring program.

Forest Practices Rules – Background and History

The Forest Practices Act which declared that “forest land resources are among the most valuable of all resources in the state” was passed by the legislature in 1974. This law and its corresponding rules regulate forestry activities on state and private lands and are designed to protect the environment and ensure that Washington continues to be a productive timber growing area. The Act also created the Forest Practices Board (the Board), a 13 member entity that is a separate agency from the Washington Department of Natural Resources (DNR). The Board, working with the public, stakeholder groups and DNR, adopts Forest Practices rules and approves guidelines (Forest Practices Board Manual) which help landowners implement the rules.

The 1974 Forest Practices Act was the first step toward protecting public resources on forestland. A flexible forest practices program was built as the infrastructure to implement the Forest Practices Act and has facilitated many changes since the original 1974 Act including:

- 1982 – rules addressing "excessively steep or slide prone slopes."
- 1987 and 1988 – new rules regarding protection of riparian areas, adaptive management and interdisciplinary teams.
- 1992 – new rules addressing cumulative effects in watersheds, retention of wildlife reserve trees; establishment of wetland management zones; limits on even-aged harvest size and timing; operations on unstable slopes; filling of wetlands; and a temperature prediction method to ensure retention of adequate riparian shade.
- 2001 – sweeping changes to the rules including: clarification and better tools for identifying unstable slopes; more rigorous protection of riparian areas and wetlands; more rigorous requirements for forest road construction and maintenance to reduce road impacts on public resources; and a requirement for road construction and maintenance planning and annual reporting. The 2001 changes also included a more robust adaptive management program and compliance monitoring program to help ensure the forest practices program continues to be responsive to new scientific knowledge and that forest practice activities are in compliance with the law.

The 2001 changes paved the way for the State of Washington to write a conservation agreement called a habitat conservation plan. The 2005 Forest Practices Habitat Conservation Plan (FPHCP) is a statewide, programmatic plan protecting over 9 million acres of state and private forest land and 60,000 miles of streams – a first of its kind in the nation due to its scope and collaborative process. The plan, approved by the federal fisheries agencies in 2006, was the result of a unified and coordinated conservation effort among state, federal, tribal and local governments, environmental interest, and small and large forest landowners.

The Board has continued to make changes to the Forest Practices rules and Board Manual since 2001. One of the most recent rule changes resulted from the December 3, 2007 storm and the profound impact it had in western Washington and Oregon and especially in the upper Chehalis River basin. Unusually heavy precipitation and high winds, along with rapid snow-melt caused severe damage to thousands of acres of forestland in the area. Significant water run-off from heavy rainfall, rapid snow melt and saturated soils resulted in extensive damage to some forest road systems due to significant water flow, numerous landslides, debris slides and slumps, and massive timber blow-down areas. The Board convened a group of experts to consider the effects of the 2007 storm in an effort to decide what, if anything needed to be done to minimize the effects of a similar storm in the future. The Board's review led to changes in the watershed analysis rules, particularly related to landslide-prone areas. The Board continues to address issues on an on-going basis as new scientific and natural systems information arises.

Peak Flows/ Unstable Slopes and the Forest Practices Rules

The scientific literature identifies peak flow and unstable slopes as key factors that could be impacted by forest management activities and that have a potential to effect downstream flooding. Peak flow impacts most likely occur during storm events. Peak flows can affect flooding, stream channel alteration, stream bank erosion, and redistribution of sediment and large organic debris. The two forest management activities that most likely affect peak flows are timber harvest and road building. The potential magnitude of the effect of these two activities may increase when either activity takes place in a rain-on-snow zone. The extent to which timber harvest alone has triggered substantially increased peak flows is likely rare (Storck et al. 1995). Indiscriminate road construction, however, can alter runoff by collecting subsurface and road-surface water that routes directly to stream channels (Chamberlin et al. 1991).

Whether or not a particular slope will fail at any given time is dependent on a variety of variables, including precipitation rate and quantity; soil moisture; hydrology; slope aspect, length, and curvature; the internal strength of the slope material (Coates and Higgins 1990; Dragovich et al. 1993a); and root strength of vegetation (Harp et al. 1997; Schmidt et al. 2001; Roering et al. 2003). Disturbances, including timber harvest and road building, that compact or weaken slope material, change the hydrology of the slope, or undercut marginally stable slopes can trigger landslide events (Rollerson et al. 1997; Swanson and Dyrness 1975; Amaranthus et al. 1985; Dragovich et al. 1993b; Gerstel 1996). Increased levels of planning and analysis can reduce the likelihood of landslides by identifying and avoiding potentially unstable landforms, as can minimizing disturbance from harvest activities in these areas (Gerstel 1994; Rashin et al. 1999; Dhakal and Sidle 2003).

Forest practices rules include specific rules that help to minimize any potential impact of forest management on peak flows and unstable slopes. The primary forest practices rule groups that minimize peak flows and provide protection to unstable slopes include:

- Roads rules which help prevent interception of surface and subsurface water by roads,
- Rain-on-snow and green-up rules which help regulate size and timing of even-aged harvesting to prevent excessive levels of immature forest cover in any given geographic area,
- Unstable slopes rules which help minimize disturbance of unstable slopes.

The Forest Practices rules related to roads serve to maintain surface and groundwater hydrologic regimes by disconnecting road drainage from the stream network, thereby preventing increases in peak flows. This is accomplished, in part, through the proper location, design, construction, maintenance and abandonment of forest roads. Additionally, forest landowners are required to have a road maintenance and abandonment plan and provide annual status reports on the plan implementation.

The potential effects of forest management on peak flows is higher in the rain-on-snow zones through the influence of increased snow accumulation in canopy openings and melt during rain-on-snow precipitation events. Forest Practices rules address rain-on-snow effects in two ways, first through the hydrology module in watershed analysis and second through the rain-on-snow rule which gives DNR authority to set conditions for forest practice activities that propose even-aged harvesting in the significant rain-on-snow zone. DNR may limit even-aged harvest size when it determines that peak flows have caused material damage to public resources. The “green-up rule” also addresses limitations on even-aged harvesting. Under the green-up rule, the size and timing of even-aged harvesting is regulated to prevent excessive levels of immature forest cover in any given geographic area.

The Forest Practices rules are designed to reduce the frequency and magnitude of debris flows and debris avalanches from slope failures. If a field review confirms the presence of unstable slopes and timber harvest and/or road construction is proposed in those areas, the forest practice is classified as Class IV-Special and becomes subject to review under the State Environmental Policy Act. Conditions can be placed on the application and when applicable, mitigation measures for unstable slopes range from avoiding unstable slopes to altering the methods or techniques used in timber harvest and/or road construction operations.

The forest practices program also has a robust Adaptive Management program (AMP) and an on-going compliance monitoring program and enforcement authority. The AMP provides science-based recommendations and technical information to assist the Board in determining if and when it is necessary or advisable to adjust rules and guidance in order to achieve established goals and objectives. The compliance monitoring program and enforcement authority help to ensure that on-going forest practice activities are in compliance with the law.

Recent and Ongoing Research through the Cooperative Monitoring, Evaluation, and Research Committee

DNR, and its statewide partners, support and participate in monitoring, evaluation, and research projects through the Adaptive Management Program. The Forest Practices Adaptive Management Program is a multi-caucus program that includes representatives from state departments (including Fish and Wildlife, Ecology, and Natural Resources), federal agencies (particularly National Marine Fisheries Service, U.S. Fish and Wildlife Service, and Environmental Protection Agency), forest landowners, county governments, the environmental community, and tribal governments. Representatives of these caucuses participate on two key Adaptive Management Program committees established by the Forest Practices Board: the Forests and Fish Policy Committee (Policy) and the Cooperative Monitoring, Evaluation, and Research (CMER) Committee.

The CMER Committee oversees and conducts research and monitoring related, in part, to assessing the effectiveness of the Forest Practices rules. Its purpose is to advance the science needed to support adaptive management. The CMER Work Plan includes projects related to unstable slopes and forest roads that are particularly relevant to the forested landscape found in the Upper and Lower Chehalis basins. Unstable slope related projects will look at landslides that occur as part of natural hydrologic processes and as well as landslides within harvested areas to help understand the potential impact of harvest on the rate of landslides. Other studies will review the rule-identified landforms in the Forest Practices rules to determine the effectiveness of buffering these landforms in preventing or avoiding an increase in landslides beyond natural background levels. Forest road related projects will continue to monitor the rate of sediment delivery from surface erosion and determine if the road characteristics that affect runoff and sediment delivery to streams are improving through time as forest roads are improved through Road Maintenance and Abandonment Planning (RMAP) implementation.

Recommended Projects for Future Funding

DNR is recommending three projects, in priority order, for funding consideration. All three projects will provide tools and information to help provide flood relief and protection in the Chehalis basin.

Project #1: Geological mapping and updated LiDAR (Light Detection and Ranging)

LiDAR and photography will supply data on floodplain elevations that are needed to understand flooding patterns, geomorphology, floodplain management, and development. In the upper Chehalis basin, LiDAR will provide data on slopes and where landslides have occurred. This will be used to test

the predictive models. Because parts of the Chehalis basin have been flown for LiDAR, a comparison of the two LiDAR data sets can be made. Geologic mapping will identify the location and physical characteristics of geologic materials, surface and subsurface constrictions, what controls groundwater divides, what controls channel migration, landforms, what is controlling the rates of erosion and landsliding, depth to bedrock, as well as the fractures and faults within the geologic materials. This information provides critical stratigraphy and geohydrologic information for informed decisions.
Estimated Cost: $4,274,600

Project #2 - Unstable Slope Criteria Project: An Evaluation of Hillslopes Regulated under Washington Forest Practices Rules.
This project will evaluate the degree to which the landforms described in the Forest Practices rules identify potentially unstable areas with a high probability of impacting public resources, as well as identify and characterize additional potentially unstable landforms. The results of the project would help inform decisions regarding forest management activities.
Estimated Cost: $200,000

Project #3 – Road Prescription Scale Effectiveness Monitoring Project
The primary purpose of this project is to evaluate the effectiveness of road maintenance categories in meeting road performance targets and to identify sensitive situations where prescriptions are not effective.
Estimated Cost: $2,200,000

Introduction

In 2011, Engrossed Substitute House Bill 2020 directed the Office of Financial Management, in collaboration with other state and federal agencies, tribes and local governments to provide a report to the governor and legislature that identifies and prioritizes flood hazard mitigation projects for the Chehalis river basin. The purpose of this chapter of the report is to provide pertinent forest practices information for the community, decision makers and other interested stakeholders to use to make decisions relating to flood relief and protection in the basin.

Forestlands are an extensive and integral part of the Chehalis river basin, comprising approximately 84% of the land base. Approximately 91% of the forestland is subject to the Washington Forest Practices Act and rules, while the remaining forestland is federal or tribal land. The Earth Economics Study commissioned by the Chehalis River Basin Flood Authority (Batker et al. 2010), explains how natural systems, including forestlands, provide flood protection – protection that can be compromised when the natural systems are lost through such actions as conversion to industrial or home sites. Forestland offers protection from flooding through hydrologic processes. For example, trees intercept rainfall and subsequent evaporation from the foliage (forest evapotranspiration) returns some of the rainfall back to the atmosphere. Permeable soils found in forests and understory vegetation absorb water, decreasing the amount of surface water runoff. Forest management activities such as timber harvest or forest road construction have the potential to decrease the natural flood protection of the forests if executed in a way that does not minimize adverse effects to these hydrologic cycle components.

Washington State has a rigorous forest practices regulatory program which prescribes forest management practices in a way that protects public resources such as water, fish and wildlife. The forest practices regulatory program is flexible and responsive to new information, which provides the ability to make changes in protective measures as scientific knowledge evolves. Additionally, lands subject to the

Forest Practices Act and rules are covered by the Forest Practices Habitat Conservation Plan, an unprecedented conservation plan, approved by the Federal government, which covers all of the state and private forestland in Washington.

Much of the material in this report is taken (in some cases quoted directly) from three primary documents: the Forest Practices Habitat Conservation Plan (FPHCP) (DNR 2005); The Forest Practices Habitat Conservation Plan Environmental Impact Statement (FPHCP EIS) (U.S. Department of Commerce, NMFS and U.S. Department of Interior, USFWS, 2006); and the National Oceanic and Atmospheric Administration (NOAA) Biological Opinion on the Washington State Forest Practices Habitat Conservation Plan (U.S. Dept. of Commerce, NMFS, 2006). (Original research and analysis for this report was not feasible given the limited time available). The three documents offered existing literature and statewide forestland characteristic summarization that helped inform this report. Most of the data characteristics such as forest land ownership, stream length and traits (fish-bearing or non-fish bearing) and all of the maps were obtained from the DNR's Geographic Information System database.

The forestland report:

- explains the evolution of Washington's public resource protection on forestland and its responsiveness to new information;
- summarizes scientific conclusions found in the literature regarding potential impacts of forest management during flooding events;
- clarifies how those impacts are mitigated through Washington State's forest practices program and rules; and
- summarizes on-going research from the forest practices Adaptive Management Program that is relevant to the Chehalis basin, and
- describes and prioritizes projects that, if funded, would provide tools and information to understand flooding patterns, geomorphology, floodplain management, and development; and reduce the risk of forest practices activities (primarily timber harvest and forest road construction) contributing during flooding events in the Chehalis river basin.

Evolution of Responsive Public Resource Protection

The citizens of Washington State value its forestland for many reasons, including public resources found on forestland such as fish, wildlife and water. Developing ways of protecting public resources on forestland during forest practices management operations is important to the citizens of the State. This section describes the evolution of the system that was developed in Washington to protect public resources on forestland. The system is flexible and responsive to new information, which provides the ability to make changes as scientific knowledge evolves.

The value of Washington's forestlands and the need to protect them has become increasingly recognized since the nineteenth century. Initially, in the 1800's, Washington's forests were viewed as a limitless resource, providing a seemingly cheap and inexhaustible supply of lumber for houses, buildings, railroads, ships and bridges—the raw materials for a nation of immigrants expanding westward (McCune and Schroedel 1998). Through the end of the nineteenth century and much of the first half of the twentieth century, forest practices in Washington were unregulated. Early in the 1900s, after Washington State experienced devastating forest fires, the legislature appointed the first State Fire Warden and Forester to oversee fire laws and to focus on suppressing forest fires (Rodgers 1995; DNR 1975). In 1945 the first legislation, commonly referred to as the "reforestation law" was enacted to regulate forest practices activities. The new law required forest landowners to reforest following logging. This was the first of many laws and Forest Practices rules to come, that would focus on protecting Washington's forests, forest industry, and public resources.

As time passed, knowledge and understanding of society's impact on the natural environment increased as concerns about its protection heightened. Two such concerns were diminished air quality and polluted rivers and streams. These concerns spurred a national environmental movement in the 1970s and passage of the Federal Water Pollution Control Act of 1972, commonly known as the Clean Water Act (CWA) (EPA 2003).

Washington State chose to address the new federal environmental laws by passing the Forest Practices Act in 1974 which declared that "forest land resources are among the most valuable of all resources in the state; that a viable forest products industry is of prime importance to the state's economy; that it is in the public interest for public and private commercial forestland to be managed consistent with sound policies of natural resource protection; that coincident with maintenance of a viable forest products industry, it is important to afford protection to forest soils, fisheries, wildlife, water quantity and quality, air quality, recreation, and scenic beauty" (RCW 76.09.010). The Act was the state's first comprehensive law addressing the impact of forest practices activities on the environment. This law and its corresponding rules regulate forestry activities on state and private lands and are designed to protect the environment and ensure that Washington continues to be a productive timber growing area. The Act also created the Forest Practices Board (the Board), a 13 member entity that is a separate agency from the Washington Department of Natural Resources (DNR). The Board, working with the public, stakeholder groups and DNR, adopts Forest Practices rules and approves guidelines (Forest Practices Board Manual) which help landowners implement the rules.

The Board adopted the first set of Forest Practices rules in 1976. Since its inception, the Board has responded repeatedly to improved understanding and knowledge to ensure continual protection of public resources. The current Forest Practices rules and guidance are, in part, the result of scientific efforts over the years to learn more about the complex ecological relationships that shape forests. And through federally approved habitat conservation plan (Forest Practices Habitat Conservation Plan) and subsequent Incidental Take Permits (described later in this section), the State of Washington provides long-term conservation of federally listed (and unlisted) aquatic species and riparian habitat on over 9 million acres of state and private forestland. The current Forest Practices rules present a robust set of protection measures to:

- Protect unstable slopes, riparian forests, and wetlands,
- Minimize the impact of even-aged harvest in rain-on-snow zones,
- Limit even-aged harvest size and timing,
- Minimize soil disturbance as a result of harvest methods,
- Ensure well designed, located, constructed, and maintained forest roads,
- Ensure fish passage to upstream habitat,
- Maintain an effective adaptive management program and compliance monitoring program.

The first modification to the Forest Practices Act came in 1975 when the Act was changed to establish a system of four classes of forest practices based on their potential to adversely impact public resources. Forest practices are classed as Class I, Class II, Class III or Class IV, with Class I having no direct potential of damaging public resources and Class IV having the greatest potential. Class IV forest practices are subject to review by means of additional State Environmental Policy Act (SEPA) procedures. The State Environmental Policy Act provides a way to identify possible environmental impacts that may result from governmental decisions and may require preparation of an Environmental Impact Statement (EIS).

In the early 1980's research began showing the importance of riparian forests and led the Board to focus on addressing riparian management zones (FPB 1985). Subsequent studies increasingly highlighted the role of large woody debris (LWD) in streams. Also, scientists were gaining a better understanding of the effects of increased in-stream sediment levels resulting from harvesting and road construction on unstable slopes. In total, new research indicated the original 1976 Forest Practices rules were likely inadequate to meet the resource protection goals of the Act. The environmental community and tribal representatives expressed concern about not only the effects of individual forest practices activities on aquatic habitat, but also the combined and synergistic effects of multiple forest practices within a watershed, known as "cumulative effects." In response, the Board commissioned a study on cumulative effects in 1983. The report, *Cumulative Effects of Forest Practices on the Environment*, was completed in 1984 (Geppert et al. 1984). The study provided a first approximation of the nature, source and extent of cumulative effects as related to forest practices activities.

In response, the Board began to consider changes to the Forest Practices rules to improve protection for riparian areas, fish and wildlife habitat, and to address cumulative effects. In a historic effort to resolve increasingly contentious natural resource protection issues without lengthy and costly lawsuits, representatives from state natural resource agencies, industrial and small forest landowners, tribes and environmental groups came together. The group developed a new, collaborative way of working on resource protection challenges through a consensus process. Their work became known as the Timber/Fish/Wildlife (TFW) Agreement, and was finalized in 1987. The agreement, in part, established ground rules for developing rule proposals, which would be forwarded to the Board for consideration (FPB 1987). The TFW Agreement also included an approach to address cumulative effects associated with forest practices, and recommended implementing an adaptive management program and the use of risk assessment techniques to identify potential problems. The TFW Agreement recommendations, together with the 1984 cumulative effects study, were used to guide the development of the watershed analysis rules adopted by the Board in 1992.

The TFW Agreement also led to significant forest practices rule revisions in 1987 and 1988, with protection of riparian areas as a primary focus (FPB 1988). These rules added width to riparian management zones and defined the number, size and species of trees required to be left standing to protect wildlife habitat and provide shade and large woody debris for fish habitat (FPB 1988 WAC 222-30-020). Two other important components of these rules were the introduction of an adaptive management program and the use of interdisciplinary (ID) teams (FPB 1988). Adaptive management uses a science based research and monitoring approach to make recommendations to the Board for modifications to the rules or guidance as needed to protect public resources. ID teams are made up of technical experts—fisheries biologists, hydrologists and geomorphologists, among others—and individuals from various stakeholder groups. The team evaluates the environmental impact of proposed forest practices and recommends potential protective measures.

The 1992 watershed analysis rules recognized the importance of using a science-based approach for assessing watershed problems and sensitivities of an entire basin, rather than reviewing forest practices activities on a site-by-site basis. Although the rules provided protection on a site-by-site basis, there were concerns that the cumulative effects of all the forest practices activities in a watershed basin may impact the watershed as a whole. The watershed analysis process resulted in identification of specific management prescriptions, which when implemented within a watershed, would reduce negative cumulative effects.

In addition to establishing the watershed analysis program to specifically address concerns about cumulative effects, the 1992 rule changes also included retention of wildlife reserve trees; establishment of wetland management zones; limits on even-aged harvest size and timing (the size and timing of even-aged harvesting is regulated to prevent excessive levels of immature forest cover in any given geographic area); more stringent environmental review of the application of chemicals; operations on unstable slopes; archaeological, historical and cultural sites; and filling of wetlands. The rules also imposed restrictions on the use of pesticides, fertilizers and other forest chemicals, and added a temperature prediction method to ensure retention of adequate riparian shade (FPB and Ecology 1992).

New watershed analyses rules facilitated the completion of approximately 60 watersheds between 1991 and 1996. Although watershed analysis was a useful tool for determining cumulative effects to watersheds, it was found to be very time-consuming and expensive to conduct, prohibiting some landowners from participating. However, the information gathered over the years and the prescriptions crafted from the completed watershed analyses across the state was very informative and established a basis for recommended rule changes in the Forests and Fish Report (FFR) described below (DNR 1999). One of the results from watershed analyses indicated that forest roads were an ongoing contributor of sediment to water bodies, in many areas, adversely impacting water quality.

In the mid-1990s, three issues emerged that led to TFW negotiations, and ultimately, revised Forest Practices rules:

- A growing number of streams were not meeting water quality standards as defined in the Federal Clean Water Act.
- The accuracy of water type base maps used to establish fish presence—and absence—for purposes of implementing appropriate forest practices protection measures were less than desirable.
- The Board needed to respond to the federal government's pending listing in 1998 of several species of salmonids in Washington as threatened or endangered under the Endangered Species Act (ESA).

These issues combined with the results from the watershed analysis process suggested that riparian buffer widths and leave-tree requirements might be inadequate to ensure healthy, functioning riparian systems. The TFW collaborative negotiation process was a preliminary step which eventually led to the production of a science-based plan—the Forests and Fish Report —for protecting water quality and aquatic and riparian-dependent species on state and private forestland in Washington State. Author groups of the Forest and Fish Report included representatives from Federal agencies (National Oceanic and Atmospheric Administration (NOAA) Fisheries, United States Fish and Wildlife Service (USFWS), Environmental Protection Agency (EPA) and the United States Department of Agriculture Forest Service (USFS) and state natural resource agencies (DNR, Ecology, Washington Department of Fish and Wildlife), the office of the governor, tribes, county representatives, large industrial forest landowners and small forest landowners.

Specific key highlights of the FFR recommendations included adoption of rules to:

- establish mature, conifer-dominated riparian forests to provide function;
- disconnect roads (particularly road runoff) from the stream network;

- protect streambank stability;
- ensure fish passage to upstream habitat;
- prevent or avoid an increase or acceleration of the naturally occurring rate of landslides due to forest practices;
- require landowners to prepare and implement Road Maintenance and Abandonment Plans (RMAPs) designed to address road-related impacts by 2016;
- establish a productive adaptive management program.

The Washington legislature passed the 1999 Salmon Recovery Act, (also known as the "Forests and Fish Law"), which directed the Board to adopt Forest Practices rules consistent with the recommendations in the Forests and Fish Report (DNR 1999). The Board adopted permanent Forest Practices rules in May 2001. These permanent Forest Practices rules which are designed to protect water quality and aquatic and riparian-dependent species and reduce cumulative effects across the landscape (FPB 2001) also help reduce the effects of forest practices activities on forest hydrology, unstable slopes and public safety. This set the stage for the State to obtain federal assurances regarding federally listed species by developing a conservation plan and obtaining Incidental Take Permits with the federal government.

The State of Washington produced a conservation plan, *2005 Forest Practices Habitat Conservation Plan* (FPHCP), which was accepted by the USFWS and NMFS. Acceptance of the FPHCP led both agencies to issue an incidental take permit to the State of Washington for federally listed aquatic species. The permits allow forest practices activities in the State to proceed without threat of lawsuit because the habitat conservation measures in the plan are sufficient to protect aquatic habitat and therefore minimize harm to federally listed aquatic species. The FPHCP is a statewide, programmatic plan protecting over 9 million acres of state and private forest land and 60,000 miles of streams – a first of its kind in the nation due to its scope and collaborative process. It includes a robust Adaptive Management Program that uses science-based information to assist the Forest Practices Board in making changes to the forest practices rules when necessary to ensure the protection of fish habitat and water quality. It also includes an ongoing Compliance Monitoring Program to determine if forest practice activities are being conducted in compliance with the Forest Practices rules.

The Board has continued to make changes to the Forest Practices rules and Board Manual since the sweeping 2001 rules changes. One of the most recent rule changes resulted from the December 3, 2007 storm and the profound impact it had in western Washington and Oregon and especially in the upper Chehalis River basin. Unusually heavy precipitation and high winds, along with rapid snow-melt caused severe damage to thousands of acres of forestland in the area. Significant water run-off from heavy rainfall, rapid snow melt and saturated soils resulted in extensive damage to some forest road systems due to significant water flow, numerous landslides, debris slides and slumps, and massive timber blow-down areas.

After the storm, the Washington Departments of Agriculture, Natural Resources, and Fish and Wildlife took immediate steps to help landowners who incurred severe damage from the storm. These agencies facilitated approval of forest practices applications to repair storm damage, assessed the impact of the storm, analyzed current processes in place to deal with a similar storm event and determined what, if anything could be done in the future to minimize the effects of a similar storm. The Forest Practices Board considered the effects of the storm and the sufficiency of the Forest Practices rules to protect against forest damage during future storms. They convened a group of experts to focus on the mass wasting prescriptions developed under watershed analysis (chapter 222-22 WAC).

The Forest Practices Board review led to these actions to help ensure public safety and public resource protection:

1. The Forest Practices rules related to watershed analysis and potentially unstable slopes and landforms were analyzed and amended in May 2011,
2. The Forest Practices Board Manual Section 11, *Standard Methodology for Conducting Watershed Analysis* was clarified and changes approved in May 2011,
3. All watershed analyses were reviewed to see if a reanalysis of the watershed for mass wasting prescriptions was needed,
4. Forest landowners were notified to assess if they wanted to sponsor or co-sponsor reanalysis of mass wasting prescriptions in watersheds where reanalysis was needed. Landowners also had a choice to rescind the mass wasting prescriptions and agree to apply Forest Practices standard rules instead of performing a watershed reanalysis for the mass wasting module.

The May 2011 rule language changes were a product of the Adaptive Management Program. Most of the effects of the rulemaking were contained in the amendments to WAC 222-22-090, *Use and review of a watershed analysis* and WAC 222-16-050, *Classes of forest practices.* The salient points of the language changes included:

- Reinforcing that watershed analyses must be kept up to date,
- Requiring that landowners interested in maintaining prescriptions (that DNR has identified for reanalysis) are responsible for committing sufficient resources to complete the reanalysis,
- Specifying that DNR will review approved prescriptions to determine the needs for reanalysis every five years, or sooner when certain conditions apply,
- Confirming that DNR can rescind prescriptions if no affected landowners wish to participate and commit resources,
- Classifying a forest practices application as Class IV-special if a watershed analysis is not current or is not being conducted in accordance with conditions required by DNR during reanalysis, and
- Giving DNR the authority to rescind prescriptions if the established timeline is not met for completing a reanalysis.

Additionally, the Forest Practices Board approved a study called the Mass Wasting Effectiveness Monitoring Project (also known as the Post-Mortem Study). This project is designed to statistically compare landslide rates among five harvest treatments and five road treatments. The treatments are sets of prescriptions associated with forest practices activities within the period in which different Forest Practices rules were in effect. It is estimated that the Post-Mortem study will be completed in the summer of 2012. More information on this study can be found in *Recent and On-Going Research Relevant to the Chehalis Basin* later in this report. Completion of this study is the first step in a series of studies. Follow-up studies will look at landslides that occur as part of natural hydrologic processes and as well as landslides within harvested areas to help understand the potential impact of harvest on the rate of landslides. Other studies will review the rule-identified landforms in the Forest Practices rules to determine the effectiveness of buffering these landforms in preventing or avoiding an increase in landslides beyond natural background levels.
The process of rescinding mass wasting watershed analysis prescriptions in watersheds where landowners did not choose to do a reanalysis of the watershed, is on-going. Currently, it appears that three watershed analyses will perform mass wasting prescription re-analyses. Thirty-six watersheds will have their mass wasting prescriptions rescinded. Only one watershed in the Chehalis basin, the Upper

Skookumchuck, will have a reanalysis performed and when complete, landowners in that watershed will be able to continue to follow the mass wasting prescriptions in the watershed analysis.

Characterization of the Upper and Lower Chehalis WRIAs

This section provides a summary of the underlying characteristics of the forestland in the Upper and Lower Chehalis Water Resource Inventory Areas (WRIA) that includes a description of the climate, geology, topography, hydrology, land cover and use, and ownership patterns within the basin.

The upper and lower Chehalis WRIAs fall under a coastal hydrologic regime where rain and rain-on-snow are dominant (see Figure 1: Chehalis Basin "Rain-On-Snow" Zones). The maritime climate is characterized by mild, wet winters and warm dry summers. Average annual precipitation ranges from 40 inches in the Puget Lowland to nearly 100 inches in the adjoining Willapa Hills. Nearly all of the precipitation falls as rain, with snow occurring infrequently. The area receives more than 75% of its annual precipitation from October through March.

The Chehalis River drains much of the area and flows into Grays Harbor at the town of Aberdeen. The Chehalis basin is the second largest basin in Washington State, second only to the Columbia River basin. Some of the major stream systems include the Wynoochee, Hoquiam, Satsop, and Chehalis river basins, as well as other smaller tributaries. The Chehalis valley is wide, draining portions of the Olympic Mountains, Cascade foothills, Black Hills and the Willapa Hills. Portions of Grays Harbor, Thurston, Pacific, Lewis, Mason, Jefferson, and Cowlitz Counties are contained within the WRIAs. Elevations range from sea level to a little over 3,000 feet. The primary surface features of the basin are the 'coastal hills' and the Chehalis valley. The coastal hills are currently one of the key timber producing areas of the State.


Figure 1: Chehalis Basin "Rain On Snow" Zones
Lower Chehalis WRIA
Upper Chehalis WRIA
Hoquiam
Aberdeen
Centralia
Chehalis
Pe Ell
101
109
105
12
8
5
N
E
S
W
Precipitation/Snow Zones
Rain dominated zone
Rain-on-snow zone
Snow dominated zone
Forest Lands Covered by FP HCP
Lands Not Covered by FP HCP
0 2.5 5 10 15
Miles
WASHINGTON STATE DEPARTMENT OF
Natural Resources
Extreme care was used during compilation of this map to insure accuracy. However, due to reliance on outside sources of information not under it's control, The Dept. of Natural Resources cannot accept responsibility for errors or ommissions. Therefore, there are no warranties which accompany this material.
Cartography: Forest Practices Div. /April 2012

Forestland makes up approximately 84% of the WRIAs within the Chehalis basin. Agricultural lands comprise 6% to 13% of the area with the largest percentage of agricultural lands in the river valleys of the Upper Chehalis WRIA. The hydrologic maturity of the forests in the WRIAs is primarily early to mid seral stage with a smaller percent in the late seral stage. Additional information on seral stage/sizes of timber can be found in research by Lunetta et al. (1977) which provides information on riparian areas and Batker et al. (2010) which provides information on all forests in the Chehalis river basin.

Approximately 9% of all forestland in these WRIAs are in Federal ownership. Tribal lands represent less than 0.5% of the WRIAs. State lands represent approximately 13% of all lands in the region, other government lands are approximately 2.5%, and private lands represent approximately 75% of all lands. Private lands dominate the WRIAs, except for the northern portion of the Lower Chehalis WRIA (see Figure 2: Chehalis Basin Forest Land by Major Ownership or HCP).

Overall, lands covered by the Forest Practices rules represent approximately 91% of the forestland in these WRIAs. Although the Forest Practices Habitat Conservation Plan covers all state and private forest land, there are other habitat conservation plans covering approximately 25% of the WRIAs, including the Department of Natural Resources State Lands habitat conservation plan and other private industry habitat conservation plans.

There are 16,326 miles of mapped streams in the Chehalis basin and 13,920 stream miles on forestland subject to Forest Practices rules in these WRIAs. This represents about 84% of all streams in the WRIAs. Approximately 3,957 stream miles or 28% of the 13,920 stream miles on lands subject to Forest Practices rules are determined to be fish-bearing (Collins 2012).

Geologically, this region has been formed by a gradual uplifting of land, with the oldest rocks approximately 57 million years old. The coastal hills are some of the most landslide-sensitive areas of the State because of the highly weathered marine sedimentary and volcanic bedrock. The degree of sensitivity depends on the underlying bedrock formation and the elevation of the hills. However, most of the underlying bedrock decays directly to sand, silt and/or clay, providing weak hillslope support, and providing little or no large substrate to armor the stream channels. Erosion in this area is dominated by mass wasting events. Mass wasting in the form of debris avalanches, debris flows, and debris torrents are by far the most common processes. In the Chehalis Headwaters Watershed Analysis Unit (WAU), 93% of inventoried landslides were classified as either debris avalanches or debris flows. Surface erosion from hillslopes is uncommon and typically does not contribute significant amounts of sediment to streams.

Heavy precipitation in the area has been conducive to erosion and landslides. The geological features resulting from highly weathered marine sedimentary and volcanic bedrock and heavy precipitation are relatively short steep slopes and low gradient stream channels. Most of the watershed analyses conducted within the Chehalis watershed resulted in the inventory of hundreds of landslides. Forest roads, and to a lesser extent, even-aged harvesting on steep slopes, contributed to many of these landslides. Deep-seated landslides and slumps occur in certain geological formations, and are scattered throughout the coastal foothills (DNR 1994a; 1994b; 1994c; 1997).

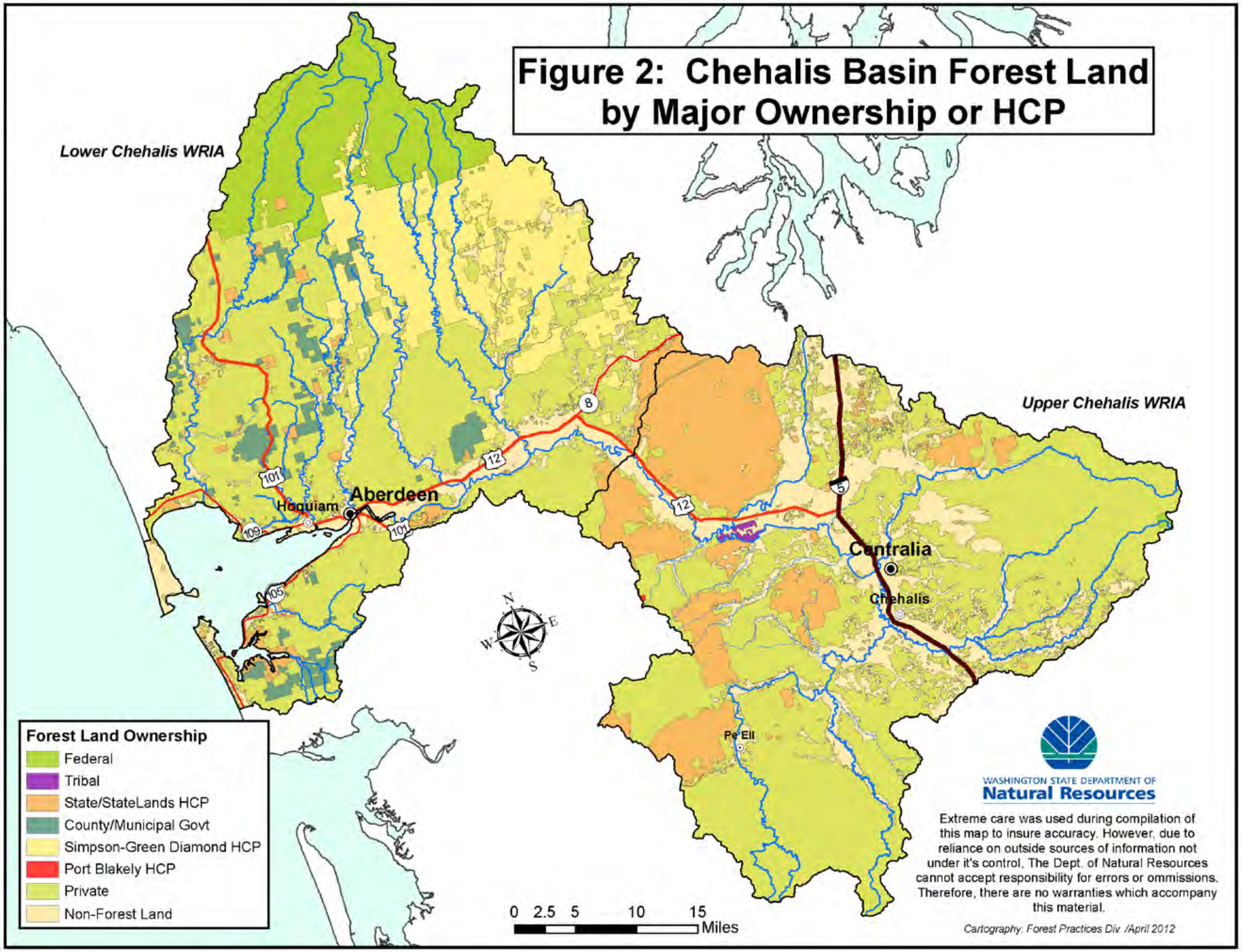
Figure 2: Chehalis Basin Forest Land by Major Ownership or HCP
Lower Chehalis WRIA
Upper Chehalis WRIA
Aberdeen
Hoquiam
Centralia
Chehalis
Pe Ell
101
109
105
12
8
5
N
E
S
W
Forest Land Ownership
Federal
Tribal
State/StateLands HCP
County/Municipal Govt
Simpson-Green Diamond HCP
Port Blakely HCP
Private
Non-Forest Land
0 2.5 5 10 15
Miles
WASHINGTON STATE DEPARTMENT OF
Natural Resources
Extreme care was used during compilation of this map to insure accuracy. However, due to reliance on outside sources of information not under it's control, The Dept. of Natural Resources cannot accept responsibility for errors or ommissions. Therefore, there are no warranties which accompany this material.
Cartography: Forest Practices Div. /April 2012

Landslides are not a factor in the lowlands of the Chehalis basin; however, streambank erosion is a problem in some areas and a significant source of fine sediment. Loss of riparian forests to agricultural land and conversion to urban land uses is a primary cause of stream bank erosion. Increased peak flows from loss of soil permeability (due to urban development) may also be a factor (WSCC 2001). The underlying geology and heavy rainfall in the coastal foothills contribute to road surface erosion. In addition, unpaved forest and rural residential roads require significant maintenance to minimize sediment delivery to channels. Forest roads require well-built drainage structures where necessary to divert road run-off on to the forest floor. In some areas, hard rock for quality road surfacing is difficult to find (DNR 1994a; 1994b; 1994c; 1997), and the next best available material must be used for road surfaces. Lower gradients in the Chehalis Valley help minimize surface erosion from unpaved roads; however, there may be pockets of locally significant road surface erosion.

Past old-growth timber harvest processes included the removal of trees within the riparian forests. In the Chehalis basin WRIAs, this harvest practice started in the early 1860s and was substantially completed by the 1960s. Subsequent conversion of forest lands to agricultural and urban lands has permanently altered riparian vegetation in the river valleys, leaving either no trees or a thin band of trees. The riparian areas along many agricultural lands provide substantially reduced large woody debris recruitment and are now dominated by alder, invasive canary grass and blackberry. It is difficult or impossible for native conifer species to re-establish within riparian areas with these vegetative characteristics. The limiting factors reports (WSCC 2001) made frequent note of the deficiencies in riparian areas adjacent to agricultural and urban lands. A photometric study by Lunetta et al. (1997) suggests that functional riparian buffers in agricultural and urban areas are substantially lacking.

The Chehalis basin floodplain has seen extensive conversion to agricultural land use. Streambank damage and erosion by livestock are scattered throughout the region (WSCC 2001). Agricultural activity has also occurred in the floodplains of smaller coastal rivers, including the Humptulips, Wynoochee, Satsop and Willapa basins. The Chehalis basin has also experienced industrial and urban development near the river mouth (Cosmopolis) and in the upper basin (Chehalis and Centralia). Rural residential development has occurred on the flatter and more accessible land throughout this region. The widespread agricultural and urban conversion in the lower reaches of the Chehalis basin has reduced the percolation of precipitation into the soil, and has likely contributed to scour and stream bank erosion.

Loss of forest canopies may increase peak flow during rain-on-snow events, which occur when heavy warm rain falls on a snow pack and the resulting run-off is the combined water content of the rain event and the water contained in the melting snow pack (see *Rain-on-Snow and Peak Flows* on page 12). However, this region generally lacks extensive areas above 1,000 feet, the average elevation above which heavy snow packs can accumulate within the Chehalis basin. There are three relatively small areas (including some area in Stillman Creek drainage and south Olympic foothills) in the WRIAs high enough in elevation to trigger this concern (See figure 1 above).

Research on the Impacts of Forest Management

Forestland is the primary land use in the Upper and Lower Chehalis basins. This section summarizes what the scientific literature says about potential impacts of forest management during flooding events. The section is focused on forest hydrology and unstable slopes – two primary aspects with the potential for impact.

Forest Hydrology and Unstable Slopes

Hydrology is the study of the distribution and circulation of water on and below the earth's surface. Surface water quantity in a forested environment is affected by climate, vegetation, and transport pathways. Climate determines the rate of precipitation amount and form (snow or rain) delivered to a watershed. Vegetation influences the delivery of water to the forest floor via interception, evaporation, condensation, evapotranspiration (water absorbed through tree roots, passed through the tree and transpired from the foliage into the air), and the canopy snowmelt processes. Transport pathways, both surface and subsurface, determine the transportation of water through the forested land. The hydrologic functions of a watershed are dependent upon these processes. When these processes are individually or cumulatively altered by forest road construction, harvesting, or other forest practices, the hydrologic continuity of the watershed is altered (Montgomery1994; Rashin et al. 1999).

In a working forest, the hydrologic processes recover from timber management activities over time as vegetation grows back. Its rate and trajectory depend upon the rate of regrowth and the suite of species occupying the site (Moore and Wondzell 2005).

Three primary water quantity metrics are generally discussed regarding forestland and potential impacts of forest harvest and road building: annual water yield, low flows, and peak flows. Water yield is the amount of water that is transported from a watershed over the course of the year. Low flows are the flows provided by groundwater to the streams during the lowest precipitation months of the year. While forest practices can impact both annual water yield and low flows, the effects are not generally associated with potential flood issues. Peak flow is the maximum instantaneous discharge measured in stream channels during high flow periods, which makes it the primary water quantity metric of interest with regards to flooding.

Urbanization, agriculture, grazing and forest management may all impact peak flow. Forest management activities may affect peak flows based upon their site specific effect, elevation within a watershed, and proportion of forest basin that has been altered by timber-related activities (Bauer and Mastin 1997).

Peak flow impacts would be most likely to occur during storm events. The direct effects of peak flows can affect flooding, stream channel alteration, bank erosion, and redistribution of sediment and large organic debris. Timber harvest and forest road construction/maintenance are the two most likely forest management activities to affect peak flows. The potential magnitude of the effect of either of these activities could increase when the activity takes place in a rain-on-snow zone. Rain-on-snow events can occur on mountain slopes in the transient snow zone, which extends from elevations of approximately 1,000 feet to 3,000 feet above sea level (Harr 1986), but can shift upward or downward during any given storm due to varying meteorological conditions.

Timber Harvest and Peak Flows

Timber harvesting alone may have an effect on flows but is likely minor. Studies that have shown peak flow increases in rain dominated watersheds (Harr et al. 1975; Harr 1986) have correlated the increases with soil compaction, rather than timber harvest. Yet other studies indicate no change in peak flow after harvest (Benda et al. 1998). If a peak flow following harvest occurs, small basins seem to be more likely to experience effects than large basins. Soil compaction caused by heavy equipment and yarding can decrease infiltration capabilities, increasing surface runoff. Forest management activities that substantially disturb the soil, such as yarding, burning, or road and skid trail construction, can alter both surface and subsurface pathways that transport water to streams (Thomas et al. 1993; Murphy 1995). Logging can also alter the internal soil structure. As tree roots die, soil "macropores" collapse or are filled in with sediment. These subsurface pathways are important for water transmission. When subsurface flow pathways are destroyed over a sizable area of steep slope, the flow can be routed to the surface and increase gully erosion and sediment delivery (Keppeler and Brown 1998). Removing trees can also result in less delivery of water to streams. In one study, researchers found that about half the yearly water inputs to a higher elevation conifer forest came from fog-drip, i.e., cloud water that condenses on tree limbs (Lovett et al. 1982). Cutting trees in a coastal and mountainous fog-drip zone could remove a large fraction of annual water inputs. The extent to which timber harvest alone has triggered substantially increased peak flows is likely rare (Storck et al. 1995).

Road Construction and Peak Flows
While timber harvest alone most likely has little effect on peak flows, indiscriminate road construction can alter runoff by collecting subsurface and road-surface water that routes directly to stream channels (Chamberlin et al. 1991). These potential effects are based upon the road management and drainage criteria, and potential for decrease (e.g., abandonment) in roads. The design, construction, and maintenance of roads interact with watershed characteristics of soil, topography, and geology and natural disturbances (such as large storms) to determine the effects of roads on the hydrology of a particular watershed. The interception of surface runoff during storms and interception of shallow groundwater flow by a road prism can affect the routing of surface water, extend the channel network (Wemple et al. 1996), increase the potential for higher peak flows, and increase the potential for mass-wasting (Montgomery 1994). In a general sense, roads can act as extensions of the drainage network if the roads drain to streams. Road-influenced peak flows have been demonstrated in small watersheds (Ziemer and Lisle 1998); however, the effects of roads on a river basin scale are less understood (Jones and Grant 1996; Beschta and Boyle et al. 1995).

Rain-On-Snow and Peak Flows
The significance of rain-on-snow events in harvested areas is the increase in water delivered to the stream system during these events compared to rainfall alone. Snow retention is modified by the nature of the forest canopy. Removal of the forest’s canopy increases snow accumulation. The canopy also has a major influence on the rate of snow melt which is strongly controlled by energy movement into the snowpack. When the forest is immature or recently harvested, wind and rain can more rapidly move energy into the snowpack, substantially accelerating the rate of melt (DNR, 1991). When warm air and rain occur on areas with a snowpack, rapid melting of the snow can occur, resulting in a pulse of water into the drainage network. Peak flow events associated with rain-on-snow might be of greater magnitude than rain-only events because the rainfall is augmented by snowmelt. However, research in the Pacific Northwest has not consistently demonstrated this effect. While Cheng (1989) found as much as a 35% increase in peak flows within 30% of the even-aged harvest in British Columbia, Fowler et al. (1987) found no effect in small watersheds in Oregon. The two most important watershed variables that affect rain-on-snow events seem to be elevation and extent of timber harvest on forestland.

Riparian and Wetland Areas
Two forested areas are particularly important to the hydrologic regimes of forestland; riparian areas and wetlands. Riparian habitat is the area adjacent to streams, rivers, lakes, and wetlands and includes floodplains and stream-associated seeps and springs. Wetlands are formally defined as those areas that are inundated or saturated with surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances, do support a prevalence of vegetation typically adapted for life in saturated soil conditions (WAC 222-16-010). This definition includes forested swamps, marshes, bogs, and other similar areas.

A wide variety of hydrologic, geomorphic, and biotic processes determine the character of riparian areas. The most important recognized functions of stream riparian areas with regards to hydrology include: streambank stability, groundwater recharge, stream energy dissipation, the routing and trapping of sediment, and large woody debris recruitment. Disturbance processes unique to stream systems (e.g., bank erosion, peak flows, and floods) all affect riparian areas (Benda et al. 1998; Montgomery and Wohl 2004; Spence et al. 1996; Reeves et al. 1995).

Riparian vegetation is important for maintaining streambank and floodplain integrity. Vegetation slows water velocity on the floodplain, and plant roots inhibit erosion along streambanks, reducing sediment deposition in streams. Riparian vegetation also helps to provide large woody debris, which is an important component of instream structure. Streamside buffers can substantially reduce fine sediment that is transported overland (Rashin et al. 1999). Riparian areas are an important source of large woody debris that enters the stream channel. Large woody debris creates storage sites for sediment in all sizes of streams and important stream structure.

Both timber harvest and stream-adjacent roads can cause the loss of some or all riparian functions within riparian lands depending on the level of harvest, level of disturbance to riparian vegetation and soil, and location of road construction. The roots of riparian vegetation help bind soil together, making soils more resistant to erosion and slope failure (Wu and Sidle 1995). In most cases, vegetation immediately adjacent to a stream channel is most important in maintaining stream bank integrity (FEMAT 1993). There can be loss of large woody debris potential when roads are built in the riparian area or timber harvest takes place.

Wetland ecosystems provide a variety of physical and biological functions. Additionally, they provide many values to society including flood attenuation, recreation, and water quality enhancement. The National Wetland Policy Forum (Conservation Foundation 1988) identified eight natural functions that wetlands may perform at a landscape level. Three of these functions are related to hydrology: 1) shoreline and bank stabilization, 2) flood flow alteration (attenuation), and 3) groundwater recharge. Headwater riverine and depressional wetlands can delay discharge of peak run-off into streams and impede passage of overbank flow downstream during storm events, thus reducing the potential for downstream flooding (Winter 1988; Roth et al. 1993).

Road construction and maintenance may have the greatest direct impact on wetland sites by permanently removing portions of the affected wetland from the landscape. Further, roads that cross wetlands without adequate provision for cross drainage can lead to hydrologic changes (Stoeckeler 1967; Boelter and Close 1974). Additionally, sedimentation from road construction and use has been found to indirectly impact wetland ecosystems (Stoeckeler 1967; Boelter and Close 1974). Timber harvest may alter wetland hydrology and cause a rise in the water table elevation (Verry 1997). Additionally, the altered water table and associated streamflow relationship could increase localized runoff and flooding (Grigal and Brooks 1997). Soil rutting and compaction from timber harvest activities can reduce infiltration, redirect flow, and alter pathways by which water moves through and from wetlands. Harvest and associated activities can deliver sediment to wetlands, diminish water quality, and lead to the filling of wetland sites.

Unstable Slopes and Landforms

Erosion is the detachment and movement of soil particles either individually, in small aggregates, or in large masses (Brooks et al. 1991). The two dominant processes of erosion on forestland are surface erosion and mass wasting. Surface erosion is the detachment and subsequent removal of soil particles and small aggregates from land surfaces by wind or water. Mass wasting includes erosion in which cohesive masses of soil are displaced. (U.S. Department of Commerce, National Marine Fisheries Service 2006).

Under natural conditions, mass wasting is the more common form of erosion on forestland in the Pacific Northwest, particularly in steep terrain (Sidle et al. 1985). Forest management activities contribute to mass wasting in the form of shallow landslides, the most common type of landslide. They occur within the rooting depth of trees. Types of shallow landslides include relatively minor rock falls, ravels, and small slumps to more serious debris avalanches, debris flows, and hyper-concentrated floods.

Debris avalanches and debris flows, the usual types of shallow landslides in steep forestland, are typically initiated by high magnitude rain or rain-on-snow events during the fall and winter months (Swanson et al. 1987). Debris avalanches and debris flows can turn into debris torrents. Debris torrents usually transport more material than the initiating event, due to scouring action on the slope or in the stream channel. Debris torrents stop moving when the channel gradient decreases substantially or when the torrent encounters a sharp bend in the channel. Debris torrents contain substantial amounts of wood and can travel varying distances, which can result in variable degrees of impact depending upon stream channel gradient, confinement, layout of the channel network, and other characteristics (Fannin and Rollerson 1993).

Debris torrents can have long-lasting effects on stream channels. The channel location and cross-section can be radically altered in such a way that normal flows and normal peak flows cannot reconfigure the channel easily (Lamberti et al. 1991). This is important because even though mass wasting for example may affect only 1% of a watershed, debris torrents can affect up to 10% of the stream system because of their mobility (Swanson et al. 1987). These channel alterations from debris torrents, however, are not always negative. For example, Benda et al. (2003) found that channel morphology and fish habitat complexity (e.g., pool density, substrate texture, and channel widths) increased in proximity to low order tributary confluences prone to debris flows. In addition to having impacts on the stream channel, debris torrents can also affect riparian buffer functions and streamside forests when bank scour is so great that streamside vegetation is removed.

Whether or not a particular slope will fail at any given time is dependent on a variety of variables, including precipitation rate and quantity; soil moisture; hydrology; slope aspect, length, and curvature; the internal strength of the slope material (Coates and Higgins 1990; Dragovich et al. 1993a); and root strength of vegetation (Harp et al. 1997; Schmidt et al. 2001; Roering et al. 2003). Disturbances, including timber harvest and road building, that compact or weaken slope material, change the hydrology of the slope, or undercut marginally stable slopes can trigger mass wasting events (Rollerson et al. 1997; Swanson and Dyrness 1975; Amaranthus et al. 1985; Dragovich et al. 1993b; Gerstel 1996). Increased levels of planning and analysis can reduce the likelihood of landslides by identifying and avoiding potentially unstable landforms, as can minimizing disturbance from harvest activities in these areas (Gerstel 1994; Rashin et al. 1999; Dhakal and Sidle 2003).

Forest practices such as timber harvesting and road construction have the potential to accelerate the rate of erosion by disturbing soils, reducing infiltration and increasing surface runoff (Swanson et al. 1987). Sidle et al. (1985) summarized several studies (Swanston 1970, 1974; O'Loughlin 1974; Ziemer and Swanston 1977; Burroughs and Thomas 1977; Gray and Megahan 1981; Ziemer 1981) indicating that slope stability depends partly on reinforcement from tree roots, especially when soils are partly or completely saturated. Even-aged timber harvesting on unstable slopes or landforms decreases rooting strength, increasing the potential frequency and magnitude of debris avalanches and debris flows (Ziemer and Swanston 1977; Wu and McKinnell III 1978). In addition to the loss of root strength, timber harvest can result in slow infiltration rates, loss of canopy interception, and loss of evapotranspiration.

In the past three decades, a greater level of understanding of risks to public resources, greater restrictions on harvest, and more requirements for mitigation related to harvest and road construction on potentially unstable areas has substantially decreased landslide frequency from historical levels (DNR 2005). The Forest Practices rules are designed to reduce the frequency and magnitude of debris flows and debris avalanches. For more detailed information, see Unstable Slope and Landforms in the next section for an extensive description of the Forest Practices rules and processes that protect unstable slopes.

Mitigation Measures for Potential Impact of Forest Management on Forestland

While research shows forest management activities have the potential to impact peak flows and unstable slopes, steps can be taken to minimize/eliminate that potential impact. This section describes the many protective measures provided by Washington's forest practices program and how the measures help to minimize impacts to forest hydrologic processes and unstable slopes.

The Forest Practices rules and regulations provide protections that help reduce possible risks from timber management practices on forest hydrologic processes and unstable slopes. The 2001 changes to the Forest Practices rules (see above "Evolution of…") increased protection significantly with regards to riparian areas, wetlands, sensitive sites, road construction/maintenance, and unstable slopes. These changes led the National Marine Fisheries Service to make the following conclusions in their biological opinion regarding statewide hydrologic impacts of forest practices. "Under the Forest Practices Habitat Conservation Plan and Incidental Take Permit, the influence of timber harvest and road management on hydrologic processes will gradually lessen as riparian buffers mature and 'road maintenance and abandonment plans' are implemented. In the long-term, effects of timber harvesting and road management on hydrologic processes will be negligible" (U.S. Department of Commerce, NMFS, 2006).

The primary types of Forest Practices rules that can help avoid impacts to hydrologic processes and unstable slopes are those that help to protect against:

- soil compaction or soil disturbance,
- impacts to riparian and wetland areas,
- interception of surface and subsurface water by roads,
- open canopy in rain-on-snow zones,
- size and timing of even-aged harvest, and
- disturbance of unstable slopes.

Forest Practices rules address each of the above potential results to minimize or avoid impact to the resource. The following Forest Practices rule groups contain protection measures that specifically help minimize negative effects on forest hydrology and unstable slopes; logging practices, riparian, wetland, and sensitive site areas, forest road construction/maintenance, rain-on-snow zones, green-up, and unstable slopes.

Logging Practices
Forest Practices rules include rules that regulate the methods of harvest. These protection measures include limits on the felling and bucking (i.e. limbing and cutting to length) of timber, the use of ground-based equipment and cable yarding (i.e. transporting logs to the landing site). Many of these measures are designed specifically to minimize soil disturbance and reduce the potential for erosion and sedimentation.

Felling and Bucking: Protection measures are designed to minimize soil disturbance, damage to residual trees and delivery of slash to typed waters (WAC 222-30-050).

Ground Based Equipment: Ground-based equipment is commonly used to fall and yard timber and to construct, maintain and abandon roads and skid trails. Ground-based equipment use is regulated to limit direct physical impacts to waters and wetlands and to minimize indirect impacts such as soil disturbance and associated erosion and sedimentation (WAC 222-30-070). Protection measures address typed waters, wetlands, riparian management zones, wetland management zones, soil moisture, residual trees, skid trails and slope restrictions. Protection measures also include a 30 foot equipment limitation zone adjacent to non-fish bearing waters (WAC 222-16-010 and WAC 222-30-021(2)).

Cable Yarding: Limitations on cable yarding in and across typed waters and wetlands are intended to minimize soil disturbance and impacts to their beds and banks (WAC 222-30-060).

Riparian Protection
Early riparian rules only considered changes in stream temperature and bank stability for the aquatic ecosystem. All riparian trees could be cut, sparing only the understory on certain temperature-sensitive streams. Over time, the Forest Practices rules have undergone numerous revisions. Currently, the conservation objective of the riparian strategy is to restore riparian function to high levels on lands covered by the Forest Practices Habitat Conservation Plan and to maintain those levels once they are attained (WAC 222-30-010(2)). Protection measures for different type waters in western Washington include protecting channel migration zones, establishing riparian management zones along fish bearing waters and perennial non-fish bearing waters; retaining no-harvest buffers adjacent to non-fish bearing perennial water sensitive sites; and establishing zones where equipment is limited along non-fish perennial and seasonal waters (WAC 222-30-021). Other riparian protection measures that apply to typed waters include restrictions on the salvage of down woody debris and the disturbance of stream banks.

Fish Bearing Waters: In fish-bearing water riparian management zones there is a core, inner and outer zone with differing prescriptions delineated in rule. No timber harvest or road construction is allowed in the 50 foot core zone (zone closest to the water) except for the construction and maintenance of road crossings and the creation and use of yarding corridors. The inner zone (middle zone) ranges from 90 feet to 200 feet depending on several factors. Timber harvest of “surplus” wood in the inner zone is only allowed if pre-determined stand requirements are met which are intended to result in a mature riparian forest stand at 140 years of age. Timber harvest is allowed in the outer zone (zone farthest from the water); however, 20 riparian leave trees per acre must be retained following harvest (WAC 222-30-021(1) (c).

Non-fish Bearing Waters: Protection measures for non-fish bearing waters in western Washington include the establishment of equipment limitation zones and riparian management zones adjacent to the waters and associated sensitive sites (WAC 222-30-021(2). An equipment limitation zone is a 30 foot wide area where equipment use is limited in order to minimize ground and soil disturbance and thus protect stream bank integrity and prevent sediment delivery to non-fish-bearing waters WAC 222-30-021(2)(a). Riparian management zones are required on at least 50% of non-fish bearing waters that run perennially throughout the year (WAC 222-30-021(2) (b).

Streambank Integrity: Timber harvesting can reduce stream bank rooting strength and log yarding can disturb stream bank structure. Both impacts can lead to accelerated erosion and sedimentation (Rashin et al. 1999). Forest practices activities in the riparian management zone core zone for fish bearing streams and in riparian management zones for non-fish bearing perennial waters must be conducted in a manner that maintains stream bank integrity (WAC 222-30-030).

Salvage logging: Down woody debris in streams and rivers stores sediment, dissipates stream energy, and provides many other functions. In riparian areas, down wood reduces the erosive power of overbank flows and creates microsites for seedling and other vegetation start-up and growth. Forest Practices rules protect these ecological functions by restricting salvage of down wood in all typed waters, channel migration zones and riparian management zones (WAC 222-30-045).

Wetland protection measures

The forest practices program includes measures to prevent, minimize and mitigate forest practices-related impacts to wetland habitats. Measures are intended to protect important ecological functions such as maintenance of surface and shallow subsurface hydrology, large woody debris recruitment, sediment filtration and others. Protection measures include providing wetland management zones adjacent to wetlands and the use of low-impact harvest systems in forested wetlands and no net loss of wetland function from road building.

Roads, Rain-on-Snow, and Unstable Slopes

The goal of the roads, rain-on-snow and unstable slopes rules is to prevent, avoid, minimize, or mitigate forest practices-related changes in erosion and hydrologic processes and the associated effects on public resources. Specific objectives include preventing forest practices-related landslides, avoiding capture and redirection of surface or groundwater, limiting sediment delivery to all typed waters, surface water and other hydrologic management, woody debris passage, protecting stream bank stability, minimizing the construction of new roads, and ensuring that there is no net loss of wetland function. The goal is to maintain surface and groundwater hydrologic regimes (magnitude, frequency, timing and routing of streamflows) by disconnecting road drainage from the stream network, preventing increases in peak flows causing scour and maintaining the hydrologic continuity of wetlands.

Roads

As mentioned earlier, roads may adversely affect riparian and aquatic habitats by altering hydrologic flowpaths, accelerating erosional processes and increasing sediment delivery to surface waters and wetlands. Forest Practices rules are designed to minimize negative road impacts through the proper location, design, construction, maintenance and abandonment of forest roads. The Forest Practices rules require that road drainage be disconnected from the stream network. Stream crossings are required to be minimized, and except for crossings, roads are to be kept out of natural channels, Channel Migration Zones, Riparian Management Zones, Equipment Limitation Zones, and sensitive sites.

Location of Roads: Forest Practices rules require that roads be fit to the topography to minimize alteration of natural features. This includes avoiding at-risk areas such as surface waters, wetlands, channel migration zones, riparian management zones, sensitive sites (including headwall seeps, side-slope seeps, alluvial fans, headwater springs), and equipment limitation zones. Forest Practices rules also require the use of existing roads in areas where new construction would lead to duplicative or unnecessary roads (WAC 222-24-020).

Road Design: Forest Practices rules include road design standards (WAC 222-24-020) which are mainly related to construction techniques and water management:

- Forest Practices rules encourage road designs that utilize balanced construction to avoid placement of excess loose dirt from excavation beside the road. In steep terrain (> 60% slopes), rules require the road to be fully cut into the slope so no fill material is used to construct the road prism and waste material is taken to stable locations.
- Water management requirements focus on maintaining hydrologic flowpaths and minimizing sediment delivery by limiting road-induced rerouting of water. Forest Practices rules include design standards for culvert sizing and drainage structure spacing. Rules also require that roads be designed so that ditch water is relieved onto the forest floor to facilitate infiltration and minimize sediment delivery.

Road Construction: Road construction requirements focus on maintaining stable road prisms and water crossing structures, and on minimizing sediment delivery to surface waters and wetlands. Maintaining stable, intact road prisms and water crossing structures is important in controlling erosion and sediment delivery, particularly in steep terrain where mass wasting is common. Forest Practices rules recognize the importance of road prism and crossing stability, and include construction measures to minimize the risk of road failure. Measures that focus on maintaining the stability of water crossing structures require the installation of structures that pass the 100-year flow, the construction of fills and embankments to withstand the 100-year flow, and the construction of headwalls and catch basins to accommodate the 100-year flow. Other construction-related Forest Practices rules are contained in WAC 222-24-030, 222-24-035, and 222-24-040.

Road Maintenance and Abandonment Plans: In an effort to reduce road-related sediment in streams, to identify roads with evidence of existing or potential instability that could adversely affect public resources, and to identify road-related blockages to upstream habitat for fish, the 2001 Forest Practices rules resulting from the Forests and Fish Report require forest landowners to develop Road Maintenance and Abandonment Plans (RMAPs) for roads within their ownership (WAC 222-24-051).

The RMAPs for large forest landowners includes an inventory of forest roads within a particular ownership, an assessment of the current road conditions, the identification of and a timetable for necessary repairs, ongoing maintenance and/or abandonment. In areas where watershed analysis has been conducted and approved, large forest landowners may elect to follow the watershed administrative unit-road maintenance plan rather than developing an RMAP under WAC 222-24-051.

Planning requirements differ for small and large forest landowners. Small forest landowners may follow the road maintenance and abandonment process for large landowners described above, or they may submit a “checklist” road maintenance and abandonment plan with each forest practices application or notification (WAC 222-24-0511).

Forest Practices rules require large forest landowners to prioritize road maintenance and abandonment planning based on a “worst first” principle. Road systems or watersheds where maintenance and abandonment work would produce the greatest benefit for public resources receive highest priority. The road maintenance and abandonment plans must prioritize work according to the following:

1. removing fish blockages,
2. preventing or limiting sediment delivery,
3. disconnecting the road and stream networks,
4. repairing or maintaining stream-adjacent parallel roads,
5. restoring hydrologic flowpaths, and
6. capitalizing on operational efficiencies.

On the anniversary date of an RMAP submittal, large forest landowners must report work accomplished during the previous year to DNR. A detailed description of work planned for the upcoming year must also be submitted for approval including any modifications to the existing work schedule. DNR's review and approval is conducted in consultation with Ecology, WDFW, affected tribes and interested parties (WAC 222-24-051).

The RMAP process is intended to bring all roads owned by large forest landowners into compliance with forest practices standards by 2016, however, landowners can request an extension to 2021. The forest roads standards require landowners to:

- Keep drainage structures functional,
- Divert captured groundwater from ditchlines onto stable portions of the forest floor,
- Maintain road surfaces to minimize erosion and delivery of water and sediment to typed waters,
- Slope or waterbar road surfaces to prevent water accumulation.

Rain-on-snow and Green-up

The potential for effects of forest management on peak flows is higher in the rain-on-snow zones through the influence of increased snow accumulation in canopy openings and melt during rain-on-snow precipitation events. Forest Practices rules address rain-on-snow effects in two ways. First, watershed analysis includes an assessment of timber harvest-induced changes in rain-on-snow generated peak flows and potential impacts to public resources. Three watershed analyses – Upper Skookumchuck, Stillman Creek and the Chehalis Headwaters have been completed in the upper and lower Chehalis WRIAs. As a result of 2011 changes to the watershed analysis Forest Practices rules, two of the watershed analysis units – Stillman Creek and Chehalis Headwaters – will have all unstable slopes prescriptions of the watershed analysis rescinded and revert to standard rules because the landowners have chosen not to perform the 5-year review. All of the prescriptions for the Upper Skookumchuck will remain viable.

The watershed analysis assessment, known as the "hydrologic change" module, is conducted for each watershed administrative unit (WAU) where watershed analysis is performed. The assessment relies on the use of a quantitative model to estimate changes in snow accumulation and melt under different harvest scenarios, and the resulting effects on peak flow magnitudes. Specific management prescriptions are developed to address rain-on snow effects in parts of the WAU where significant hydrologic change is likely to occur and resources are sensitive to those changes. Prescriptions typically involve limits on even-aged harvesting to maintain a minimum level of hydrologically mature forest cover in the watershed or sub-watershed. Once approved by DNR, the management prescriptions become the Forest Practices rules for the WAU. In the Upper Skookumchuck watershed analysis, the hydrologic module resulted in a prescription to maintain a 10% or less increase in peak flows by using the Timber, Fish, and Wildlife model for predicting peak flows to evaluate harvests in listed sub-basins (DNR 1997). The hydrology module in the Stillman creek watershed rated the potential effects of peak flow due to harvest on flooding as low risk. However, the analysis recommended the "maintenance of 40% or more mature cover in the rain-on-snow zone as added insurance against any peak flow changes" (DNR 1994b). Prescriptions in the Chehalis headwaters watershed suggest that there should be "not less than 40% hydrologically mature cover and should not exceed 40% hydrologically immature cover" in rain-on-snow zones (DNR 1994a).

Secondly, Forest Practices rules address rain-on-snow effects in areas where watershed analysis has not been performed. A forest practices rule commonly known as the "rain-on- snow rule" gives DNR authority to set conditions on permits for forest practices applications and notifications that propose even-aged harvesting in the significant rain-on-snow zone (WAC 222-22-100(2)). Under the rain-on-snow rule, DNR may limit even-aged harvest size when it determines that peak flows have caused material damage to public resources including water, fish, wildlife and public capital improvements (WAC 222-22-100(2)). Guidelines direct applicants and DNR to consider alternatives to even-aged harvests in high-risk areas.

In addition to the rain-on-snow rule, a set of forest practices standards collectively known as the "green-up rules" (WAC 222-30-025) also mitigate hydrologic changes associated with timber harvest. Under the green-up rule, the size and timing of even-aged harvesting is regulated to prevent excessive levels of immature forest cover in any given geographic area. Harvest proposals that result in more than 120 acres of contiguous, even-aged harvest within a single ownership require review by an interdisciplinary team. Harvest proposals that result in more than 240 acres of contiguous even-aged harvest within a single ownership are prohibited (WAC 222-30-025).

Unstable Slopes and Landforms

The Forest Practices rules – and program as a whole– address, in part, the potential for forest management-related landslides that could deliver sediment or debris to public resources or threaten public safety. While most protection measures are prescriptive in nature, those related to unstable slopes and landforms are not. Instead, protection is provided through an outcome-based, decision-making process that is conducted in accordance with the Forest Practices rules and the State Environmental Policy Act (SEPA) (chapter 43.21C RCW; and chapter 197-11 WAC (SEPA Rules). The only exception to this outcome-based, decision-making process occurs in areas where watershed analysis has been conducted and approved, management prescriptions are in place to address unstable slopes and the prescriptions are specific to the site or situation and do not call for additional analysis (WAC 222-16-050(1)(d)(iii)). In these cases, proposed timber harvest and construction activities on unstable slopes must adhere to the approved management prescriptions stated in the watershed analysis. The only watershed analysis unstable slope module prescriptions that will remain valid in the Upper and Lower Chehalis basin WRIAs are those in the Upper Skookumchuck watershed.

The first step in the outcome based decision making process is a review of forest practices applications. All forest practices applications are reviewed to determine the class of the application as well as for other administrative reasons. Forest practices are classed based on the potential for the proposed operation(s) to adversely affect public resources – from Class I forest practices that have no direct potential for damaging a public resource to Class IV – Special forest practices having the greatest potential for impact. During review, the applications are screened for unstable slopes using data provided by Geographic Information Systems. Foresters conduct a field review to assess if unstable slopes are indicated. If the field review confirms the presence of unstable slope and timber harvest and/or road construction is proposed in those areas, the forest practices application is classified as Class IV-Special and becomes subject to review under the State Environmental Policy Act.

Class IV-Special forest practices related to unstable slopes include – as described in WAC 222-16-050 (1)(d) – timber harvest, or construction of roads, landings, gravel pits, rock quarries, or spoil disposal areas, on potentially unstable slopes or landforms (see WAC 222-16-050 (1)(d)(i) below) that has the potential to deliver sediment or debris to a public resource or that has the potential to threaten public safety, and which has been field verified by the department.

Unstable slopes are often classified according to dominant landslide type. WAC 222-16-050 (1)(d)(i) recognize four classes of unstable slopes:

- Landforms typically associated with debris avalanches, debris flows and debris torrents. This class includes inner gorges, bedrock hollows and convergent headwalls with slopes greater 70%.
- Landforms susceptible to debris avalanches. This class includes toes of deep-seated landslides with slopes greater than 65% and the outer edges of meander bends along valley walls or high terraces of unconfined meandering channels.
- Groundwater recharge areas of deep-seated landslides in glacial sediments. This is an area up-gradient that can contribute water to a deep-seated landslide in glacial sediments. A change in the hydrologic regime of these landslides has the potential to accelerate a wide range of mass-wasting processes commonly associated with deep-seated landslides.
- Areas with indicators of potential slope instability that cumulatively indicate the presence of unstable slopes. These can include hummocky or benched surfaces; fresh deposits of rock, soil, or other debris at the base of a slope; ponding of water in irregular depressions; cracks in roads across or along slopes; seepage lines or springs; or missing stumps on steep convergent slopes.

Forest practices applications classed as Class IV - Special require compliance with both the Forest Practices Act and the State Environmental Policy Act because they have the potential for a substantial impact on the environment. The State Environmental Policy Act provides a way to identify possible environmental impacts that may result from governmental decisions. Through this process, DNR evaluates proposed timber harvest and construction activities on unstable slopes to determine if the activities will have a “probable significant adverse impact.” The determination is based on the agency’s evaluation of the proposal – conducted in consultation with other affected agencies and tribes – as well as comments received from interested parties through the SEPA review process.

The State Environmental Policy Act rules require applicants to complete an environmental checklist for Class IV-Special forest practices applications. The checklist is a detailed listing of potential environmental impacts associated with the proposed activity. The Board has established additional SEPA policies that are specific to forest practices (WAC 222-10-030). These policies require, in part, specific mitigation measures or conditions designed to avoid accelerating rates and magnitudes of mass wasting that could deliver sediment or debris to a public resource. The policies also require applicants to conduct and submit a geotechnical assessment of proposed forest practice(s). A qualified expert must prepare the assessment. A qualified expert is a highly qualified individual who is licensed with the state’s Geologist Licensing Board (WAC 308-15) with an engineering geologist’s license and at least three years of experience in evaluating forestland.

In addition to reviewing information submitted by the applicant, DNR staff conducts their own evaluation of proposals involving unstable slopes, including the applicant’s geotechnical assessment. The evaluation often includes review by a DNR geologist and/or interdisciplinary team. DNR geologists meet the forest practices definition of a “qualified expert” and are licensed under the state’s Geologist Licensing Law. Interdisciplinary team members typically represent other agencies and affected tribes and often have unstable slopes expertise.

After reviewing the proposal, consulting with other affected agencies and tribes, and considering comments received from other interested parties through the SEPA review process, DNR issues a decision under the SEPA commonly known as a “threshold determination.” In making a decision, Forest Practices rules require DNR to consider:

1. if the proposal is likely to increase the probability of mass movement on or near the site,
2. whether sediment or debris would be delivered to a public resource or be delivered in a manner that would threaten public safety, and
3. whether such movement and delivery are likely to cause significant adverse impacts (WAC 222-10-030(2)).

If DNR determines the proposed activities are likely to have a probable significant adverse impact, a “determination of significance” is issued and the applicant must prepare an Environmental Impact Statement (EIS) in accordance with SEPA requirements. If DNR determines the adverse impacts identified in the EIS are significant and reasonable measures are insufficient to mitigate the impacts, the forest practices application is denied. If DNR determines the proposed activities are not likely to have a probable significant adverse impact, a “determination of non-significance” is issued and the forest practices application is approved. In many cases, DNR’s approval of a forest practices application contains “conditions” or additional requirements with which the applicant must comply. The conditions usually include protection measures that must be implemented to mitigate impacts associated with the proposal.

Mitigation measures range from avoiding unstable slopes to altering the methods or techniques used in timber harvest and/or construction operations. Unstable slopes avoidance is the most commonly used mitigation measure and results in the lowest hazard and risk. Where timber harvest and/or construction activities occur on unstable slopes, a variety of mitigation measures are employed to reduce the likelihood of mass wasting. Harvest-related mitigation measures typically include minimum stand density requirements to maintain rooting strength and slope hydrology, and full suspension log yarding to reduce soil disturbance and damage to residual vegetation. Construction related mitigation measures often relate to the design and/or location of roads and landings. Full-bench end-haul (i.e., no fill or sidecast material) construction techniques are routinely required on unstable slopes. Where fill material is necessary, the use of quarried rock rather than “native” soil or fill is often required to increase the structural strength of road prisms and stream crossings. These are just a few examples of the many mitigation measures used to address unstable slopes issues. The measures used in a given situation are dependent upon the nature of the impact being mitigated.

In addition to the Forest Practices rules, and the State Environmental Policy Act and process, DNR also provides unstable slopes training for DNR staff, forest landowners, and staff from cooperating agencies and organizations. The training includes topics such as landslide processes, factors affecting slope stability, indicators of slope instability and identification of unstable slopes and landforms.

Compliance and Enforcement

DNR region forest practices staff, forest landowners, timber owners and operators are responsible for ensuring that ongoing forest practices are in compliance with the Forest Practices rules. Field staff visit on-going timber operations to ensure compliance and prioritize compliance visits based largely on the potential risk to public resources posed by the operation. For example, forest practices that propose substantial road construction in steep terrain are more likely to receive regular compliance visits than those with limited road construction on gentle slopes.

In addition to the ongoing region forest practices staff compliance visits, WAC 222-08-160(4) describes a continual review of the Forest Practices rules through a compliance monitoring program. This program-wide, state-wide effort helps to determine whether forest practices are being conducted in compliance with the Forest Practices rules. The Forest Practices Board receives regular compliance monitoring reports. The results of the reports help inform the Board regarding improvements that may be needed – including rule modification, rule language clarification, or training and education needs.

Field staff have several tools available to them for compliance and enforcement purposes. The Forest Practices Act (76.09 RCW) and the Forest Practices Board, by policy, encourage informal, practical, result-oriented resolution of violations and action needed to prevent damage to public resources. It is also Board policy to use a progressive approach to enforcement that begins with consultation and voluntary efforts to achieve compliance while reserving civil penalties (i.e. monetary fines) to more serious infractions. Compliance and enforcement tools available to field staff include; supplemental directives, informal conferences, notices to comply, stop work orders, technical assistance compliance notices, notices of correction, corrective actions, civil penalties, disapprovals, financial assurances and criminal penalties (WAC 222-46).

It's important to note that DNR has the authority to issue a stop work order if there is any violation of the Forest Practices Act or rules, there is a deviation from an approved application or immediate action is necessary to prevent continuation of or to avoid material damage to a public resource. This is an official, formal notice served to an operator to temporarily or permanently shut down all or part of an operation in progress. This action may be taken to prevent material damage to public resources when no violation, unauthorized deviation or negligence has occurred (WAC 222-46-040)**.**

Reforestation

In Washington, reforestation is required following harvest unless the forest practices application indicated that the land would be converted to another use, or DNR has determined that the remaining trees are considered an established stand. Generally, the harvested area is considered reforested when, within three years of harvest, there are an average of 150 (eastern Washington) or 190 (western Washington) or more vigorous, undamaged commercial species seedlings per acre that have survived on the site for at least one growing season (WAC 222-34**)**.

Recent and On-Going Research Relevant to the Chehalis Basin

Scientific research regarding forest management and its impact on hydrology and unstable slopes was summarized above (see "Research on the Impacts of Forest Management"). However, scientific study is ongoing. This section summarizes the most recent and on-going research from Washington State's Forest Practices Adaptive Management Program that relates to forestland and water quantity issues and is relevant to the Chehalis basin.

DNR, and its statewide partners, support and participate in monitoring, evaluation, and research projects through the Adaptive Management Program. The Board adopted a more formalized Adaptive Management Program (WAC 222-12-045) in concurrence with the 1999 Salmon Recovery Act (see section above "Evolution of…protection). The intent of the Adaptive Management Program is to produce technical information and science-based recommendations to assist the Forest Practices Board in determining if and when it is necessary or advisable to adjust Forest Practices rules and guidance in order to achieve resource goals and objectives.

The Forest Practices Adaptive Management Program is a multi-caucus program that includes representatives from state departments (including Fish and Wildlife, Ecology, and Natural Resources), federal agencies (particularly National Marine Fisheries Service, U.S. Fish and Wildlife Service, and Environmental Protection Agency), forest landowners, county governments, the environmental community, and tribal governments. Representatives of these caucuses participate on two key Adaptive Management Program committees established by the Forest Practices Board: the Forests and Fish Policy Committee (Policy) and the Cooperative Monitoring, Evaluation, and Research (CMER) Committee.

Policy, in part, makes recommendations to the Forest Practices Board regarding CMER Committee priorities and projects, final project reports and forest practices rule and/or guidance amendments. The CMER Committee oversees and conducts research and monitoring related, in part, to assessing the effectiveness of the Forest Practices rules. Its purpose is to advance the science needed to support adaptive management. CMER's work is independently peer-reviewed to determine if it's scientifically sound and technically reliable.

Based on recommendations from Policy and CMER, CMER annually develops a work plan and associated budget for approval by the Forest Practices Board. The CMER Work Plan presents an integrated strategy for conducting research and monitoring to provide scientific information to support the Forest Practices Adaptive Management Program. The primary purpose of the work plan is to inform CMER participants, Policy constituents, the Board and interested members of the public about CMER's research and monitoring activities. Continued annual revisions are anticipated in response to research findings of CMER and the broader scientific community, as well as changes in policy priorities and funding.

A complete list and current status of CMER projects, along with the current CMER workplan, can be found on the CMER website – http://www.dnr.wa.gov/AboutDNR/BoardsCouncils/CMER/Pages/Home.aspx. The CMER projects cover a range of topics related to the Forest Practices rules and are at various stages of development or completion. Projects originated as priority research topics in Schedule L-1 of the 1999 Forests and Fish Report (DNR 1999), which was later revised and adopted by the Forest Practices Board in 2001 and incorporated into the Forest Practices Habitat Conservation Plan.

The CMER Work Plan is organized in a hierarchical format consisting of rule groups, programs, and projects. Two rule groups in particular, the Unstable Slopes Rule Group and the Roads Rule Group, describe selected projects (in response to critical questions below – *A*, *B*, *C* (Unstable Slopes Rule Group), *D* and *E* (Roads Rule Group) that are particularly relevant to the forested landscape found in the Upper and Lower Chehalis basins.

Unstable Slopes Rule Group

A. What screening tools can be developed to assist in the identification of potentially unstable landforms that minimize the omission of potentially unstable landforms? (Unstable Landform Identification Program)

The purpose of the Unstable Landform Identification Program is to provide a set of screening tools to identify forested areas containing potentially unstable slopes and to focus field verification activities on potential problem areas, thereby improving the ability to avoid them.

The Unstable Landform Identification Program consists of five projects that provide statewide information on the distribution of unstable landforms:

1. Shallow Rapid Landslide Screen for GIS Project
2. Technical Guidelines for Geotechnical Reports Project
3. Regional Unstable Landforms Identification Project (RLIP)
4. Landform Hazard Classification System and Mapping Protocols Project
5. Landslide Hazard Zonation Project

1. ***Shallow Rapid Landslide Screen for GIS Project***
   Description: This project has three phases. The first phase of this project compared different slope stability models. Based on the results of that study, Policy directed DNR to develop a GIS-based screen of modeled slope stability based on digital elevation model (DEM) topography for the westside. This first phase was completed in 2001 and was released as TFW Report 118 titled, "Comparison of GIS-Based Models of Shallow Landsliding for Application to Watershed Management." The second phase produced a modeled slope stability screen, which is available on the DNR forest practices website. A third phase has been proposed to identify topographic model(s) appropriate for similar mapping on the eastside and is on hold.
   Status: Phase 1 and 2 — Complete; Phase 3 — On hold.

   The Shallow Rapid Landslide Screen is used by all DNR regions in screening FPAs for classification. Geologists and forest engineers use this screen as a first cut to determine if further investigation is needed.

2. ***Technical Guidelines for Geotechnical Reports Project***
   Description: This project develops technical guidelines for geotechnical reports used in the SEPA review process. The guidelines include identification of appropriate analytical tools and techniques appropriate for different projects and at different scales.
   Status: Complete.

   The Technical Guidelines for Geotechnical Reports are being used in all submitted Class IV special reports. Having a standard for reports is vital to the consistency of the review process.

3. ***Regional Unstable Landforms Identification Project (RLIP)***
   Description: This completed project provided a coordinator to work with Timber, Fish and Wildlife (TFW) cooperators within each DNR region in order to identify unstable landforms that do not meet the statewide landform descriptions. Its results also serve as an interim screen for deep-seated landslides by identifying lithologies that promote deep-seated landslides; however, the project did not actually map individual deep-seated landslides but rather the areas where they occur in abundance. In 2005, data from this project were placed into the hazard zones spatial database, which is used by DNR for classifying applications and by the Landslide Hazard Zonation team as preexisting work that they incorporate into their studies.
   Status: Complete.

The results of the Regional Unstable Landforms Identification Project have been rolled into the Landslide Hazard Zonation (LHZ) hazard areas. Copies of reports on all identified regional landforms are used in each DNR region.

4. ***Landform Hazard Classification System and Mapping Protocols Project***
   Description: This project developed a detailed protocol to be used to map landslides and potentially unstable landforms in a consistent manner, leading to the assignment of hazard to unstable slopes in the forested environment. This project was completed in 2004; the protocol has subsequently been used for the implementation of the LHZ Project (described below) and by state lands geologists for large blocks of land under state ownership.
   Status: This project was completed in 2004 and has been utilized in the LHZ Project.

   The Landform Hazard Classification System and Mapping Protocols Project is the written and accepted protocol for the Landslide Hazard Zonation (LHZ) Project. These LHZ protocols are designed to ensure that all the final documents are consistent and comparable.

5. ***Landslide Hazard Zonation (LHZ) Project***
   Description: This is a multiphase project. During Phase 1, all mass wasting modules from completed watershed analyses and other information on unstable landforms, landslides, and unstable slopes were collected and compiled in a GIS database. This database has been made available for free download to the public and is utilized as a screening tool in the forest practices application review process.

   During Phase 2, mass wasting modules from 22 incomplete watershed analyses were either finished, reviewed, and added to the database or were rejected. Eleven of these were never completed.

   During Phase 3, the protocol was being implemented at the watershed scale following a list of priority watersheds based on presence of steep slopes and FPHCP lands.

   The LHZ protocol was used to complete 59 WAUs. Due to a suspension of legislative funding in July 2009, completion of the LHZ project has been postponed. If and when funding is available, priorities will be reassessed, as 34 of the original 56 priority WAUs for watershed analyses have not been completed.
   Status: Phases 1 and 2 – Complete; Phase 3 – On hold waiting for additional funding.

B. *Are the forest practices unstable slopes rules reducing the rate of management-induced landsliding at the landscape level? Are the mass wasting prescriptions and mitigation measures effective at preventing landslides from roads and harvest units?* (Mass Wasting Effectiveness Monitoring Program)

The purpose of the Mass Wasting Effectiveness Monitoring Program is to assess the degree to which implementation of the Forest Practices rules is preventing or avoiding an increase in landsliding beyond natural background levels.

1. ***Mass Wasting Effectiveness Monitoring Project (aka Post-Mortem)***
   Description: This project is designed to statistically compare landslide densities among five harvest treatments and five road treatments. The treatments are sets of prescriptions associated

with the period in which different Forest Practices rules were in effect. Given a storm event that produces a significant population of landslides, landslide data will be collected within 4-square-mile blocks, and all area encompassed by the block will be classified into one of the five harvest and five road treatments. Harvest and road landslides will be analyzed separately, and all analyses will be made relative to the block response. Tests will be conducted to determine whether there are differences in the density or sediment delivery volume of landslides associated with each of the harvest and road strata.

Independent Scientific Peer Review (ISPR) of the study design was completed over the summer of 2007. The study design was being revised when the landslide-producing December 2–3, 2007 storm occurred. Final approval of the study design was given by CMER in January 2008. Policy and the Forest Practices Board approved moving forward with implementation in February 2008. The project was implemented in the spring of 2008. Additional data were incorporated into the study in the fall of 2009.

Status: The study report has undergone ISPR review and is expected to be finalized in 2012.

C. Are unstable landforms being correctly and uniformly identified and evaluated for potential hazard? (Mass Wasting Effectiveness Monitoring Program)

2. ***Unstable Slope Criteria Project: An Evaluation of Hillslopes Regulated under Washington Forest Practices Rules***
Description: This project will evaluate the degree to which the landforms described in the unstable slopes rules identify potentially unstable areas with a high probability of impacting public resources. The project will be designed to evaluate the original Forests & Fish Report Schedule L-1 research topic: "*Test the accuracy and lack of bias of the criteria for identifying unstable landforms in predicting areas with a high risk of instability*" (DNR 1999). Policy's direction to CMER is to evaluate the landslide susceptibility of different slopes/landforms in the interest of evaluating current rule-identified landforms and identifying/characterizing additional potentially unstable landforms.

Status: The project is currently being scoped (and is included in the "Recommended Projects" section at the end of this report).

The Roads Rule Group
The intent of the Forest Practices rules for roads is to protect water quality and riparian/aquatic habitat by minimizing sediment delivery to fish and non-fish bearing waters from road erosion and mass wasting, as well as minimizing changes in hillslope and stream hydrology due to roads. The road rules protect water quality and riparian/aquatic habitats through prescriptions and road best management practices.

Implementation of these prescriptions through road maintenance and abandonment plans (RMAPs) is intended to minimize road surface sediment production and the hydrologic connection between the road system and the stream network, and the risk of road-related landslides caused by inadequately built and maintained roads.

D. Are field or analytical methods needed to support the monitoring program? (Road Sub-Basin- Scale Effectiveness Monitoring Program)

The purpose of the Road Sub-Basin-Scale Effectiveness Monitoring Program is to determine the degree to which the road rule package is effective at meeting performance targets for surface erosion sediment and water established at the sub-basin scale as a whole across the state.

1. ***Road Surface Erosion Model Update Project***
   Description: The road surface erosion model within the Surface Erosion Module of the Washington Forest Practices Board Manual on Standard Methodology for Conducting Watershed Analysis (version 4.0, November 1997) is an empirically derived model for estimating surface erosion and sediment delivery to streams from forest roads. The primary purpose of this project is to refine and adapt the model for use in forest road monitoring and as an assessment method. Revisions include standardizing input variables and developing repeatable application protocols. This project also includes development, testing, and refinement of standardized protocols for field application of the revised road surface erosion model for use at the site and road-segment scale.

   Status: This project was completed in 2003 and produced the Washington State Road Surface Erosion Model (WARSEM).

E. Are road prescriptions effective at meeting sub-basin-scale performance targets for sediment and water? (*Road Sub-Basin- Scale Effectiveness Monitoring Program)*

1. ***Road Sub-Basin-Scale Effectiveness Monitoring Project***
   Description: The main purpose of this project is to provide data that can be used to assess the degree to which sub-basin-scale performance targets, and therefore resource objectives, are being met throughout the state. This project also characterizes the extent of road conditions that reduce surface erosion (e.g., improved surfacing, reduced runoff to streams). Data collected at the sub-basin scale will determine the status and assess trends of key indicators of road connectivity using WARSEM-modeled sediment delivery through time. Forest road systems in randomly selected sample areas that are proportionately distributed statewide in areas under Forest Practices rules, independent of ownership, are being monitored. Small forest landowner properties are included in the study whenever they fall within the sampling blocks. Data are collected to determine the degree to which roads meet established performance targets and the strength of the relationship between those reported measures and the percentage of sample area under implemented RMAPs.

   Status: There are three phases of this research.

   Phase 1 sampled of 60 four-square-mile blocks randomly selected across Washington State. It is intended that sampling occur once or twice (Phase 2 and 3) more during the years of RMAP implementation to understand the long-term trend of road erosion and to determine if the performance targets are achieved at the end of RMAP implementation.

   Results from Phase 1 show road managers reported that over half of the sample units had at least 85% of road length meeting post-RMAP standards. Across all samples, an average of 11% of the road length was hydrologically connected to streams or wetlands, though much variability exists between regions and blocks. Sixty-two percent of the road samples met the regional performance target for hydrologic connectivity, and 88% of the samples met the sediment target. These are all favorable results, given that they were observed less than halfway through the RMAP implementation period. Sediment delivery performance by sample block was statistically correlated with progress toward RMAP standards. However, hydrologic connectivity was not statistically related to progress toward rule standards, reflecting that connectivity targets are difficult to achieve for roads located in areas of high stream density. The results of future monitoring events (planned interval of five years) will identify what changes in road performance result from additional road improvements.

Results from Phase 1 underwent Independent Scientific Peer Review and were approved by CMER in early 2010. Sampling during Phases 2 and 3 are scheduled to occur, respectively, later within the RMAP implementation period and following completion currently scheduled for 2016. Phase 2 and 3 will determine if road characteristics that affect runoff and sediment delivery to streams are improving through time.

Advisory language was placed in the Board Manual Section 3 – Guidelines for Forest Roads – recommending that landowners identify those road segments which they believe are in good repair, but which the study indicates remain highly connected to the channel network.

Recommended Projects

The literature indicates that forest management on forestland has the potential to have an effect on peak flows and unstable slopes (see "Research on the Impacts of Forest Management" section). The forest practices Adaptive Management Program is currently involved in on-going projects to produce technical information and science-based recommendations to assist the Board in determining if and when it is necessary or advisable to adjust Forest Practices rules and guidance in order to achieve resource goals and objectives. However, there are additional projects that if funded, could provide valuable knowledge or tools, which when used, have the potential to measurably improve public resource protection. DNR is recommending three projects, in priority order, for funding consideration that have a direct link to the Chehalis Basin and flooding impacts.

Project #1: Geological mapping and updated LiDAR (Light Detection and Ranging)

The 2007 storm was the third time in 20 years that flooding has closed I-5. The following project (in two parts) offers needed tools to assist in solving some of the problems in the Chehalis basin.

LiDAR will supply data on floodplain elevations that are needed to understand flooding patterns, geomorphology, floodplain management, and development. In the upper Chehalis basin, LiDAR will provide data on slopes and where landslides have occurred. This will be used to test the predictive models. Because parts of the Chehalis basin have been flown for LiDAR a comparison of the two LiDAR data sets can be made.

Part 1(a) **–** Surface and subsurface geological mapping

Year 1 - Accomplish surface and subsurface geological mapping of the Centralia and east half of the Adna 7.5 minute quadrangle. Geological mapping will be useful in solving many of the problems associated with flooding and floodplain development and for evaluating levees, dredging, and dam proposals.

Geologic mapping will identify the location and physical characteristics of geologic materials, surface and subsurface constrictions, what controls groundwater divides, what controls channel migration, landforms, what is controlling the rates of erosion and landsliding, depth to bedrock, as well as the fractures and faults within the geologic materials. This information provides critical stratigraphy and geohydrologic information for informed decisions. For example, it will provide a picture of the subsurface geology and shape of the basin, which is necessary to determine hydrologic characteristics. These could be mapped starting summer 2012. Initial mapping can begin without new LiDAR. Subsequently, more detailed mapping may be needed to resolve site specific issues. LiDAR will dramatically enhance the quality of the geologic mapping in Lewis County.

Estimated Cost for mapping the first one and ½ quadrangles: $261,000

Years 2 through 5 - Accomplish geological mapping of the middle and upper Chehalis basin. Geologic mapping will identify the location of existing landslide deposits and failure prone geologic materials. This information is necessary for geomorphologic and slope stability analyses, both of which can model the areas susceptible to future landslide activity as well as provide estimates of the amount of sediment that will be delivered to the streams in the Chehalis basin. This information is critical to determining hydrologic capacities within the basin and thereby determining what the effectiveness of a flood control plan will be. For example, the mapping will help define aquifers and aquacludes within the basin. The Chehalis basin is a very large basin and DNR recommends that at least the area upstream of Capital Forest be geologically mapped. There are 13 7.5 minute quadrangles that should be mapped in Lewis and Thurston counties.

Estimated Mapping Cost for 13 quadrangles: $2,260,000

***Part 1(b)* –** Updated LIDAR for high resolution elevation model
In the *Chehalis Basin Ecosystem Restoration General Investigation Study Baseline Hydrology and Hydraulics Modeling, Draft Hydrologic Analysis Report* (USAE 2011), the scope of work for the update phase recommends adding previously unmodeled parts of the Chehalis to the previous models. DNR suggests that it is time to do a comprehensive model using 3-D methods and current conditions of topography. That would require acquiring post-2007 topography by LIDAR with a common specification, preferably acquired as a new contiguous block.

The Upper Chehalis WRIA is 830,805 acres and the Lower Chehalis WRIA is 939,467 acres. The cost to fly LiDAR is currently $.78/ac for large blocks such as these. An additional 27% is included for indirect costs, for a total estimated cost of $1,753,600.

Estimated Total Cost for LiDAR: $1,753,600

Total Estimated cost for Project #1 $4,274,600

Project #2 - Unstable Slope Criteria Project: An Evaluation of Hillslopes Regulated under Washington Forest Practices Rules.
The project will address the following question:
Are unstable landforms being correctly and uniformly identified and evaluated for potential hazard?
This project is part of the 2013 CMER Work Plan and is estimated to begin in July, 2013. It will evaluate the degree to which the landforms described in the Forest Practices rules identify potentially unstable areas with a high probability of impacting public resources, as well as identify and characterize additional potentially unstable landforms.

Estimated Cost: **$200,000**

Project #3 – Road Prescription-Scale Effectiveness Monitoring

The project will address the following question:

Are road prescriptions effective at meeting site-scale performance targets for sediment and water?

The primary purpose of this project is to evaluate the effectiveness of road maintenance categories in meeting road performance targets and to identify sensitive situations where prescriptions are not effective.

This 10-year project includes development, field implementation, data assimilation, and report writing stages.

Estimated Cost: **$2,200,000**

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Comments on DNR Chehalis River Basin Forestland Report

SUBMITTED VIA EMAIL BY PAUL PICKETT, WASHINGTON DEPARTMENT OF ECOLOGY - JUNE 8, 2012

Subject: RE: Chehalis Flooding Technical Workshop

My focus for comments is on:

- What points does there seem to be agreement on?
- What points is there disagreement on?
- What are the information gaps?

1. The report asserts that the forest practices rules will help protect and restore hydrologic processes. There are beneficial effects on hydrology from the rules, such as those for rain-on-snow, maximum cut size, green-up, and stream buffers. There is uncertainty about the effectiveness of implementation, i.e. are landowners doing the practices as intended. And there is uncertainty about the effectiveness of existing rules to protect and restore hydrologic processes.
2. Page 1, Executive Summary 1st paragraph, "Forest management activities such as timber harvest or forest road construction have the potential to decrease the natural flood protection of the forests if executed in a way that does not minimize adverse effects to these hydrologic cycle components.": This statement is confusing and somewhat disingenuous, since it suggests that impacts can be avoided entirely. If they make this claim, they should support it with scientific literature, but it appears unlikely that literature exists to support that claim. A better statement would be "Forest management activities such as timber harvest or forest road construction have the potential to decrease the natural flood protection of the forests, and the impacts of activities can be minimized by the use of appropriate Best Management Practices."
3. Page 1, Executive Summary 2nd paragraph: This paragraph is worded in a way to suggest that the forest practices regulations effectively "protect public resources" in a way that is "flexible and responsive". The rules are <u>intended</u> to protect resources, but recognize that effectiveness is uncertain and that additional studies are needed to determine the extent of effectiveness. Blanket assertions of this sort are less helpful than understanding where the effectiveness and responsiveness of the program has been documented and where additional study or improvements are needed.
4. Page 2-3, "Peak Flows/Unstable Slopes and the Forest Practices Rules":
    a) The response to forest harvest is strongly seasonal. In conifer-dominated forest basins, streamflow may increase by several hundred percent during the late summer and early fall period in the first five years after harvest. (also page 18, last paragraph)
        i. Jones, J. A., and Post, D. A., 2004, Seasonal and successional streamflow response to forest cutting and regrowth in the northwest and eastern United States: Water Resources Research, v. 40, no. 5.
    b) Other citations are available to show that forest harvest can increase the volume of water for rain-on-snow events.
        i. Coffin, B. A., and Harr, R. D., 1992, Effects of forest cover on volume of water delivery to soil during rain-on-snow: Timber Fish & Wildlife, Washington Department of Natural Resources.
        ii. Marks, D., Kimball, J., Tingey, D., and Link, T., 1998, The sensitivity of snowmelt processes to climate conditions and forest cover during rain-on-snow: a case study of the 1996 Pacific Northwest flood: Hydrological Processes, v. 12, no. 10-11, p. 1569-1587.

c) “The extent to which timber harvest alone has triggered substantially increased peak flows is likely rare” (also p.19, end of 1st paragraph): Not an accurate statement. This is an area of active research with new studies showing potential impacts.
   i. Moore, R. D., and Wondzell, S. M., 2005, Physical hydrology and the effects of forest harvesting in the Pacific Northwest: a review: Journal of the American Water Resources Association, v. 41, no. 4, p. 763-784.
   ii. Alila, Y., Kura, K., P., Schnorbus, M., and Hudson, R., 2009, Forests and floods: A new paradigm sheds light on age-old controversies: Water Resour. Res., v. 45, no. 8, p. W08416.

d) Other citations are available that show the impact of road runoff.
   i. Tague, C., and Band, L., 2001, Simulating the impact of road construction and forest harvesting on hydrologic response: Earth Surface Processes and Landforms, v. 26, no. 2, p. 135-151.
   ii. Wemple, B. C., and Jones, J. A., 2003, Runoff production on forest roads in a steep, mountain catchment: Water Resources Research, v. 39, no. 8, p. [np].

5. Page 3, 4th paragraph: How are road maintenance and abandonment plans reported? Are they being fully implemented, and are they effective?
6. Page 3, last paragraph, “Forest Practices rules address rain-on-snow effects in two ways, first through the hydrology module in watershed analysis…”: Currently watershed analyses are rarely conducted, and the hydrology module may be outdated.
7. Page 3, last paragraph, “DNR may limit even-aged harvest size when it determines that peak flows have caused material damage to public resources”: How often has this analysis been done in the Chehalis basin? Could it be done more often in the future as a flood mitigation measure?
8. Page 19, “Timber Harvest and Peak Flows”,
   a) “Timber harvesting alone may have an effect on flows but is likely minor.”: This assertion is not well-supported by studies. For example, one study states: “Peak flow frequency increases after harvesting increase with return period, with the largest events (100-year) becoming 5–6.7 times more frequent, and medium-sized events (10 year) becoming 1.7–2 times more frequent.” (Kuras´, P. K., Y. Alila, and M. Weiler (2012), Forest harvesting effects on the magnitude and frequency of peak flows can increase with return period, Water Resour. Res., 48, W01544, doi:10.1029/2011WR010705.)
   b) “If a peak flow following harvest occurs, small basins seem to be more likely to experience effects than large basins.” No explanation or citation is provided to support this statement. You would expect it would be easier to detect peak flow changes in small watersheds where a higher proportion of the basin will have undergone harvest, but there would still be an effect in a large basin.
9. Page 19, “Road Construction and Peak Flows”, “While timber harvest alone most likely has little effect on peak flows,…”: Disagree with wording. Better would be: “While there is uncertainty around the effect of timber harvest on peak flows,…”
10. Pages 20-21, “Riparian and Wetland Areas”: The hydrologic functions of riparian and wetland areas are described, but the impact on their disturbance on peak flows is not addressed. In the context of the Chehalis Basin, the cumulative effect of forest management on riparian and wetland areas and hydrology is unknown. This is an area of further research.
11. Page 31, “Compliance and Enforcement”: The report should note that unstable slopes are not evaluated for compliance or included in DNR’s compliance monitoring summary report.
12. Page 38 and onward, “Recommended Projects”: In general the price-tag on the projects should be examined closely before a decision is made to support them.

a) Project #1(a): Geological mapping provides valuable information. The cost and timing should be weighed against other funding priorities. This is likely a long term project, but the quads should all be prioritized and a program defined for completing this work over the next 5 to 10 years.
b) Project #1(b): This would be a very useful project and could provide the basis for better GIS mapping and a predictive hydrologic model of the basin.
c) Project #2: The value of this project for flood mitigation is unclear.
d) Project #3: The value of this project for flood mitigation is unclear.
e) Project #4: It's not clear if this project will focus on the Chehalis basin. The estimated cost should be reviewed

13. The cumulative effects of timber practices and the potential for watershed restoration to mitigate flooding would be better understood if a hydrologic model of the basin were available. Some thought should be given to the input needs of such a model and the data gaps identified. Then research could be targeted to fill those gaps. Questions for the upland forested areas could include:
    a) What are the stand ages and current vegetation cover for forest lands?
    b) What are the heights and density of vegetation in riparian buffer areas?
    c) Where are the current, historical, and potential wetland and pond areas?
    d) How do stand age and forest practices affect infiltration and what infiltration rates apply to different forest areas?
    e) Where are the current and historical forest roads, and what condition are they in with respect to channeling runoff and connection to streams?
    f) What are the channel slope, width, and substrate composition of upland tributaries in forest areas?

Seattle Times article on the ongoing scientific debate about the contribution (if any) of forest practices to flooding

LANDSLIDE STUDY BOGGED DOWN BY SCIENTIFIC DISPUTE

Originally published Sunday, June 24, 2012 at 8:12 PM
Corrected version
By Hal Bernton, Seattle Times staff reporter

A $1.5 million study by the state Department of Natural Resource to see whether current logging restrictions were reducing landslides is more than two years behind schedule as scientists argue over the report's conclusions.
Four years ago, the Washington Department of Natural Resources launched a $1.5 million study to find out if state logging restrictions on unstable slopes were helping reduce the frequency and size of landslides.

Field crews tramped through the steep backcountry of Western Washington to catalog 1,147 landslides triggered during powerful storms of December 2007.

But the study is some two years overdue. It's now bogged down by a bitter dispute among scientists over what knowledge can be gleaned from the formidable accumulation of data, preventing it from being finalized.

The study is intended to help guide state rule-makers in the high-stakes effort to determine which trees should be left behind on slide-prone timberlands to help protect streams and other public resources.

The draft conclusion appears relatively tame, noting that the findings support "the hypothesis that avoidance of clear cut harvests on unstable terrain reduces the size and frequency of landslides," according to a draft copy obtained by The Seattle Times.

Critics say the study has numerous problems and doesn't offer evidence to back up the key conclusion that buffers reduce landslides.

"Correct the misinterpretations, and make it clear that the unstable slope buffer effectiveness could not be determined," wrote A.J. Kroll, a scientist for Weyerhaeuser, which owns Southwest Washington timberlands that were hit by many of the slides.

The study "simply does not address the rules. ... In fact, the effectiveness of the rules may be much better or much worse than indicated in this study," wrote Leslie Lingley, a geologist with the state Division of Forestry that regulates the timber industry.

The five scientists who authored the study include two who work as private consultants, two who at the time of the study were employed by tribal organizations, and a timber-industry geologist with Rayonier.

They note the study already has gone through peer review and say much of the criticism was raised "well after the appropriate stage."

"The authors are not convinced that further dialogue is likely to be productive," they wrote in response to their critics. "We do not see a path forward with respect to issues raised."

The study focused on 55,000 acres of timberlands in the Willapa Hills, the epicenter of 2007 storms, and some 550 miles of logging roads.

The slides dumped mud and debris into swollen rivers, helping fuel the floods that slammed houses, barns and farm fields downstream

The scientific clash over the study unfolds amid continuing controversy over logging on slide-prone landscapes.

Current rules typically require buffers of uncut trees to remain on unstable slopes where landslides might send mud and debris into waterways or other public resources. Unstable slopes are defined under rules put into place in 2001 as steep inner gorges, bedrock hollows and other terrain prone to slide.

The study found that the current rules often did not appear to be followed, identifying some 47 slides that occurred on slopes that had been clear-cut since 2001, even though the land met the state definition for unstable terrain.

The study also found that more than 40 percent of the landslides occurred on slopes that did not meet the state definition.

Environmentalists who have reviewed the study believe it offers ammunition for tougher enforcement of current rules and for expansion of the definitions of unstable slopes to cover more land.

"This study is evidence that steep and unstable slope rules and regulations are inadequate and enforcement is appalling," said Peter Goldman, of the Washington Forest Law Center.

Kevin Godbout, a Weyerhaeuser official, says that his company already has taken a number of steps since the 2007 slides to improve identification of unstable terrain that could be buffered with uncut trees.

"We have beefed up our staff of geologists, and reviewed the whole process of how we screen for unstable slopes," Godbout said.

The future of the study remains unclear.

It emerged from a scientific research committee established by the state to develop studies that can guide review and potential change to state forestry rules.

Chris Mendoza, a co-chair of that committee, says that many of the objections to the study were raised after a vote was taken to end the formal review process, and that it should now become final.

Others disagree. To resolve the dispute, a state policy group, at a meeting earlier this month, recently discussed whether the state should eventually hire a mediator.

Bridget Moran, a Department of Natural Resources deputy supervisor, is confident that common ground eventually will be found.

"We're trying to resolve whatever issues are out there, so we can proceed ahead and finalize the report," Moran said. "This is a big important study, and we want to get it right."

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Information in this article, originally published June 24, 2012, was corrected on June 25, 2012. A previous version of this story incorrectly summarized one of the findings. The study found that more than 40 percent of the landslides occurred in areas that did not meet the state definition of unstable slopes.[4]

[4] http://o.seattletimes.nwsource.com/html/localnews/2018521201_landslidestudy25m.html

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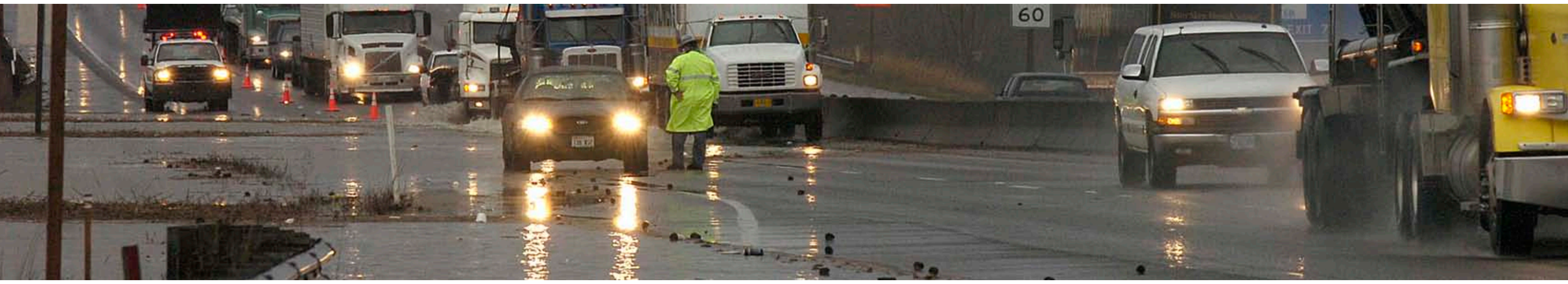
Appendix H: Evaluation of Benefit-Cost Work Regarding Chehalis River Flood Control



A Conceptual Evaluation of Benefit-Cost Work Conducted Regarding Chehalis River Flood Control

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July 12, 2012

Executive Summary

The Benefit-Cost Analysis Center at the University of Washington has been asked by the William D. Ruckelshaus Center to analyze the benefit-cost analyses produced concerning various proposed alternatives for mitigating severe flooding in the Chehalis River basin. This is in keeping with Engrossed House Substitute Bill 2020,[5] which requires that the state Office of Financial Management prepare a report on flood hazard mitigation in the Chehalis basin that summarizes "the benefits and costs of recommended projects, using available information and accepted benefit/cost methods" (Section 1033, 2:e). We find that the existing analyses, namely EES Consulting's flood retention project analysis[6] and the Army Corps of Engineer's levee system analysis[7] provide a sound basis for assessing the social benefits and costs not just of the structural projects they directly consider but also for the portfolio of alternatives, including numerous programmatic or non-structural actions, under consideration by the Chehalis Basin Flood Authority. Given the inherent uncertainty of any complex modeling exercise and the necessity of analyst discretion in any benefit-cost analysis (BCA) application, we do not focus on specific model parameter estimates or valuations. Instead, we focus on conceptual strengths and weakness, particularly as related to the ability to make inter-project comparisons. We highly encourage clear presentation and transparency, since the goal for BCA is not to foster full consensus but to provide a framework for a coherent discussion of values and preferences.

We find that one of the primary strengths of the current portfolio of analyses is that it provides a conceptual basis for qualitatively evaluating the benefits of projects that have not been formally analyzed. The HAZUS flood model damages estimated by EES in their evaluation of the flood retention alternatives provide an anchor for considering the flood prevention or mitigation value of other alternatives. Even in the absence of further HAZUS model runs that examine the potential effects of other policies, policy makers can use these estimated damages as a guide for thinking about what the returns to other projects might be as well. Thus, the current data means that policy makers should not require BCAs of comparable scope (and expense) for all other projects. For instance, the 2003 "Multi-Purpose Water Storage Assessment" prepared for the Chehalis Basin Partnership estimates costs for several programmatic projects: Block agricultural drainages ($207,000); low-impact development ($120,000); beaver reintroduction ($170,000); and forest conservation/restoration ($300,000). With the benefit of existing data, these types of projects can be analyzed without using a full, separate BCA. Given the massive flood damage figures provided in EES's analysis (hundreds of millions of dollars in flood damages from severe events such as the 2007 flood), such measures would appear to be sound investments given their comparatively miniscule costs and relatively low uncertainty (i.e., project costs would not likely balloon and flood mitigation effects will likely be realized).

Lastly, we identify several issues that are not sufficiently addressed by existing analyses that policy makers should be mindful of as they make inter-project comparisons, including:

(1) A clear focus on flood prevention/mitigation policy as a public investment: It is not enough to simply determine whether estimated project benefits exceed estimated project costs. Instead, net project benefits should be evaluated against the potential returns from an alternative project or an alternative use of public funds.

(2) The inadequacy of simple benefit and cost estimates for reflecting uncertainty: In evaluating project alternatives, a single benefit and cost cannot demonstrate how much confidence policy makers should place in

[5] ESHB 2010, Chapter 49
[6] Chehalis River Flood Water Retention Project Phase IIB Feasibility Study, finalized April 14, 2011.
[7] Centralia Flood Risk Management Project, Chehalis River: Draft Close-out Report, as of January 2012

an estimate. Such “points estimates:” are an insufficient basis for project selection because they do not speak to project “upside” and “downside”. In other words, it is critically important to consider potential outcomes should assumptions and estimates prove incorrect (e.g., if an estimated cost proves far to low, or an environmental impact prove far greater than anticipated).

(3) The time frame on which benefits and costs are modeled to occur: Due to the opportunity cost of funds, the financial viability of a project is greatly determined by interest rate, or time value, assigned to project costs and benefits. This means that *when* benefits and costs are modeled to occur greatly affects the outcome?

(4) An appropriate basis for comparison: A BCA should estimate the difference in outcomes between what is likely to occur if a project is funded and if it is not. In other words, project benefits and costs should not include changes or expenditures that are likely to happen even if a project is not implemented. This is particularly important when considering the selection of multiple projects, since numerous small programmatic or non-structural projects might obviate the benefits of a large structural project.

In what follows, we discuss each of these points in greater detail.

• • •

I. Introduction

The Benefit-Cost Analysis Center at the University of Washington has been asked by the William D. Ruckelshaus Center to analyze the benefit-cost analyses produced concerning various proposed alternatives for mitigating severe flooding in the Chehalis River basin. As a rubric for this task, the investigators have drawn on the current theoretical understanding and best practices found in the benefit cost literature. Particularly, the investigators have used the recent MacArthur Foundation report, produced by the Center: Principles and Standards for Benefit-Cost Analysis (Zerbe et al. 2010).[8]

The BCAs conducted regarding the various policy alternatives (including EES Consulting's analysis of flood-retention facilities and the US Army Corps of Engineer's analysis of new levees on the Chehalis River), involve different data, models, and analysts; thus, in each section we emphasize the ability to make meaningful comparisons across policy alternatives. We envision this review as a conceptual analysis of methodology and key issues. Given the inherent uncertainty of complex social-ecological systems (Folke et al. 2005; Gunderson and Holling 2002) and the reality that no counting exercise is wholly value-neutral (Stone 2012), it is important to consider that no BCA can expect to be fully accurate or address all policy considerations. However, what is most important is that BCA facilitates a better, more-informed policy decision, not that a BCA be completely accurate. A simple, "back of the envelope" analysis can still help policy makers select the most efficient policy alternative. This reality is of particular importance in this case, since only a few alternatives under consideration have been formally analyzed. Moreover, even if stakeholders disagree about a particular model assumption (for instance, salmon survival rate passing through the water retention facility), BCA provides a means by which to explore the potential ramifications of such disagreement.

We employ this philosophy in our review, emphasizing the role of BCA in facilitating a robust discussion of the assumptions, methods, and concerns for policy decision-making raised by BCA about the various policy alternatives. In other words, we emphasize the decision-making usefulness (and barriers to usefulness) found in the existing portfolio of project analyses. Clarity and transparency is most important in this regard. For instance, stakeholders might disagree on the value estimated for a model parameter (e.g., how many users will visit the recreation site), but so long as this estimate is clearly shown in the analysis, each stakeholder can evaluate model results in light their preferred number. Thus, the ultimate goal of a benefit-cost analysis should not be to foster complete consensus, but rather to constructively guide debate about policy alternatives and ground this debate in a scientific evaluation of economic effects.

In our review of the benefit-cost work presented to us, we find that the authors of the various reports have provided a strong knowledge base regarding the economic impacts of various flood protection alternatives. In the next section, we describe how the existing works provide a basis for decision making going forward. We then describe how the projects considered in detail in these analyses can be reasonably compared to projects that have not been studied at the same level of detail. In conclusion, we also provide several recommendations as to how these analyses can be made even more useful for policy makers. These "points for consideration" are all oriented towards the goal of facilitating comparison across projects and developing a common basis for discussion about policy alternatives and impacts. We identify and discuss five important issues that merit consideration in this regard: (1) Policy goals and objectives; (2) Risk and uncertainty; (3) The yearly distribution of benefits and costs over the project time horizon; and (4) An appropriate baseline for comparison.

[8] Other recent texts that reflect the state-of-the-art include Adler and Posner 2001, Boardman et al. 2011, Brent 2008, de Rus 2012, and Zerbe and Bellas 2006.

II. Moving Forward With Existing Analyses and Data

Benefit-cost analysis, carefully done, is an exceedingly difficult exercise and the works we have reviewed demonstrate meticulous research, careful consideration, and artful problem solving. In what follows, we describe several important takeaways from the existing body of analyses that provide as basis for decision making as policy makers move forward.

1. Clear causal linkages

Causality, a question as to whether an expenditure directly results in a change in net benefits, is central to BCA (Drake et al. 2009). As a general principle, the further removed causal drivers are from estimated effects, the less confidence decision makers should place in estimated values. For most alternatives considered in this case, the causal link between costs and benefits is largely straightforward. For instance, whether policy makers choose to improve the levee system or implement a suite of non-structural policies, there is no doubt that such measures would reduce or prevent flooding should such an event occur. This holds true for livestock pads, , flood retention facilities, , temporary water storage on farmland, and other alternatives as well, since there is a concrete physical link between such measures and flood mitigation. While the magnitude and geographic nature of a flood event will always be uncertain, policy makers can be confident, for instance, that walls along I-5 will prevent I-5 from closing under designated conditions.

One caveat we would add in this regard, however, is that as more and more assumptions are required in order to predict a causal effect, policy makers should be more and more wary of the validity of our estimate. For instance, an estimate of benefits associated with changes in land use management by local governments requires assumptions about future growth patterns, the cumulative impact of a diverse spate of management actions, and the degree to which such measures are implemented (and enforced) successfully going forward. Thus, the overall cost and benefit estimates for this alternative are dependent on an assumed link from zoning and land-use regulations to actual land use behavior to resultant flood prevention/mitigation; if regulations are insufficiently enforced, for example, then the estimated level of flood reduction benefits will not be achieved.

As another example, consider the predicted effect of the multi-purpose dam on the spring-run Chinook salmon stock: Anchor QEA's model predicts that the stock will increase by 140% under optimal stream flow management and target survival passage rates at the dam. Regardless of one's view on the validity of this prediction, we must bear in mind that it hinges upon the accuracy of multiple assumptions, including: (1) those related to the impact of the dam on stream flow and water temperature; (2) those related to how the dam will be managed; (3) those related to fish passage survival rates (4) the behavior of juvenile and adult Chinook in response to a major change in their environment where there is little currently known about the behavior of juvenile fish in the river. However, there is absolute certainty that the dam eliminates some salmon-spawning habitat.

Conversely, if policy makers were to choose to put walls along I-5 and re-vegetate upstream land, this re-vegetation would also be predicted to increase the salmon stock by creating improving water and habitat quality. However, if this did not prove the case, re-vegetation would most certainly at least not *reduce* the salmon stock. In other words, avoiding significant harm to the Chehalis River spring-run Chinook stock under the multi-purpose dam scenario depends on policy makers being *right* about numerous predictions; on the other hand, avoiding harm to salmon under several other scenarios can be achieved even if policy makers are *wrong* about many of the predicted effects.

Thus, in assessing the various policy alternatives, policy makers must remain mindful of the robustness of benefit and cost estimates. Figure 1 provides an example from Anchor QEA's salmon impact study that demonstrates such an approach. Figure 1 demonstrates the potential range of impacts on Winter steelhead spawners in the Chehalis River, providing not only the most likely estimate but upper and lower boundaries reflecting the overall distribution of potential outcomes:

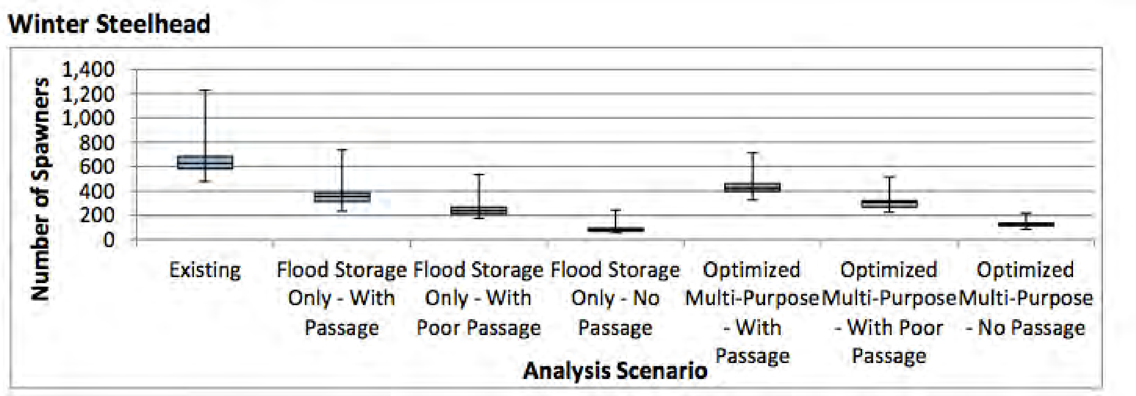

Figure 1: Example of estimate range from Anchor QEA study, figure 6-2, page 75.

In other words, it is important to consider how likely it is that the hypothesized chain of events actually occurs, and how different the policy outcome might be if these assumptions are not borne out. While we pointed out an example regarding salmon impacts above that might give cause for concern, in the aggregate we find this to be a cause for confidence in the existing analyses. With the exception of environmental impacts such as to salmon stocks, the causal link between project costs and benefits appears robust, well established, and straightforward.

2. Tractable estimation of benefits

The estimation of flood reduction benefits, such as avoided structural damages and transportation closures, has been carefully conducted and excellently detailed. The HAZUS model used to project flood events is widely accepted in the published literature (for recent examples, see Dierauer et al. 2012 and Whitehead et al. 2009). Often the estimation of non-monetary benefits and costs injects a great deal of uncertainty into BCA. This is especially the case when state-preference methodologies are used (e.g., the Earth Economics report on ecosystem services benefits).[9] However, the projects under consideration, both structural (e.g., levies or dam facility) and non-structural (e.g., riparian restoration or land-use protocols) achieve benefits associated with preventing damages to structures, livestock, crops, and other built capital that have market prices. In other words, many of these items are bought and sold in markets, and thus their market prices can be used to estimate damages. Likewise, the revealed preference methodology[10] used to assess the cost of interstate and railway closures utilizes market behavior as well. While the uncertain nature of flood events means prior estimation of damages is a somewhat impossible exercise, decision makers should be confident that these estimates provide a suitable basis for inter-project comparison that is well founded in actual market outcomes.

[9] In stated-preference valuation, benefits and costs are estimated using answers provided in hypothetical choice scenarios (see Champ et al. 2003). For instance, an analyst might choose to use contingent valuation to model the value of a salmon stock, asking people how much they would be willing to pay to prevent the stock from decreasing or how much they would except in exchange for the stock decreasing by a specified amount.

[10] Revealed preference methods use actual market behavior to estimate the values of nonmarket goods associated with the observable transaction (Boardman et al. 2010). For instance, there is no actual price associated with a one-day closure of Interstate 5, but by estimating the cost of additional time, added transportation costs, and lost commerce fostered by a closure, analysts can develop an estimate as to how much a one-day closure decreases net social welfare.

III. Inter-project Comparisons (including projects without formal BCAs)

We find that one of the primary strengths of the current portfolio of analyses is that it provides a conceptual basis for qualitatively evaluating the benefits of projects that have not been formally analyzed. The HAZUS flood model damages estimated by EES in their evaluation of the flood retention alternatives provide an anchor for considering the flood prevention or mitigation value of other alternatives. Even in the absence of further HAZUS model runs that examine the potential effects of other policies, policy makers can use these estimated damages as a guide for thinking about what the returns to other projects might be as well. Thus, the current data means that policy makers should not require BCAs of comparable scope (and expense) for all other projects.

For instance, the 2003 "Multi-Purpose Water Storage Assessment" prepared for the Chehalis Basin Partnership estimates costs for several programmatic projects: Block agricultural drainages ($207,000); low-impact development ($120,000); beaver reintroduction ($170,000); and forest conservation/restoration ($300,000). With the benefit of existing data, these types of projects can be analyzed without using a full, separate BCA. Given the massive flood damage figures provided in EES's analysis (hundreds of millions of dollars in flood damages from severe events such as the 2007 flood), such measures would appear to be sound investments given their comparatively miniscule costs and relatively low uncertainty (i.e., project costs would not likely balloon and flood mitigation effects will likely be realized).

Similarly, if a portfolio of projects, such as additional/increased levees, livestock pads, and walls along I-5, provides a similar flood protection footprint as the flood retention facility project, then decision makers can be confident that the flood reduction benefits will be similar and can tractably compare these alternatives on the basis of their cost and associated risks.

Section D below provides five key points that are not only intended to improve the use of existing analyses, but to aid in comparison between fully quantified projects and those with cost estimates and qualitatively described benefits.

IV. Important Issues for Consideration in Comparing Projects

1. Policy Goals and Objectives

Benefit-cost analysis (BCA), and cost-benefit-analysis (CBA),[11] which are generally regarded as equivalent terms, are accounting frameworks used to evaluate the economic consequences of decisions (Boardman et al. 2010; Zerbe and Dively 1994). One might think of BCA as being the public-sector equivalent of a typical investment analysis as conducted by a firm. However, whereas in a typical financial analysis the objective is simply to maximize the difference between revenues and the total cost market-priced inputs, in an economic BCA the objective is to maximize social welfare benefits (de Rus 2012; Zerbe and Bellas 2006). This vastly increases the complexity of the exercise, as the exact definition of social welfare is of course a vexing political question. However, given the caveat that social welfare is a fluid term, what is wholly unambiguous about BCA then is that takes efficiency to be the justification for policy decision-making. While in reality, policies are justified on grounds of equity, security, and liberty (Stone 2012) as well, it is important to bear in mind that the BCA framework does not allow us to measure how policy alternatives fare in these other three regards. Whether or

[11] Zerbe (2007) has attempted to treat BCA as "better-defined subcategory of CBA", whose legal foundations tend to ameliorate or eliminate the criticisms of CBA.

not a policy is justified on these alternative grounds must be considered outside the framework of the benefit-cost model itself.

The empirical implication of this is that BCAs must view public projects as investments in social welfare. Of course, other policy goals besides efficiency must be considered in this decision making process; indeed, the desire to provide security and safety for citizens of the region is a primary motivation for flood prevention and mitigation. However, BCA only considers project efficiency, and thus must be evaluated using an investment-oriented approach. An investment-oriented approach evaluates a project in terms a comparison between the social value achieved from project outputs and the value of goods sacrificed elsewhere for the sake of the project (de Rus 2012). In other words, a project should be evaluated not in terms of whether its benefits are greater than its costs, but instead in terms of whether the net benefits gained by the expenditure of project costs exceeds the opportunity cost of those funds. As an analogy, a private individual would presumably weigh any investment or purchasing decision against the return gained from leaving funds in an interest-accruing savings account, not against the return from leaving money buried in his backyard. Public investment decisions (made on the justification of efficiency) should be subject to this same principle of opportunity cost.

Thus, in evaluating these project alternatives it is important to look beyond benefit-cost ratios. A benefit-cost ratio, simply the ratio of project benefits over project costs, only reveals whether project benefits exceed project costs (i.e., a B/C ratio greater than one). This is the policy equivalent of burying money in the backyard, as it effectively equates to there being no opportunity cost. For instance, consider a project that costs $100 million but receives $150 million in benefits. This project would have a benefit-cost ratio of 1.5. An alternative project, costing $50 million and receiving $90 million in benefits, would have what would appear to be a more favorable benefit-cost ratio of 1.8. However, the first project actually produces $50 million in net benefits, while the second produces $40 million. Because benefit-cost ratios are insensitive to magnitude, project selection according to this metric would potentially forgo an additional $10 million in social welfare.

For this reason, having a benefit-cost ratio greater than one is an important, but not sufficient, condition for project selection on the basis of efficiency. When considering project efficiency, a project should be prioritized if it creates greater net benefit than other policy alternatives.Net social benefits are the fundamental basis on which efficiency should be determined (Zerbe et al. 2010). This is represented as net present value (NPV), which is calculated as the present value of all project benefits minus the present value of all project costs. This metric allows for the ordering of projects in terms of their net change in social welfare. Note that efficiency is only one of several public policy goals. Projects having a benefit-cost ratio that is less than one (and a negative NPV) might be selected, but on the basis of other social goals and political criteria. In such cases, a benefit cost ratio greater than one is neither necessary nor sufficient.

A second important reason for considering projects on the basis of NPV is that this statistic is insensitive to the choice of which side of the benefit-cost ledger values are counted on (Boardman et al. 2010). For example, the cost savings associated with not having to raise I-5 given the flood prevention offered by the flood retention project could logically be counted as either benefits or negative costs. This choice would not affect the flood retention project's NPV whatsoever, but could dramatically affect the benefit-cost ratio. Consider a project with $2 million in benefits and $1 million in costs. If an additional cost savings of $500,000 is counted as a benefit, the benefit-cost ratio becomes 2.5. Those same cost savings, if counted as a negative cost, produce a benefit-cost ratio of 4. Empirically, the outcome in terms of net benefits would be exactly the same; there is no difference between the two projects. However, the benefit-cost ratio metric would lead one to believe that the second project is far superior to the first. Given that a benefit to one party can represent a cost to another, the concept of benefit and cost categories is not necessarily useful (Boardman et al. 2010). Due to these concerns, we recommend that the presentation of analyses move away from a focus on benefit-cost ratios and instead clearly present the NPV associated with various policy alternatives. For instance, EES's report presents project benefits and costs, but uses several tables of benefit-cost ratios as a summary metric (see pages 5 and 6). It would be more helpful to present net benefits such that projects can be better compared.

As an additional concern in this regard, we advocate that an investment-oriented approach be used when considering ancillary project costs and benefits as well. Projects with multiple components should be considered both in total and in terms of how different project components perform. Thus, analyses should clearly present not only overall benefits and costs, but the isolated benefits and costs associated with the different optional components of an omnibus project.

For instance, one policy alternative, the multi-purpose dam, has benefits and costs associated not only with flood prevention but also with recreation, ecosystem services, energy production, and renewable energy credits. The benefit and cost differences between the flood-control only and multi-purpose facilities have nothing to do with flood control, and so it is inaccurate to simply model the additional benefits of the multi-purpose dam as simply getting "more bang for the buck" from a flood prevention project. These additional benefits come at a real cost. Since the same level of flood protection is achieved whether the dam is built as a flood-control only or multi-purpose facility, the question that must be asked then is whether the additional cost of the multi-purpose dam represents an efficient investment in recreation, ecosystem services, and energy production? In other words, is there a different project or suite of recreational, environmental, and energy production projects that might provide a better return on the approximately $90 million in additional funds required to build the multi-purpose facility?

As an example, Anchor QEA's Chehalis Fish Study finds that the multi-purpose facility could be managed to significantly *improve* the stock of spring-run Chinook salmon in the Chehalis River by improving stream conditions in warm, low-flow periods. This benefit comes at a cost, however, and thus it is important for policy makers to consider whether a similar outcome could be more efficiently achieved via other means (e.g., upstream habitat restoration). This same principle applies to the benefits of hydropower production and recreation.

2. Uncertainty

The Army Corps' Draft Close-out analysis on levees gives only a single benefit and cost estimate (page 16). Such use of "point estimates" in benefit-cost analysis conveys a degree of understanding and certainty that is not in keeping with the true nature of our predictive abilities. There is a vast body of literature demonstrating that complex socio-ecological systems, such as the Chehalis basin, are characterized by inherent, irreducible uncertainty (see Folke et al. 2005; Gunderson and Holling 2002; Holling 1973).[12] In other words, even with perfect, complete data, system outcomes cannot always be accurately or precisely predicted. Moreover, analysts of course do not have the benefit of perfect information, and instead must estimate numerous benefits and costs within the model. This reality should not in any way discredit BCA modeling, since as previously discussed a model need not be correct to be useful. The lack of a fully comprehensive, let alone perfect, analysis should not prevent completion of a useful analysis (Farrow and Viscusi 2011).

Nonetheless, the use of point estimates (e.g. presenting a benefit figure and a cost figure) for summarizing a benefit-cost analysis does not paint an adequate picture of uncertainty with which to make policy decisions. The way in which uncertainty is treated (or perhaps more accurately, not treated) in the analyses we have examined

[12] Note that risk and uncertainty are traditionally defined as distinct, with risk referring to a source of imprecision for which the probability of different outcomes can be assigned, and uncertainty denoting an unknown or stochastic process for which precise quantitative description is unfeasible or unavailable. However, Farrow and Viscusi (2011) point out that in the context of policy-making, probabilities associated with different outcomes are largely treated in the same fashion whether precisely quantified or poorly understood; this renders the distinction largely meaningless empirically.

is especially troubling given the high variability associated with flood events. Not only is the year-to-year occurrence of flood events highly variable (as evidenced by the rash of severe floods in recent decades) but the nature of flood events themselves varies greatly as well. For instance, flood damages are dependent not just on the amount of precipitation, but also on the location of the precipitation and preceding conditions (e.g., already high water levels).

The analyses we have examined use an expected-value framework for valuing uncertain outcomes. This method is widely used, since it offers a tractable means by which to develop a single monetary estimate of the value of an uncertain payout. The expected value framework simply multiplies the value of an event by its probability of occurrence. For instance, the prevention or mitigation of a 500-year level flood event, which is hypothesized to occur once every 500 years, is given a yearly value of 1/500th of the cost associated with the estimated damages from such an event.

The issue with the expected valuation method is that the one outcome we know with absolute certainty will not occur is that the benefits of flood prevention and mitigation will not simply accrue as an even, yearly benefit flow. Instead, there will be zero monetary benefits from flood protection in most years, and significant monetary benefits from flood protection in those (likely few) years that floods do occur. Moreover, the expected value framework assumes dependence between years within a project's lifespan by modeling outcomes such that a 10-year level flood, for instance, can possibly occur only five times in the life of a 50 year project. In reality, an event of this magnitude could occur any number of times or even not at all within a 50-year period. Though unlikely, a 10-year event might occur three years in a row, and then not again for 30 years. Fixing the number and distribution of flood events projects a degree of certainty into project evaluation that does not adequately inform decision makers about the likely economic outcome of flood mitigation or prevention policies.

One method to better address uncertainty, used in several of the analyses, is to conduct sensitivity analysis. A sensitivity analysis simply varies a given parameter or estimate within the BCA model and evaluates how the overall benefit-cost estimate changes as a function of that value (see Karoly 2010). This is easily accomplished and yet adds a great deal of information value to the analysis. For instance, EES's evaluation of flood retention facilities models presents not only expected construction costs but low and high estimates as well, (see Figure 2); the report does not, however, take the simple next step of conducting a sensitivity analysis regarding project costs. Using the low, base, and high cost estimates, it is relatively straightforward to generate three net benefits estimates using this range of cost estimates. This would demonstrate how "sensitive" project efficiency is to the project cost estimate. Sensitivity analyses should be more fully incorporated into the analysis so that policy makers can better see the effect of specific model assumptions.

Table 3
Project Cost Estimates[26]
2010 Dollars

	Base	Low	High
Flood Reduction			
Upper Chehalis	$165,230,000	$129,258,200	$235,079,000
South Fork	$93,060,000	$72,800,100	$141,258,000
Both Projects	$258,290,000	$202,058,300	$376,337,000
Multi-Purpose			
Upper Chehalis	$245,060,000	$191,708,200	$338,858,000
South Fork	$148,540,000	$116,202,600	$213,382,000
Both Projects	$393,600,000	$307,910,800	$552,240,000

Figure 2: Example of sensitivity analysis from EES Phase IIb report, page 27.

More importantly however, the most informative way of presenting a benefit-cost model is to use a probabilistic analysis method (often referred to as Monte Carlo simulation).[13] Monte Carlo simulations should be the standard means by which to assess net policy benefits (Vining and Wiemer 2020). A Monte Carlo simulation entails specifying probability distributions for the various model parameters and then running the model a large number of times (typically 10,000). Each model "run" selects from the distribution of each parameter to get a specific value for use in that particular iteration of the model. The resultant distribution of model results can provide valuable information about overall model variability and sensitivity to changes in parameter values. Given that all values included in the benefit-cost analysis are of course estimates, this can demonstrate the degree to which the predicted outcome is dependent on the specific values of these estimates. Another way of conceptualizing this is to think of this simulation as representing a simultaneous sensitivity analysis on multiple parameters within the model. The resultant output, for instance, could describe how the estimated net benefits of a water retention facility vary as the discount rate changes or as the frequency or severity of flooding varies.

The value of a Monte Carlo simulation, as opposed to a sensitivity analysis, is that provides significantly more information to policy makers. Should a project actually be implemented, the accuracy of prior estimates are likely to prove highly varied. Some assumptions will prove correct and some will prove incorrect, and some estimates will prove too high and some will prove too low. A Monte Carlo simulation treats each of these assumption and estimate as uncertain, and thus over the course of thousands of model iterations the simulation can develop a picture of policy outcomes as a function of this representative assortment of estimates. This facilitates three key informational benefits:

a. Relative importance of different sources of uncertainty

Just as in a sensitivity analysis, one can view the overall trend in net social benefits as the function of a particular parameter or other model input. This allows policy makers to determine how much importance should be placed on a particular aspect of the model. For instance, if the multi-purpose flood retention facility shows a similar likelihood of producing positive net benefits whether renewable energy credits are valued highly, at close to the predicted point estimate, or near zero, then policy makers can be less concerned about factoring in uncertainty over the continuation of this program, since the project would appear to be a "winner" in any case.

b. Variability in project outcomes

One can observe not only mean estimates of net benefits, but outcome variability as well. For example, one can observe whether net benefits are clustered closely to the mean value across all simulations (i.e., low variability), or whether there a widely divergent pattern of modeled outcomes. This is useful not only for looking at overall variability, but particularly for analyzing the risk-reward tradeoffs associated with the project. Outcome variance is not necessarily normally distributed. For instance, imagine a scenario in only 51% of simulated projects produced positive net benefits, but among the "losing" projects the mean net benefit estimate was -$100 million, while among the "winning" projects the mean net benefit estimate was $10 million. Presumably, policy makers would consider such a scenario differently than if faced with a policy showing the same percentage of winning projects but with winning projects now having a mean net benefit of $100 million and losing projects having a mean net benefit of -$10 million.

[13] See Caulkins (2002, 489-490) for an excellent (and succinct) discussion of concerning the use of Monte Carlo simulation for policy decision-making.

c. Treatment of high-consequence, low-probability events

Perhaps most importantly in the case of projects related to low-probability, high-consequence events such as severe flooding, a Monte Carlo simulation can be used to paint a more useful picture of potential outcomes given different states of the world. A Monte Carlo simulation allows us to move away from the expected value framework and develop an overall picture of how policy outcomes might vary given different temporal and severity patterns of flood events. For instance, simulation results can demonstrate how relatively dependent the net benefits of different projects are on the occurrence of high-magnitude events as opposed to smaller flood events.[14] Examining project outcomes under different potential world states (e.g., with or without a severe 500-year flood) provides a more comprehensive assessment of the policy decision. Modeling the protection benefits associated with flood events in this fashion can give policy makers a more realistic picture of potential project outcomes, and should be included in these analyses.

3. Intertemporal Valuation

A significant challenge in benefit-cost analysis is addressing the intertemporal distribution of project costs and benefits. Benefits and costs occurring in the future are discounted to present day value to reflect the opportunity cost of funds. While the practice of discounting is generally accepted (Boardman et al. 2010), a significant issue for modern BCA is that there is considerable theoretical disagreement in the published literature as to what the most appropriate rate of interest is (see Moore et al. 2004; Weitzman 2001) and great inconsistency in the application of discounting empirically (Hahn et al. 2000; Morrison 1998; Zerbe and Dively 1994).

The use of a discount rate in BCA is hugely important, because the choice of a particular rate can determine whether a project is estimated to have positive net benefits. Consider the temporal characteristics of any of the large infrastructure projects evaluated for flood mitigation in the Chehalis basin: The costs associated with building a flood retention facility, walling-off I-5, and raising levees are all borne up front, while flood protection benefits are evenly distributed throughout the life of the project. A higher discount rate, i.e. one that reflects a higher opportunity cost, will make these types of projects seem less efficient than will a lower rate, since the discounting effect on future benefit flows will be felt more severely than on near-term cost expenditures.

In evaluating the economic merits of various project alternatives, it is important to be very clear about what the discount rate represents, and what it does not. For instance, the Earth Economics ecosystem services valuation report defines the discount rate as reflecting the importance of future events and the likelihood of capital depreciation. In other words, the report states that if we place a greater value on long-term flood protection, than a lower discount rate is called for in the analysis. We find this to be inaccurate. For government projects the present value of future cash flows is not determined by the relative importance placed on near or long term effects, but rather the opportunity cost of funds. In other words, if a government project were to produce $1 million of benefits in ten years time at an up front cost of $500,000, then the project's selection would only be justified (on the ground of efficiency) if the government did not have an alternative investment that could engender a greater return over that same time period. This has nothing to do with the degree to which people value long-term flood protection relative to short-term flood protection.

It must be stated that there is nothing that precludes policy makers from favoring a long-term project with lower yearly benefits over a short-term project with higher yearly benefits. Economic efficiency is only one of many

[14] A simple means of modeling in this fashion is to simulate a real number from a uniform distribution of 0 to 1 for each project year and each flood level included in the model (e.g, 10-year, 50-year, 100-year, and 500-year floods). As an example, a ten-year flood is hypothesized to have a 10% chance of occurring each year. If the number generated in associated with a given year and the ten-year flood level was greater than .90, a flood (and thus flood prevention benefits) could be modeled to occur for that year.

goals held for public policy, and numerous values can –and should- enter into the project decision-making process. However, in assessing the temporal distribution of monetary benefits and costs to determine the economic efficiency of a project, there is no justifiable discount rate other than one that reflects the sponsoring party's opportunity cost of funds. With regard to selecting an appropriate discount rate, we again emphasize that public projects should be viewed as an investment in social welfare. Thus as a basic rule of thumb, every project selected on the basis of efficiency should at the very least engender a return on investment greater than could be achieved simply by investing in treasury bonds or a comparable asset (Burgess and Zerbe 2011).[15] Burgess and Zerbe (2011) find this rate of return to be between 6% and 8%.

Our primary recommendation, however, is that regardless of rate, the important aspect with regards to discounting in BCA is to be very explicit about the rate employed in an analysis and to discuss the rationale behind the selection of that rate. We find that this is not treated adequately in the BCAs reviewed. Moreover, BCAs should employ a sensitivity analysis of the discount rate, evaluating project outcomes using a low, median, and high interest rate. If the ranking of project alternatives remains stable across these rates, then the choice of a discount rate likely does not need to be a key point of consideration in the decision-making process. However, if choice of a discount rate does greatly affect the rank ordering of alternatives, this indicates that the various alternatives have very different temporal characteristics. In such cases, the choice of a discount rate matters greatly, and should be carefully vetted and justified within the analysis.

4. Developing an appropriate basis for comparison

A significant challenge in benefit-cost analysis is that benefits and costs must be defined relative to an appropriate null alternative. In other words, benefits and costs should be calculated in terms of the difference between what is likely to happen in the absence of a given policy and what is likely to happen should the policy be implemented (Zerbe et al. 2010). This issue would appear to be highly significant in the analysis of the various flood protection/mitigation projects, since the implementation of one project might eliminate the need for another. While we find no methodological issues with the way in which analysts have developed their basis for comparison, we find that a more detailed discussion about how this it is defined and analyzed within the BCA is greatly warranted. This is yet another issue in BCA where clarity and transparency are of utmost importance, since a clear discussion of the comparison being employed serves to evaluate the degree to which a BCA accurately reflects the nature of the policy decision (Karoly 2010).

Of specific concern in this regard is the treatment of project alternatives within analyses. For instance, the analysis of flood-retention facilities credits cost savings from no longer raising Interstate 5 as a benefit to the project. We support the technical approach EES Consulting has used to model this. However, it is not clear to us what the most appropriate basis for comparison is in this case, given that recent data indicates the dam would not be sufficient to prevent I-5 from flooding in an event comparable to the 2007 flooding (personal communication with WDOT).

Note that this would seem to be an area ofclarity is need, as EES's report states that WDOT has said that further I-5 flood protection would not be initiated so long as the flood retention facility prevented I-5 from flooding in a 100-year level event. Communication with WDOT indicates that a levee or roadbed raising project considered if I-5 will still flood during an event comparable to the flooding in 2007 (a 500-year event in some parts of the Chehalis Basin). Until such ambiguity can be resolved, models should present outcomes under each of these scenarios. As an example, we envision three scenarios for the flood retention facility: (1) Scenario 1, in which the flood retention facility is credited with I-5 flood prevention benefits in years 1-10 of the project and then

[15] It is important to stress that the criteria of efficiency is only one heuristic by which to make policy decisions, and so it would be incorrect to hold that all policies must adhere to such a rule. However, any decision-making process that intends to be based on a examination of benefits and costs (i.e., efficiency), as is the case for Chehalis flooding mitigation, should appropriately consider the social opportunity cost of funds.

credited with the cost savings of not raising I-5 in year 11 *and debited the flood prevention benefits forgone by the fact that the dam alone does not eliminate the risk of flooding in years 11-50*; (2) Scenario 2, in which the flood retention facility is simply credited with flood prevention benefits for all 50 years of the project; and (3) Scenario 3, in which both the flood retention facility and levees around I-5 are built, and the flood retention facility is credited with any cost savings associated with reducing the size/scope of the I-5 wall/levee system built.

V. Conclusion

In this document, we analyze the existing BCAs prepared concerning flood prevention or mitigation projects in the Chehalis Basin. We find that the existing analyses provide a sound basis for assessing the social benefits and costs associate with the suite of programmatic, structural, and non-structural policy measures currently being weighed by the Chehalis River Basin Flood Authority. As described, one of the primary strengths of the current portfolio of analyses is that it provides a conceptual basis for qualitatively evaluating the benefits of projects that have not been formally advertised. Even in the absence of further HAZUS model runs that examine the potential effects of other policy measures, policy makers can use the damages estimated in association with the flood retention facility and levee alternatives as a guide for thinking about what the returns to other projects might be as well.

We find that several issues insufficiently addressed by existing analyses, including the use of net benefits instead of benefit-cost ratios for the consideration of projects, the need for estimate ranges, sensitivity analyses, and probabilistic simulations for modeling the effects in such complex scenarios, clear discussion of project benefit and cost time frames, and the comparative basis on which benefits and costs are estimated. All of these concerns can be readily addressed with minimal effort and without additional analysis. For more guidance on these and other benefit-cost techniques, please refer the UW BCA Center's recent Benefit-Cost Analysis Principles and Standards Report (Zerbe et al. 2010); this report provides a definitive discussion of state-of-the-art BCA.

In conclusion, we would advocate that the Flood Authority use the existing body of benefit-cost data to inform the decision process, but not as a decision making device. BCA is most useful for crafting equitable, efficient policy when decision makers weigh BCA data alongside numerous other bodies of knowledge and policy concerns. Moreover, it is critical that policy makers pay careful attention not only to what is in a BCA, but also to what is not included in the analysis and what outcomes might result if the analysis does not prove wholly accurate. Lastly, it is crucial that policy makers consider that BCA does not need to be completely accurate or fully comprehensive in order to improve policy decision making. Thus, informational concerns should not prevent the Flood Authority from moving forward in addressing the pressing policy problem of flooding in the Chehalis Basin.

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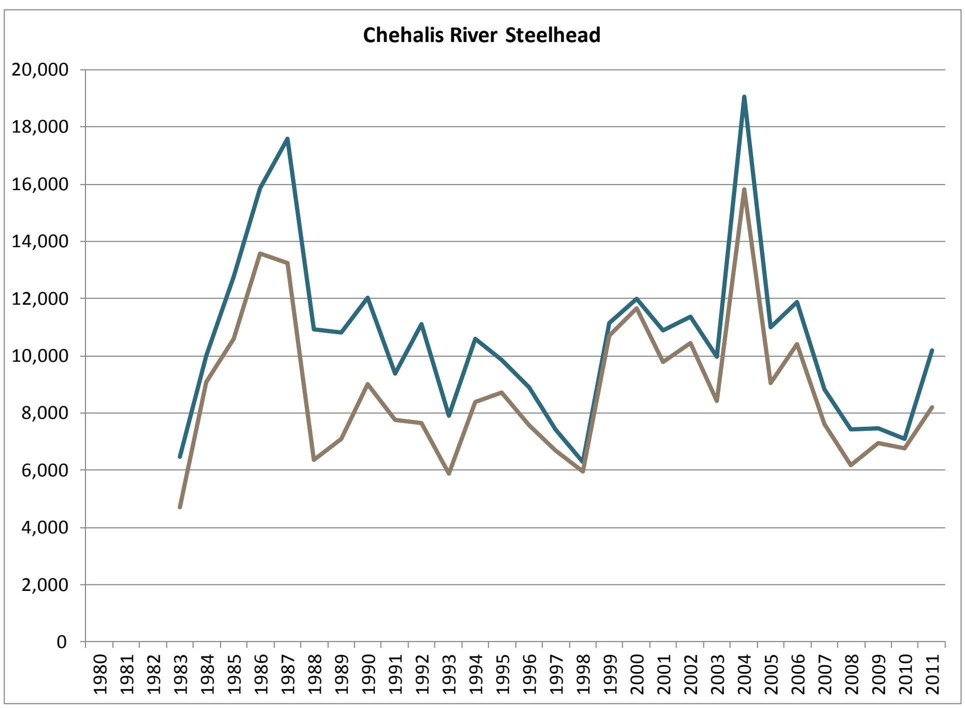
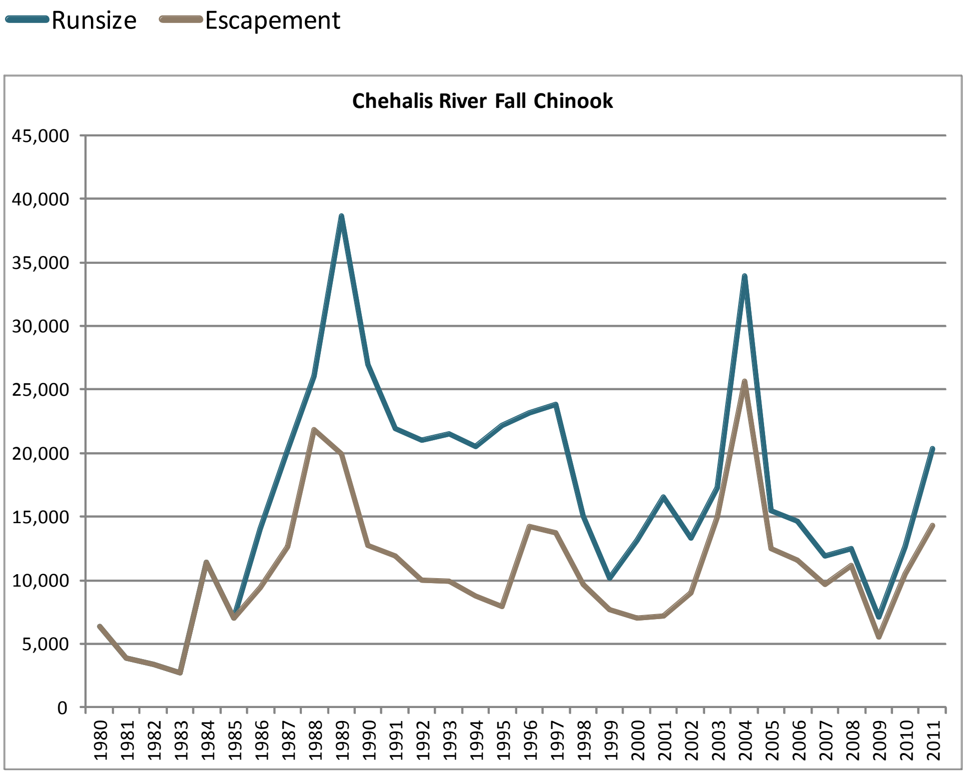
Appendix I: Chehalis River – Salmon Runsizes and Escapements

Appendix I: Chehalis River–Salmon Runsizes and Escapements

This appendix from the Washington Department of Fish and Wildlife (WDFW) provides annual runsizes and spawning escapement numbers for Chehalis River steelhead, fall Chinook, spring Chinook, chum, and coho salmon for the years 1980 - 2011. Annual fish harvest is calculated by determining the difference between the line representing runsize and the line representing escapement for each year.

Runsize Escapement




Runsize
Escapement
Chehalis River Fall Chinook
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
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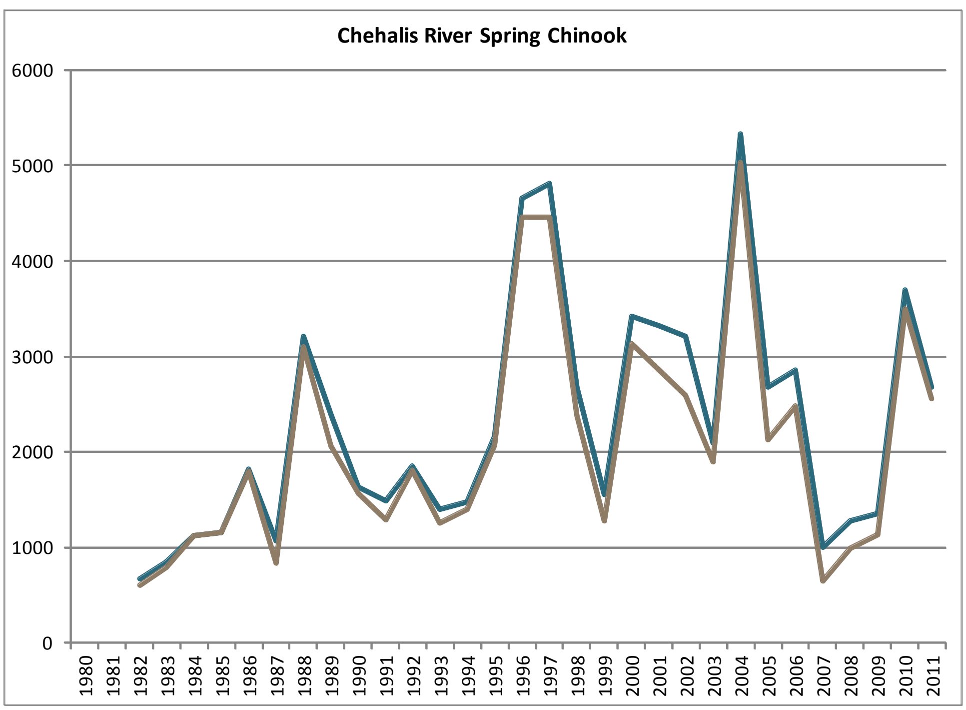
2007
2008
2009
2010
2011


Chehalis River Spring Chinook
6000
5000
4000
3000
2000
1000
0
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
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2008
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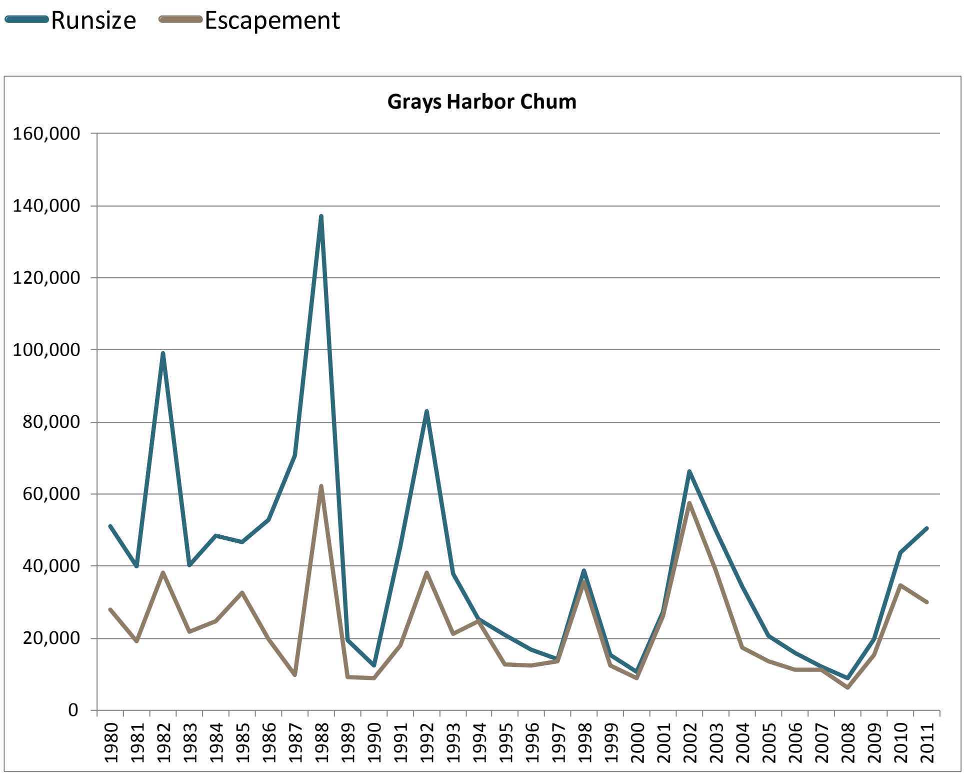
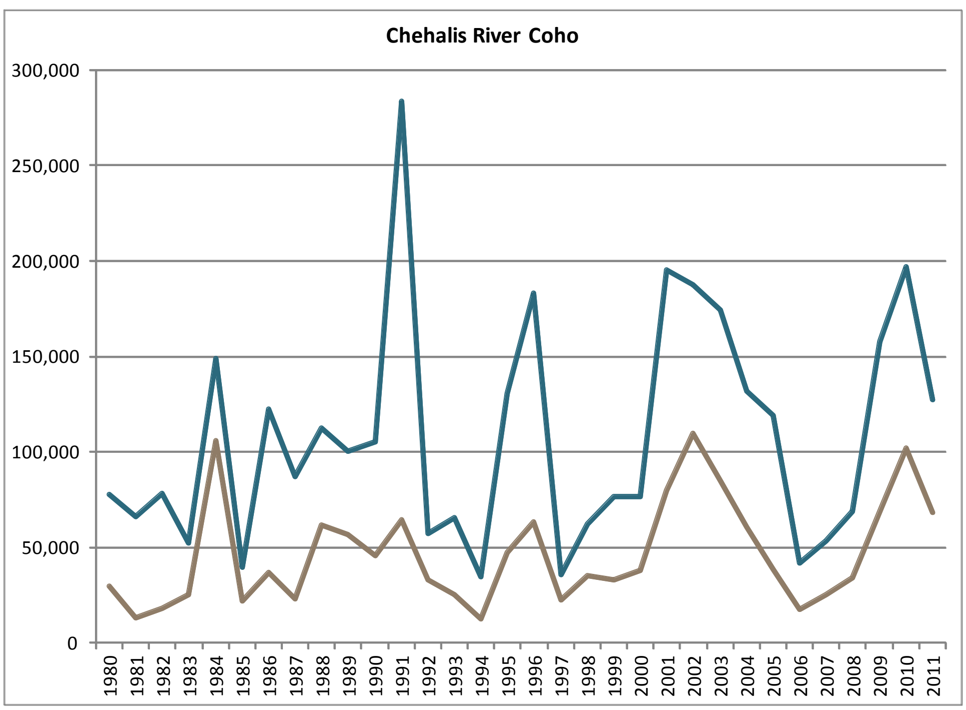
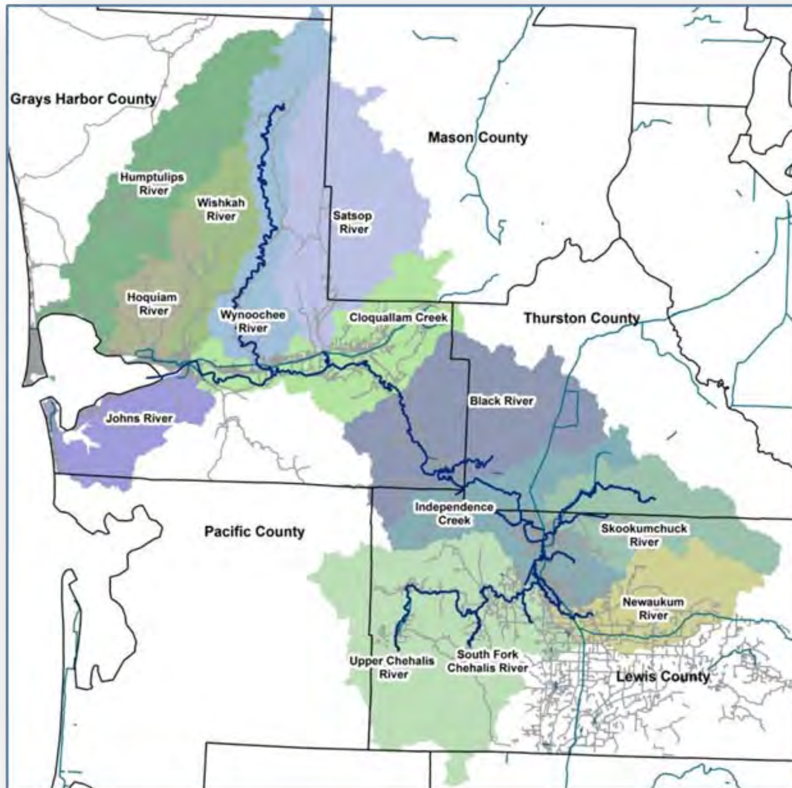
2010
2011


Runsize
Escapement
Grays Harbor Chum
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


Chehalis River Coho
300,000
250,000
200,000
150,000
100,000
50,000
0
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

Appendix J: Chehalis River Hydraulic Model Development

Draft Report - Chehalis River
Hydraulic Model Development Project



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WEST Consultants

Prepared for:
Chehalis River Basin Flood Authority

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Executive Summary

Numerous studies have been undertaken to evaluate flood damage reduction in the Chehalis River basin. These include work for the Federal Emergency Management Agency (FEMA), the US Army Corps of Engineers (Corps), Lewis County, and the Lewis County Public Utility District (PUD). Much of the effort has focused on the development of a hydraulic model for the mainstem of the Chehalis River and application of that model to simulate the "100-year flood". The studies have provided insight into floodplain management issues; however, work to date has focused primarily on the Chehalis River upstream of Grand Mound. The Chehalis River Basin Flood Authority (Flood Authority) recognized a need to extend the work downstream from Grand Mound to the mouth of the Chehalis River at Grays Harbor.

The Washington State Legislature concurred with the Flood Authority regarding the need to study the lower portions of the river. Through a budget proviso in Engrossed Substitute House Bill (ESHB) 2020 the Legislature provided funding to "complete the hydraulic model for the Chehalis River to calculate flood levels, flood damages, and benefits of proposed flood mitigation projects for the lower portions of the river."

The Flood Authority retained WATERSHED Science & Engineering (WSE) and subconsultants WEST Consultants, Pacific Geomatic Services and Minister & Glaeser Surveying to develop a hydraulic model and evaluate flood relief alternatives for the Chehalis River basin. While the primary objective of the Flood Authority project are to develop the hydraulic model, additional tasks identified over the course of the project have been completed to the extent possible considering funding and schedule constraints. These include collection of field survey data, workshops and education regarding basin flood issues, and evaluation and reporting on a wide range of flood relief alternatives.

The hydraulic model developed for this study extends from the mouth of the Chehalis River to upstream of Pe Ell, a distance of more than 108 miles. The model also includes significant portions of key tributaries including the following: Wynoochee River (54 miles), Satsop River (2 miles), Black River (10 miles), Lincoln Creek (4 miles), Skookumchuck River (21 miles), Hanford Creek (6 miles), Salzer Creek (5 miles), Newaukum River (10 miles), Dillenbaugh Creek (3.5 miles), and South Fork Chehalis (5.8 miles). While the model was developed primarily to evaluate the effects on the main stem Chehalis River of large-scale flood relief projects it can also serve as a tool for the evaluation of hydraulic conditions and flooding on these tributaries. In fact, the model has already been used by WSE to evaluate the effects of potential modifications to the railroad bridge downstream of Bucoda on the Skookumchuck River.

The hydraulic model developed for this study was used to evaluate 15 individual flood relief projects, and the results of those evaluations were reported to the Flood Authority and stakeholders at meetings in April and May 2012. Based on feedback from the Flood Authority the projects were grouped into combinations and additional modeling was conducted. The additional modeling was presented to a broader group of basin stakeholders at meetings in Lacey in May 2012 and in Grand Mound in June 2012. After receiving feedback at those meetings three additional combinations were formulated and evaluated. In total more than 25 potential flood relief projects or combinations of projects were evaluated with the results reported herein. The results have also been provided to the State Office of Financial Management and the Flood Authority for use in defining an appropriate path forward for basin wide flood relief.

The baseline hydraulic model developed for this project represents the best available information on hydraulic conditions in the modeled reaches. However, it must be recognized that the model includes both newly modeled reaches (e.g. Chehalis River between Porter and Aberdeen) and reaches based on older models. Some of the older model reaches were updated with newly collected cross section surveys, while others use cross sections collected as long ago as 2001. Similarly, in some portions of the model floodplain topographic data were updated to reflect new LiDAR data while in other reaches the topographic data dates back to 2002. While it would have been preferable to update the entire model with new field surveyed cross sections and up to date topographic data the model is still a significant improvement over any tool that has been previously available and it should benefit flood relief investigations throughout the basin. As time and resources allow it is recommended that the model be updated to use new topographic and survey data, that the updated model be refined to address any new infrastructure that has been built since the original model development, and that the updated model be calibrated to available flood information.

Chehalis Basin Hydraulic Model Report

Background

Over the past 15 years numerous studies have been undertaken to evaluate flood damage reduction in the Chehalis River basin. These projects include work for the Federal Emergency Management Agency (FEMA), the US Army Corps of Engineers (Corps), Lewis County, the Lewis County Prosecuting Attorney's Office, and the Lewis County Public Utility District (PUD). Much of this recent work has focused on the development of a hydraulic model for the mainstem of the Chehalis River between Doty and Grand Mound and application of that model to simulate the "100-year flood". Work for Lewis County and the PUD focused on application of the FEMA model to evaluate the potential benefits or impacts of various proposed flood damage reduction projects including upstream water storage. Work by the Corps has focused on evaluation of new and heightened levees along the Chehalis River near the cities of Chehalis and Centralia and flood storage at Skookumchuck dam.

The previous studies have provided insight into issues related to floodplain management in the upper basin; however, work to date has focused primarily on the Chehalis River upstream of Grand Mound. The Chehalis River Basin Flood Authority (Flood Authority) recognized the need to extend the hydrologic and hydraulic modeling downstream from Grand Mound to the mouth of the Chehalis River at Grays Harbor and to use the extended model to evaluate the potential impact of upstream flood damage reduction projects on downstream flooding.

The Washington State Legislature concurred with the Flood Authority regarding the need to study the lower portions of the river. Through a budget proviso in Engrossed Substitute House Bill (ESHB) 2020 the Legislature provided funding to "complete the hydraulic model for the Chehalis River to calculate flood levels, flood damages, and benefits of proposed flood mitigation projects for the lower portions of the river." The Office of Financial Management also showed support for this study in an agreement signed with the Flood Authority in early August 2011.

Concurrent with the efforts of the Flood Authority, the U.S. Army Corps of Engineers (Corps) identified a need for additional hydraulic modeling to support "ecosystem restoration" planning in this same area, and procured funding to support this through the Corps' Basinwide General Investigation process. Considering the need for hydraulic modeling to support both ecosystem restoration and flood risk reduction, and a desire to make the best use of available resources, the Flood Authority retained WATERSHED Science & Engineering (WSE) and WEST Consultants (WEST) to work with the Corps, WSDOT, and other basin stakeholders to develop a basinwide hydraulic model and conduct analyses of potential flood damage reduction projects. This report documents model development and application efforts by the WSE team.

Engrossed Substitute House Bill 2020

As noted above, the current study effort is funded through a budget proviso in ESHB 2020. The specific sections of the bill that are relevant to the work of the Flood Authority are found in Section 1033 starting on Page 19 and read as follows:

Catastrophic Flood Relief (20084850)

(1) The appropriations in this section are subject to the following conditions and limitations:

(a) $1,320,000 of the appropriations are provided solely for the Chehalis basin flood control authority or other local flood districts

(i) to study, develop, construct, maintain, operate, and fund flood control measures throughout the basin,

(ii) to complete by December25 2011 the ongoing study of the effect of possible retention structures on fish in the basin, and

(iii) to complete the hydraulic model for the Chehalis river to calculate flood levels, flood damages, and benefits of proposed flood mitigation projects for the lower portions of the river; and

(b) $1,200,000 of the appropriations are provided solely for nonfederal matching funds and state agency costs associated with the United States army corps of engineers flood hazard mitigation projects for the Chehalis river basin. p. 19 ESHB 2020.SL

(2) By July 2012, the office of financial management, in collaboration with the department of transportation and the department of ecology, and affected and interested federal agencies, tribal governments and local governments, must provide a report to the governor and legislature that identifies recommended priority flood hazard mitigation projects in the Chehalis river basin for continued feasibility and design work. The report must:

(a) Address the potential for flood mitigation through upstream water retention facilities, including benefits and impacts to fish and potential mitigation of impacts;

(b) Describe the current alignment and design of the federal flood levees proposed at Centralia and Chehalis, including extent of protection provided to these communities, and any upstream or downstream effects of the levees;

(c) Evaluate alternative projects that could protect the interstate highway and the municipal airport at Centralia and Chehalis, and ensure access to medical and other critical community facilities during flood events;

(d) Discuss other alternatives that could provide flood relief and protection in the basin, such as replacement of highway bridges that constrain flood waters, flood easements on agricultural lands, livestock evacuation facilities and routes, small-scale water diversion and retention, use of riparian habitat and environmental restoration projects to mitigate damages from flood waters, and other projects or programs;

(e) Summarize the benefits and costs of recommended projects, using available information and accepted benefit/cost methods; and

(f) Identify the responsible parties and procedures for making final decisions on funding, construction and governance of recommended flood projects, any related and necessary government agreements, and a schedule for these decisions.

(3) It is the intent of the legislature to fulfill the commitment of section 101, chapter 179, Laws of 2008 and chapter 180, Laws of 2008, by appropriating funds when the federal match requirement is needed.

Flood Authority Contracting

Given the need to develop hydrologic and hydraulic modeling to evaluate ecosystem restoration and flood risk reduction projects the Flood Authority issued a request for qualifications on July 25, 2011. Four responses were received by the August 8, 2011 deadline. Flood Authority staff then worked with technical staff from state, federal, and local agencies to develop screening criteria and review and score the responses. After consultation with the technical team, the Flood Authority's Executive Committee selected three firms to interview and ultimately asked two firms (WATERSHED Science & Engineering and WEST Consultants) to collaborate to complete this project. WSE and WEST revised their proposals into a joint effort with WSE as the prime and overall technical lead and WEST as their key subconsultant. This collaboration provided the Flood Authority with the technical and management expertise they wanted and addressed the Flood Authority's desire to leverage available resources, as WEST was already under contract to the Corps of Engineers to develop modeling for portions of the basin as part of the General Investigation.

The Executive Committee approved the WSE contract and recommended to the Lewis County Board of County Commissioners (BOCC) (as the lead agency for the Flood Authority) that this contract be adopted. On September 6th the BOCC entered into a contract with WATERSHED Science & Engineering (WSE) and subconsultants WEST Consultants (WEST), Pacific Geomatic Services (PGS) and Minister Glaeser Surveying (MGS) to develop a hydraulic model and evaluate flood relief alternatives for the Chehalis River basin. While the primary objective of the Flood Authority's project was to develop a hydraulic model, other, secondary objectives identified over the course of the project have been addressed to the extent possible considering funding and schedule constraints.

Scope of Work

The Scope of Work for the hydraulic model development project was finalized in October 2011. The scope was prepared by WSE in coordination with the Flood Authority to define the tasks necessary to address the ESHB 2020. The scope was amended in January 2012 to include hydraulic modeling and analysis of key tributaries. Key tasks in the final scope are summarized below:

Task 1 - Overall Project Management, Stakeholder Involvement, Regular Communication with Flood Authority
WSE is responsible to the Flood Authority for the overall management of the model development project including administering the contract and providing monthly invoicing and progress reports. This task also includes presentations at key milestones and as necessary to keep the Flood Authority fully informed about the status of the work.

Task 2 - Initial Basin Reconnaissance
The project team conducted targeted field reconnaissance of the basin, contacted key stakeholder groups, coordinated with the State technical team, and gathered information (including topographic and survey data).

Task 3 - Conduct Adequacy Review of Existing Floodplain Topographic and LiDAR Data
This task was deferred. No work was conducted under this task.

Task 4 - Detailed Work Plan Development

A detailed Work Plan was developed to guide the Chehalis River hydraulic model development project. The Work Plan included schedule milestones, scope information and estimated costs for each task. The draft Work Plan was distributed by the Flood Authority to interested agencies and Tribes for review and comment.

Task 5 - Refine Hydraulic Model to reflect Flood Authority Interest

WEST Consultants is currently under contract to the Corps to develop a hydraulic model of the Chehalis River (Pe Ell to Montesano with the exception of Grand Mound to Porter) under the Basin-wide General Investigation (GI). The Corps project includes collection of bathymetric survey data for model cross sections in several reaches and the development of hydrologic data for the basin. Based on stakeholder input, the Flood Authority tasked the WSE project team with modifying, enhancing, or refining the Corps hydrologic and hydraulic modeling. The following sub-tasks were completed:

Task 5a - Obtain new channel survey data for the Chehalis River between Grand Mound (RM 60.6) and Porter (RM 33) - The Twin Cities hydraulic model includes cross sections in this reach but the exact location of those cross sections was not known. A portion of the reach, from RM 41 to Grand Mound, was surveyed by Minister Glaeser in 2001 for the Corps but that survey data is now more than 10 years old and not likely to be representative of current channel conditions. Given these considerations and knowing that a reliable model of this reach is critical for meeting ESHB 2020 requirements, additional survey data collection to support model development for this reach (Task 5b) was needed.

Task 5b - Refine model of Chehalis River between Lewis/Thurston County line and Porter - This reach was included in the earlier Twin Cities hydraulic model. The Corps GI study contract did not call for additional model refinement, however, considering the date of the cross section and topographic information in the model the accuracy and reliability of the simulations in this reach is a concern. This task included developing a new hydraulic model using the new cross section data described in Task 5a and the 2002 PSLC LiDAR data and then validating the model against available observations.

Task 5c - Extend Corps Hydraulic Model downstream from Montesano to Aberdeen - the GI Study contract included development of a hydraulic model for the Chehalis River upstream of the confluence with the Wynoochee River at Montesano. The Chehalis River reach downstream of the Wynoochee River is significantly tidally influenced and more hydraulically complex due to significant side channels and backwater channels in the floodplain. Under this task the HEC-RAS model was extended to Aberdeen including collecting additional channel and overbank survey data. Model development for this reach also required additional hydrologic analysis to provide data for hydraulic model calibration and validation.

Task 5d - Refine hydraulic model of main stem Chehalis River - as noted previously WEST is concurrently working with the Corps to develop a hydraulic model of the mainstem Chehalis River from Montesano to Pe Ell. However, that model was not sufficiently detailed in some locations to meet the needs of the Flood Authority and stakeholders. The Corps model (including the Twin Cities portion of the model) was updated under this task to facilitate Flood Authority investigations.

Task 6 - Extend Hydraulic Modeling (Including Survey, Hydrology and Hydraulics)
The work currently being done by the Corps has been leveraged extensively to meet the Flood Authority's needs for hydraulic modeling in the lower Chehalis River. However, the following sub-tasks were included in the detailed work plan to address specific considerations in the model development:

Task 6a - Expand or refine Corps hydrology analysis – The Corps hydrologic data for the basin were refined and additional hydrologic data were developed as needed to address the needs of the Flood Authority and stakeholders.

Task 6b - Refine/revise/extend hydraulic modeling of tributaries - as noted previously the Twin Cities hydraulic model included several tributaries, but these were not always sufficiently modeled to meet the needs of the Flood Authority. Additional modeling efforts were undertaken on the Satsop River, Black River, Skookumchuck River, and Newaukum River.

Task 6c - Review and refine Twin Cities model – Cross sections orientations in the Twin Cities portion of the Chehalis River model were reviewed and modified where appropriate. Storage area connections and other model assumptions were also evaluated and modified as necessary to improve model calibration.

Task 6d - Re-cut cross sections using "best available" LiDAR – After modifying the orientation of some cross sections in the Twin Cities model the cross sections were re-cut using the best available LiDAR data described above.

Task 7 - QA/QC Technical Review of WEST Consultants Hydrologic and Hydraulic Modeling
WEST Consultants developed hydrologic and hydraulic data for the Chehalis River basin under contract with the Corps. These baseline analyses were subject to independent technical review by WSE to ensure they adequately meet the needs and objectives of the Flood Authority as defined in the work plan.

Task 8 - Technical Evaluation, Reporting of Flood Relief Alternatives to Flood Authority
A range of possible flood damage reduction projects are under consideration in the basin. These include (1) upstream storage projects on the Upper Chehalis, South Fork Chehalis and Skookumchuck Dams, (2) USACE proposed levee modifications and (3) combinations of storage and levee projects. The following tasks were completed:

Task 8a - Under this sub-task, the proposed upstream retention facility on the main stem Chehalis River above Pe Ell was modeled and evaluated.

Task 8b - Under this sub-task, dozens of other flood relief alternatives in the watershed were modeled and evaluated.

Task 9 - Provide QA/QC Technical Review of WSE Flood Relief Alternatives Analysis
The flood relief alternatives analyses described in Task 8 were subject to independent technical review to ensure the needs and objectives of the Flood Authority were met.

Task 10 - Milestone Meetings / Conference Calls with Flood Authority
The project team coordinated presentations, communications, and information transfer to the Flood Authority at key milestones in the project to ensure that Flood Authority members were kept fully informed.

Task 11 - Comprehensive Project Report

This report has been prepared to document the findings of the hydraulic model investigations.

Other Hydraulic Modeling and Analysis Efforts

Federal, State, and local efforts are currently underway in the Chehalis River Basin to reduce flood damages and restore the ecosystem. The Federal Emergency Management Agency (FEMA) recently prepared a revised Flood Insurance Study (FIS) for Lewis County including the Chehalis River, Hanaford Creek, Lincoln Creek, Salzer Creek, Skookumchuck River, South Fork Chehalis River, and Stearns Creek (FEMA, 2011). The FIS hydraulic model was based on a previously developed UNET model of the Chehalis River and tributaries, which was converted to a HEC-RAS model. The final FIS HEC-RAS model consisted of approximately 150 river miles and 700 river cross-sections. While the model extended downstream to the town of Porter in Grays Harbor County, the portion of the model that was geo-referenced and calibrated ended at Grand Mound.

The Corps is currently conducting a Basinwide General Investigation (GI) including the development of hydrologic and hydraulic modeling for portions of the basin (USACE, 2012). The GI models will be used to establish baseline conditions to evaluate potential aquatic ecosystem restoration measures. Concurrent with the GI effort the Corps and its local partner, Washington State, are reevaluating the authorized Twin Cities flood damage reduction project, which proposed the construction of levees to protect parts of Centralia, Chehalis, and I-5, as well as modifications to Skookumchuck Dam (USACE, 2012). In addition to that effort, WSDOT is evaluating a range of options for protecting I-5 from flooding (WSDOT, 2012).

Relationship of current project to concurrent efforts by USACE and WSDOT

WEST is working under contract to the Corps to develop the baseline hydrologic and hydraulic modeling for the Chehalis River basin (GI Study). That work includes hydraulic modeling for the Chehalis River between Montesano and Porter and between Doty and Pe Ell as well as the lower 51 miles of the Wynoochee River. The Corps project to model the lower Chehalis River between Montesano and Porter is of particular relevance to the Flood Authority. When combined with the FEMA Twin Cities hydraulic model (Porter to Doty) and the Flood Authority model being developed by WSE (Montesano to Aberdeen) the result is a comprehensive hydraulic model extending from Aberdeen upstream as far as the proposed retention facility site on the main stem Chehalis River near Pe Ell, a distance of 108 river miles (plus tributaries).

Basin Characteristics and Flood Issues

Basin Characteristics

The Chehalis River basin is located in southwest Washington, encompassing a drainage area of approximately 2,100 square miles (See Figure 1). The river rises in the Willapa Hills and runs generally east, then north, and then west to its mouth at Grays Harbor. Elevations range from over 3,000 feet in the headwaters to 150 - 200 feet in the Twin Cities area to sea level at the mouth. Major tributaries to the Chehalis River include the South Fork Chehalis, Newaukum, Skookumchuck, Black, Satsop, and Wynoochee Rivers. Communities along the Chehalis River include Doty, Pe Ell, Chehalis, Centralia, Oakville, Montesano, and Aberdeen. Mean annual precipitation in the upper watershed ranges from 45 near Chehalis to more than 120 inches per year in the Willapa Hills upstream of Pe Ell.

Figure 2 and Figure 3 show the schematic of the stream network in the Upper and Lower Chehalis River basins, respectively. The upper portions of tributaries such as the South Fork Chehalis River, the Newaukum River, the

Skookumchuck River, the Satsop River and the Wynoochee River are located in steep, mountainous terrain, with steep channel slopes and very narrow floodplains. The lower portions of these tributaries, as well as most of the smaller tributaries that join the Chehalis River lower in the basin are characterized by lower gradient, meandering channels with broad floodplains. These lower reaches offer significant temporary flood storage.

Flood Characteristics

Floods in the Chehalis River Basin typically occur in the November to February time frame. They are driven for the most part by atmospheric river (aka "Pineapple Express") weather systems, which tap moisture from the tropics and funnel it to locations in western Washington, resulting in heavy precipitation. Significant flood events have occurred frequently in the Chehalis River basin. The annual peak flow record at the Chehalis River gage near Doty indicates that, in the last forty years alone, significant floods (greater than 20,000 cfs) occurred in January 1972, January 1990, November 1990, February 1996, December 2007, and January 2009. The gage on the Chehalis River near Grand Mound shows that the five largest peak flows in the past 85 years, all of which exceeded 50,000 cfs, have occurred since 1986 (December 2007, February 1996, January 1990, November 1986, January 2009). Significant widespread flooding and damage was associated with each of these events.

For the purposes of the current project only extreme, basin wide, floods were evaluated. These are large throughout the basin, have high flows on the mainstem Chehalis River (as measured at Grand Mound), and have a range in contributions from the major tributaries. The basin wide floods evaluated for this study were not selected to capture individual tributary design flood events, extreme high tide events, or anomalous conditions (e.g. dam break flood, etc). The modeled floods include the historical events of February 1996, December 2007, and January 2009, as well as a hypothetical basin wide flood event, developed by WEST for the Corps GI study. The characteristics of each of these events are described below:

February 1996 Event – This was a large frontal storm with very broad rainfall distribution throughout the Chehalis River basin and beyond (from north of Seattle to southern Oregon). The 24-hour rainfall totals throughout the basin generally ranged from 10+ year to 100+ year recurrence. It was extremely cold in the month prior to the storm and there may have been some snow accumulations in mid elevations. The resulting flood was the second largest in the historic record at many basin streamflow gages including Grand Mound (82 year record), Porter (63 year record), and Doty (71 year record) and the 4th largest in the historic record on the South Fork Chehalis (71 years aggregate record). It is still the largest flood in the observed record on the Skookumchuck River (71 years aggregate record) and Newaukum River (71 year record).

December 2007 Event – This event was a classic atmospheric river (pineapple express) type event with a fairly narrow path of extreme rainfall. The highest rainfall center was concentrated in the Willapa Hills in the Upper Chehalis River Basin (main stem and South Fork). Unlike 1996, the December 2007 storm was focused in the Chehalis Basin and parts of the Olympic mountain range, and was much smaller south of the Chehalis Basin. Additionally, there was not much low level snow immediately prior to the event. The 2007 storm set records for 24-hour precipitation in the upper basin, although the heaviest precipitation was actually limited to about 12 hours or less at many locations. The resulting flood was the largest in the historic record at Grand Mound (82 years), Porter (63 years), Doty (71 years), and the South Fork Chehalis (71 years aggregate record). It was the third largest storm in the 71 year record on the Newaukum River. On the Skookumchuck, however, it was only the 55th largest storm in the 71 years aggregate record due in part to less rainfall seen in that portion of the basin and in part due to incidental storage at Skookumchuck Dam. The peak discharge on the Chehalis River at

Doty (USGS estimate 63,100 cfs) was more than double the next highest flood in the 72 year record (28,900 cfs in 1996) and was approximately 67% greater than the current estimate of the 100-year flood. In contrast, at Grand Mound the USGS estimated flow was only about 6% higher than the next highest event (1996).

January 2009 Event – This event was focused primarily in the eastern and northern portions of the Chehalis River Basin although significant rain still fell in the upper watershed. Flooding, or near flooding, of Interstate 5 was caused by high flows on the Newaukum system which peaked well in advance (12 hours or more) of the arrival of the peak Chehalis River flow from the upper basin. The January 2009 event also caused very high flows in many lower basin tributaries (Satsop, Black…etc.). The resulting flood was the 5th largest in the 82 year historic record at Grand Mound and the 7th largest in 71 years at Doty. The January 2009 event was the second largest observed flood on the South Fork Chehalis (after 2007) and Newaukum Rivers (after 1996) and the third largest on the Skookumchuck (after 1996 and 1953). At Porter on the Chehalis River, the 2009 flood was the 3rd largest in the 63 year record reflecting large contributions from lower basin tributaries. The January 2009 event was the third largest event in the historic record on the Wynoochee (in 39 years since the construction of the dam) and the 5th largest event on the Satsop (in 82 years). Considering the flow at Porter and on the lower basin tributaries the January 2009 event is estimated to be the second largest event in the historic record downstream of Montesano.

100-year Design Event – The 100-year design event developed by WEST is described fully in the Corps GI Report (USACE, 2012). On the recent floods in the basin, the design event is most similar to February 1996 with broadly distributed extreme precipitation. The analysis targeted matching the 100-year discharge at Grand Mound and then distributed tributary inflows based on statistical analyses of observed flows on the tributaries versus mainstem flows (with regard to both magnitude and timing of flows). The design event sought to match both instantaneous peaks and longer durations (from 1 to 15 days).

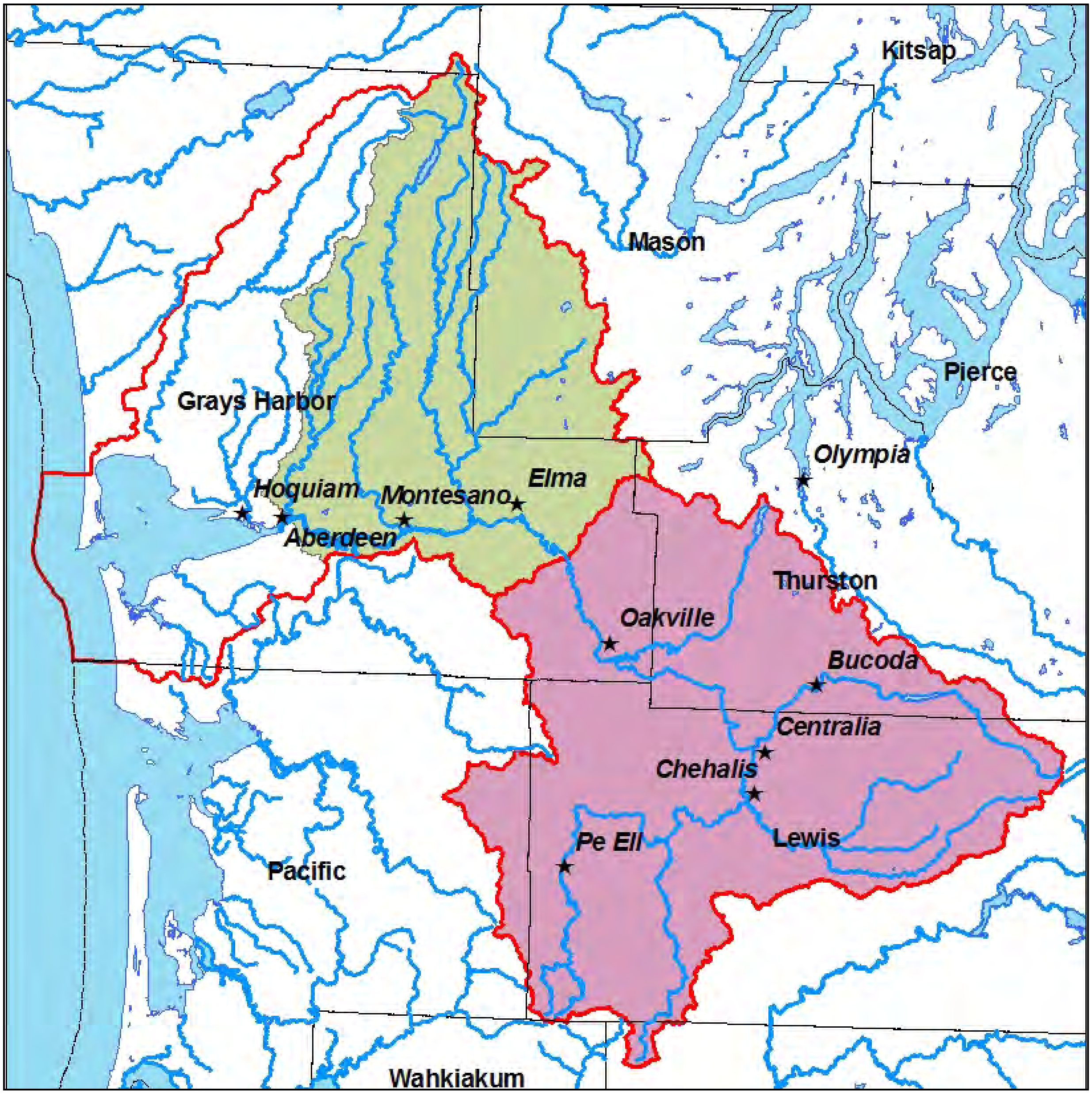

Figure 1. Study Area within the Watershed Boundaries of WRIAs 22 and 23

Figure 2. Upper Chehalis River Basin (WRIA 23)

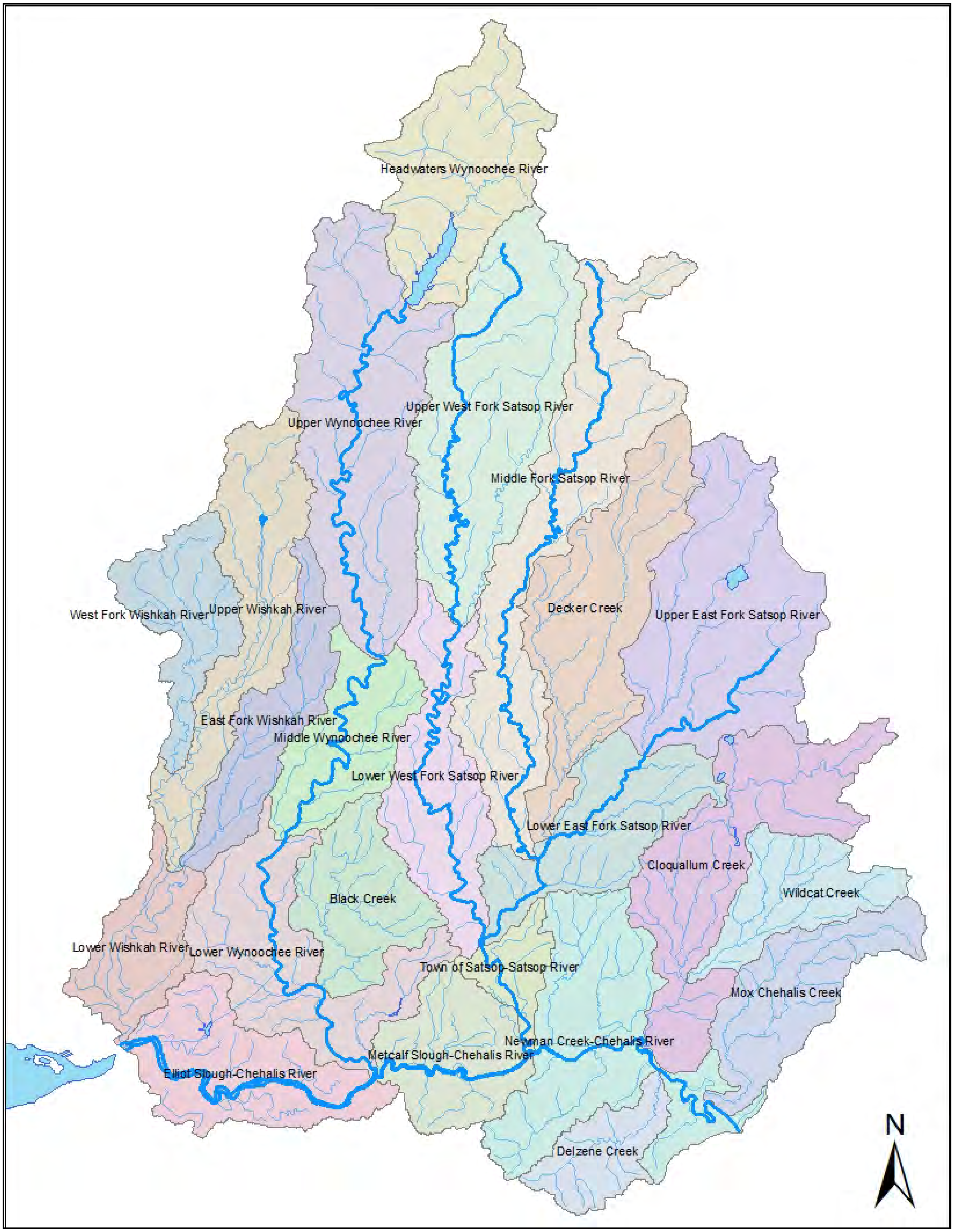

Figure 3. Lower Chehalis River Basin (WRIA 22)

Model Development

Basic Data and Information

Existing Hydraulic Models

As described previously, numerous hydraulic studies have been completed in the Chehalis River basin. Many of these have developed and applied hydraulic models to analyze rivers and streams within the basin. These models, and data used in their development, have been incorporated into the current modeling effort wherever feasible.

The original Chehalis River Basin Flood Insurance Study (FIS) completed for FEMA (c. 1982) included steady state hydraulic modeling (HEC-2) of portions of the Chehalis River, Black River, Newaukum River, Hanaford Creek, and South Fork Chehalis River. That effort was superseded by a study conducted by Pacific International Engineering (PIE) for the Corps in 2001. The PIE work included development of a UNET unsteady state hydraulic model including the main stem Chehalis River between Porter and Doty plus portions of significant tributaries including the Black River, Lincoln Creek, Skookumchuck River, Hanaford Creek, Salzer Creek, Newaukum River, Dillenbaugh Creek, Stearns Creek, and the South Fork Chehalis River. That model was used in the Corps 2003 General Reevaluation Report (GRR) study of the Chehalis River basin.

FEMA recently completed a revised Flood Insurance Study for Lewis County including the Chehalis River, Hanaford Creek, Lincoln Creek, Salzer Creek, Skookumchuck River, South Fork Chehalis River, and Sterns Creek (FEMA, 2011). For the hydraulic modeling, the previously developed UNET model of the Chehalis River and tributaries used in the USACE 2003 GRR study was converted to a model using the USACE Hydrologic Engineering Center (HEC)'s River Analysis System (HEC-RAS) software (HEC, 2010). The complete HEC-RAS model used in the study consists of approximately 150 river miles and 700 river cross-sections, and extends to Porter in Grays Harbor County.

The current modeling effort for the Flood Authority began with the existing FEMA Twin Cities Model as its basis. The model was extended both upstream and downstream and up some of the tributaries as described below. New cross sections were surveyed for portions of the model and topographic data were replaced with more recent data wherever possible. Model branches for the Satsop and Wynoochee Rivers were also added as follows:

The Corps previously developed a HEC-RAS model of the lower Satsop River, from its mouth to Highway 12 (approximately 2 miles) in 2004 as part of a gravel pit restoration project (WEST, 2004). Cross section data used in that model were based upon 2002 channel survey and 2002 LiDAR. That Satsop River model was incorporated into the Flood Authority Model as a branch, although it is recognized that the channel cross sections in that model have changed considerably since 2002.

WEST, under contract to the Corps of Engineers, recently completed a hydraulic model of the Wynoochee River (USACE, 2012). That model extends 51 miles upstream from the confluence with the Chehalis River near Montesano, to the Wynoochee Dam based on 2009 survey and LiDAR. The Wynoochee River model was incorporated into the Flood Authority model as a branch.

Topographic Data

Topographic data from various sources were used in the development of the Chehalis River hydraulic model. Digital elevation models (DEMs) were used to provide information on the overbank geometry, to evaluate hydraulic connections in the model, and to analyze the areas and depths of inundation under the different flood scenarios. The topographic data sets are primarily based on LiDAR flown within the last 10 years, with the exception of USACE contours, which come from aerial photogrammetric survey completed in 1999. Because the topographic data were collected at different times, and for different purposes, there are many areas where two or more DEMs overlap. In such cases, the most recent DEM was used for the hydraulic modeling and analysis. The following list details topographic datasets used in this study (See Figure 4):

<u>South West Washington 2009</u> – A one meter resolution LiDAR grid flown for FEMA and the Oregon LiDAR Consortium in 2009, which covers the Wynoochee River Basin and the lower 13 miles of the Chehalis River Floodplain. Data was accessed through the Puget Sound LiDAR Consortium website.

<u>Centralia 2006</u> – LiDAR coverage of City of Centralia flown in 2006 including the lower portions of Hanaford, Salzer and Lincoln Creek, and the Skookumchuck River. Additionally covers the Chehalis River from River mile 67.86 to 61.05 and the Skookumchuck Overflow Reach.

<u>Lewis County 2005-2006</u> – LiDAR coverage from 2005 and 2006 including the upper portions of the Newaukum, South Fork Chehalis, and Chehalis River, as well as the upper portions of Lincoln, Salzer, Newaukum, Dillenbaugh, and Sterns Creek. Data provided by Lewis County.

<u>PSLC 2002</u> – LiDAR coverage for the Puget Sound Lowlands from 2002, accessed from Puget Sound LiDAR Consortium website, covers a large portion of south west Thurston County including the upper 15 miles of the Skookumchuck River, and extends down the Lower Chehalis River from mile 61 to its mouth.

<u>USACE 1999</u> – Topographic survey collected by the USACE in 1999 covers portions of the Chehalis and Newaukum River, and Dillenbaugh Creek near Centralia and Chehalis, and the upper Chehalis River between river mile 95 and 104.

NOAA Bathymetric data is available for Grays Harbor and portions of the Lower Chehalis River, although the date these were collected and the accuracy specification of the data are unknown. These data were used for in-channel portions of the three most downstream cross sections of the Lower Chehalis River, which extend into Grays Harbor.

Several new LiDAR data sets are currently in development. LiDAR for the main Chehalis river valley upstream of Montesano to Grand Mound and in various parts of Lewis County are being developed through a joint effort between FEMA and Lewis County. The LiDAR flights were completed in January and February 2012 but data are not available for use in the Flood Authority project. It is anticipated that these data will become available in summer 2012. New LIDAR for Thurston County was also collected in June and July 2011 but the post processed, quality controlled data did not become available until June 2012. These new LiDAR data sets are expected to provide much better resolution in areas of the basin, especially in regions that are currently only covered by the 1999 Corps photogrammetry or the PSLC 2002 LiDAR data. The new data will reflect channel and floodplain changes that have occurred since the previous data collection efforts and provide a good representation of current topographic conditions. This is particularly important for the Satsop River channel, which is very dynamic, and for potions of the Chehalis River between Grand Mound and Montesano.

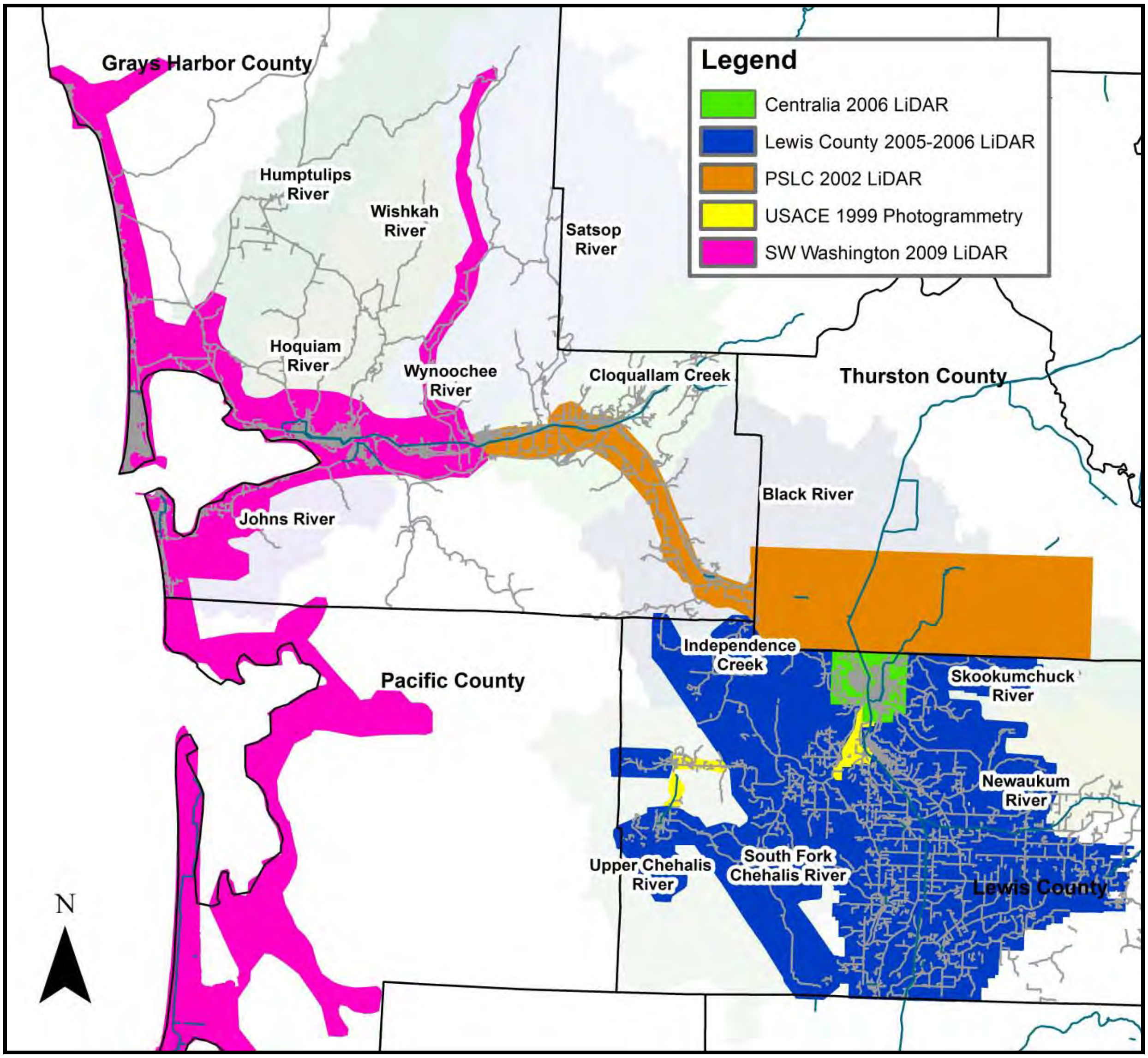

Figure 4. Chehalis Topographic Coverage Boundaries over WRIA 22 and 23

New Cross Section Surveys

New cross section surveys were collected to support the upstream and downstream extensions of the model and to provide current bathymetric data in areas that were previously modeled. Pacific Geomatic Services (PGS) collected forty five (45) cross sections within the Chehalis River channel between the mouth of the river and river mile 12, plus a depth profile along Preacher's slough, a main overflow path in the lower Chehalis floodplain. PGS also collected twenty-one (21) cross sections within the Skookumchuck River channel between river mile 9.8 and 12 and twenty (20) cross sections within the Satsop River between Highway 12 and the Chehalis River. These data were collected in November and December 2011

Minister Glaeser surveyed 70 sections within the Chehalis River between Pe Ell and Doty, 84 sections between Grand Mound and Porter, and 60 sections between Porter and Montesano.

WSDOT Additional Survey of I-5 and Airport Levee

In April 2012 WSDOT completed topographic survey to detail portions of I-5, the Chehalis-Centralia Airport levees, and the Highway 6 / I-5 overpass near the city of Chehalis, WA. These data were used to refine connections in the model including airport levee overtopping, I-5 overflows, Market Street overtopping, and Dillenbaugh creek breakout flow at I-5.

Hydrology (from USACE study)

Hydrologic data for the current modeling effort is being obtained from the concurrent Corps GI study (USACE, 2012). For that study WEST was tasked with developing basin wide flood flow hydrographs at return periods ranging from 1.5 to 500-years and seasonal low flow data. In addition, hydraulic model inputs were developed for three calibration events; February 1996, December 2007, and January 2009. The data developed for the Corps study are being used without modification for the current study, providing consistency between the two modeling efforts.

In addition to the Corps hydrologic data a downstream boundary condition at Aberdeen was required. Observed data is not currently collected at Aberdeen; therefore, a correction factor was applied to NOAA tide predictions at Aberdeen based on a comparison of observed and predicted tides at Westport. Applied corrections could be either positive or negative and ranged as high as 3 feet or more. Transposition of the differences between Westport and Aberdeen included a half hour offset to account for the difference in peak tide timing between the predicted tides at the two stations.

Model Configuration

As documented above, the final Chehalis River Basin baseline hydraulic model developed for the Flood Authority leveraged concurrent modeling efforts being conducted for the Corps, and utilized new survey to further refine and extend the earlier FEMA Twin Cities model. Table 1 lists the agency that funded development of each segment of the model, the surveyor and date for new cross section surveys, and the firm responsible for the development of the hydraulic model. Additional details for the model development are provided below.

Table 1. Chehalis River Model Reach Summary

	Reach	Client	Cross Section Survey	Model Development
Chehalis River	Pe Ell to Doty	USACE	MGS, 2011	WEST
	Doty to Grand Mound	FEMA	USACE, 2000	NHC, WEST, WSE[1]
	Grand Mound to Porter	FA	MGS, 2011	PIE, WEST
	Porter to Montesano	USACE	MGS, 2011	WEST/WSE
	Montesano to Mouth	FA	PGS, 2011	WSE
Tributaries	Satsop	USACE	USACE 2001, PGS, 2012[2]	WEST/WSE
	Wynoochee	USACE	USACE, 2009	WEST
	Skookumchuck	FA	PGS, 2012	WEST/WSE[3]
	Newaukum	FA	USACE, 2001	WSE
	Black	FA	MGS, 2011	WEST/WSE

[1]The original HEC-RAS model was developed by NHC for FEMA based on an earlier PIE UNET model. WEST georeferenced and re-cut cross sections in the model under the Flood Authority contract. WSE made final refinements and revisions to the model to improve the calibration and better reflect physical features in the Twin Cities area.

[2]New surveyed geometry was used for a comparison of channel changes but was not incorporated into the final model.

[3]WEST georeferenced the Skookumchuck model. WSE incorporated new survey and added a bypass reach in Bucoda (RM 9.8)

Upstream Extension (Pe Ell to Doty - WEST for USACE)

WEST extended the Chehalis River model upstream of Doty to Pe Ell as part of the Corps GI study. Channel geometry data in the model were based on new MGS field surveys. Overbank topography was based on 1999 USACE contours and 2005-2006 Lewis County LiDAR where available.

Twin Cities (Doty to Grand Mound)

The model between Doty and Grand Mound is based on the FEMA Twin Cities model. Although reach refinement was not originally scoped for this portion of the model, the Twin Cities model reach was ultimately refined considerably by WSE and WEST to resolve legacy issues such as overlapping cross sections and inaccurate reach lengths at tributary junctions that were discovered during model integration. The model was also revised by WSE to better reflect physical features in the Twin Cities area (railroads, road grades, Interstate 5, culverts, etc.) and to better calibrate to observed high water marks from February 1996 and December 2007.

Grand Mound to Porter (WEST for USACE and Flood Authority)

Although the Chehalis between Grand Mound and Porter was included in the earlier Twin Cities modeling, previous efforts by the Corps and/or FEMA did not include georeferencing or otherwise refining the model in the reach downstream of Grand Mound. Under the Corps GI Study effort WEST reconfigured this reach using new channel survey data collected by MGS under Task 5b of the Flood Authority Contract. The new model development used topographic data from the 2002 PSLC LiDAR data set.

Porter to Montesano (WEST for USACE and WSE for Flood Authority)

Extension of the model downstream of Porter to Montesano was completed by WEST as part of the USACE GI study. New MGS survey collected under contract to the Corps was used in channel, with 2002 PSLC LiDAR for overbank areas. This reach of the model was subsequently refined by WSE to better match observed water marks near the South Elma and Porter Creek roads provided by lower basin landowners in June 2012.

Montesano to Aberdeen (WSE for Flood Authority)

No previous hydraulic modeling was found for the lower 12 miles of the Chehalis River between Montesano and Grays Harbor. WSE developed the model geometry for this reach based on new PGS channel survey and 2009 LiDAR data. Unsteady capabilities within HEC-RAS allowed the incorporation of a time varying tidal boundary condition at the downstream end of the model. The model was calibrated to data for the USGS stage gage at Montesano.

Tributaries

Modeling of four tributaries to the Chehalis River: the Skookumchuck, Black, Newaukum and Satsop Rivers, was expanded or refined under Task 6. In addition, a branch representing the Wynoochee River was incorporated into the basin wide model. The intent of work on the tributaries was to evaluate existing models and refine/replace/extend them as necessary to meet the needs of the Flood Authority and basin stakeholders.

Satsop (WSE for Flood Authority)

Grays Harbor County indicated that a hydraulic model of the Satsop/Chehalis River confluence area would be very useful in light of upcoming project proposals on the Satsop River. Using a model developed by WEST as part of a Corps of Engineers floodplain restoration project in 2004 the lower Satsop River, from SR 12 to its mouth, was included as a branch in the Chehalis River hydraulic model. The 2004 model was based on cross sections that were field surveyed in 2002 and overbank data from the PSLC 2002 LiDAR data set. Unfortunately, there has been significant lateral movement of the Satsop River channel since the previous surveys were obtained and therefore the model is somewhat outdated. However, until new LiDAR data are available for the overbank floodplain it is not possible to refine the lower Satsop River branch.

In lieu of an updated model, WSE assessed how changes to the Satsop River channel since the earlier Corps project affect the accuracy of the existing model. Twenty (20) cross sections were surveyed along the Satsop River and the new cross section surveys were graphically compared to the earlier survey data using Excel. Comparisons of the channel location (as estimated from the LiDAR data at the time of the earlier survey and a recent aerial photograph) were also made. The results of these comparisons determined that the Satsop channel has shifted considerably, although it is not possible to conclude based on the survey data alone whether the Satsop channel has gained or lost conveyance capacity since 2001. The evaluations are summarized in an earlier WSE memorandum; “Satsop River Channel and Cross Section Comparisons” (WSE, 2012a).

Skookumchuck (WSE for Flood Authority)

The Twin Cities Skookumchuck model reach (from RM 6.42 to 21.77) was georeferenced by WEST, including an update of channel overbank elevations based on 2002 PSLC LiDAR. WSE then refined the model in the vicinity of Bucoda (RM 9.8 - 12) using channel survey collected by PGS, and calibrated the model using high water elevations from the January 2009 flood event. Refinement of the Skookumchuck River model reach included the addition of a "Bucoda Bypass" reach, which allows a much more accurate representation of the split-flow flooding that occurs through the town of Bucoda.

The refined Skookumchuck model was then utilized to determine the impact of bridge constrictions on flood levels within the town of Bucoda. This analysis is documented in an earlier WSE memo - "Skookumchuck River Model Update and Bucoda Flood Reduction Alternative Investigation" (WSE, 2012b).

Newaukum (WSE for Flood Authority)

The Twin Cities model included portions of the Newaukum River from its mouth upstream to approximately River Mile 4.1 at Labree Road, as well as the lower 3.45 miles of Dillenbaugh Creek, which receives overflows from the Newaukum River both upstream and downstream of Labree Road. Modeling conducted for the Corps of Engineers in the 1990s by PIE using UNET, and more recently in 2001 by Northwest Hydraulic Consultants (NHC) using HEC-RAS, covered the entire main stem of the Newaukum River including upstream of Labree Road to RM 10.63 (just below the North Fork confluence). NHC's modeling used data from various sources but primarily the UNET model developed by PIE. Neither the PIE nor the NHC model was geo-referenced (e.g. tied to a fixed horizontal coordinate system); however, AutoCAD files from PIE are available to show the location and alignment of the model cross-sections.

WSE geo-referenced, refined, and extended the existing model of the Newaukum River, upstream of Labree Road from RM 4.11 to RM 10.63, and incorporated this extension into the Flood Authority model. The floodplain portions of all cross-sections were re-cut using 2002 LiDAR data obtained from the Puget Sound LiDAR Consortium (PSLC) and merged with channel cross section data from the NHC model. Cross-sections in the NHC model that were not shown on the PIE AutoCAD drawings were located along the channel based on their reach lengths, then extended appropriately across the floodplain and cut from the LiDAR data.

The work performed by WSE is fully documented in "Newaukum River Model Extension and Refinement" (WSE, 2011c).

Black (WEST for Flood Authority)

Georeferencing of the Black River model was updated by WEST using 2001 cross section surveys obtained from W. & H. Pacific. Storage area locations, volumes, and connections were updated using the 2002 LiDAR data. The revised/refined model was calibrated to high water mark information for the confluence area obtained from Glen Connelly of the Chehalis Tribe.

Model Review

The HEC-RAS Hydraulic Model developed by the WSE/WEST Project team was subject to detailed review by the State Technical Team (comprised of staff from WSDOT, WADOE, and WDFW), by the Corps, and by WSDOT. The goal of these independent reviews was to ensure that the model was technically well developed and to facilitate acceptance by other stakeholders working in the basin. In particular, having the model reviewed and accepted by WSDOT and the Corps was instrumental in those agencies acceptance of the model for future hydraulic investigations. The fact that WSDOT, the Corps, and the Flood Authority are all working from the same baseline hydraulic model should make future discussions of flood relief alternatives more productive.

State Technical Team

WSE and WEST presented a preliminary version of the Chehalis River hydraulic model to a group of State technical staff at a coordination meeting at WEST's offices on February 23, 2012. Following that meeting the model and available documentation were provided to the State team for review and comment. Three State reviewers provided detailed written comments on the model: Paul Pickett (DOE), Casey Kramer (WSDOT), and Guy Hoyle-Dodson (DOE). These comments were well formed and generally helpful in identifying areas in the hydraulic model that required additional consideration and/or refinement. The comments were reviewed and discussed by the WSE-WEST team and a number of modifications were made to the model to address concerns. In some cases, no changes to the model were necessary, either because the model was already configured appropriately or because the comments raised questions beyond the scope of the current study. General responses to the reviewer's comments were provided in a memorandum entitled "Response to State team comments on Chehalis River Hydraulic Model" (WSE, 2012d). These responses were discussed further with the individual reviewers to ensure that the model could be refined appropriately. Brief summaries of the comments and responses are provided below:

RE: Paul Pickett comment letter of 3/30/2012:

Mr. Pickett's comments focused primarily on the hydrologic data proposed for use in the evaluation of flood relief alternatives. He noted that flood events in a basin as large and complex as the Chehalis Basin can come in many different forms and that a comprehensive analysis of flood relief alternatives would require a range of design events to be simulated. In our response we provided data showing that the largest flood events observed in the Chehalis basin have similar enough characteristics to make the proposed design event modeling approach reasonable for the current effort. We also noted that the hydrology for this project was done as part of the concurrent Corps project and using the same hydrology maintains consistency between the modeling efforts.

To evaluate basin hydrology data from the top 10 annual peaks at the Grand Mound gage were compared to the corresponding peaks at major upstream gages. The key findings of this analysis are as follows:

1) A large flow (herein defined as among the top 10 highest peaks recorded) on the Chehalis at Grand Mound has never happened without a correspondingly large flow on the Chehalis River at Doty.
2) A large flow at Doty is a reliable (although not perfect) indicator of a large flow at Grand Mound.
3) A large flow on the Chehalis at Grand Mound can happen with or without a significant flow contribution from the Skookumchuck River.
4) A large flow on the Skookumchuck is not a very good indicator of large flows at Grand Mound.
5) Peak flows on the Newaukum and South Fork are similarly correlated to the flows at Grand Mound, less so than the Doty flows but more so than the Skookumchuck flows.

The hydrologic analyses indicated that the Corps approach provides a reasonable representation of large flood events in the Chehalis River basin. However, as we agreed with Mr. Pickett that there is significant variability in storm timing and magnitude in the Chehalis River basin, the work plan for the project was modified to include analysis of three historical floods (1996, 2007, and 2009) in addition to the 100-year design event modeling.

RE: Guy Hoyle-Dodson comment letter of 4/1/2012:

Mr. Hoyle Dodson's comments on the HEC-RAS model were particularly comprehensive including comments on general modeling approaches as well as a number of specific areas of concern or question. While many of these related to the new model reaches being developed for this study, a large number were specifically related to the "Twin Cities" portion of the model previously developed by others. That said, and in an effort to make the model as robust and useful as possible, we reviewed all of the comments and attempted to address all of them in refining the model. We also provide responses to Mr. Hoyle- Dodson's comments in our detailed response letter (WSE 2012d).

RE: Casey Kramer comment letter of 4/2/2012:

Mr. Kramer's comments were discussed between Mr. Kramer, WSE, WEST, and NHC staff in a meeting at WSE's office on March 27, 2012. A plan of action was agreed upon for updating the model to address the comments. It should be noted that Mr. Kramer's model comments focused on the Twin Cities portion of the model constructed by others and not actually part of the current model development effort. However, to ensure that future analyses conducted with the model are as useful as possible modifications were made to the model to better simulate the area upstream of Mellen Street and along the lower reaches of Dillenbaugh Creek where it passes under I-5. These are detailed in WSE's April 2012 comment response letter and discussed further below.

USACE

As noted previously, the Corps has a concurrent project to develop a hydraulic model of the Chehalis River for use in ecosystem investigations (USACE 2012a). The work being conducted by the WSE/WEST team under contract with the Flood Authority is highly integrated with WEST's work for the Corps. Specific deliverables developed by WEST, including the hydrology and hydraulic modeling, have been submitted and subject to the Corps rigorous ITR process. The comprehensive model generated by the WSE project team has also been provided to the Corps for review and comment. It is our understanding that the Corps review is currently on hold pending allocation of funding. Any comments provided by the Corps will be responded to and reflected in future refinements to the model as appropriate.

WSDOT

In addition to the comment letter from Casey Kramer described above, WSDOT and its consultant Northwest Hydraulic Consultants (NHC) provided additional review of the Chehalis River hydraulic model after initial refinements were made. This work included direct coordination between NHC and WSE to refine portions of the model in the Twin Cities area, a re-release of the existing conditions geometry on May 2, 2012, and a technical team meeting at WSDOT headquarters on May 9, 2012. WSDOT is currently applying the model to evaluate a range of possible alternatives for protecting the Interstate 5 from flooding. As such, they have great interest in ensuring that the model is well formulated and appropriate for modeling, particularly in this area. Model issues raised by NHC and WSDOT were addressed in revisions to the existing conditions model that was subsequently distributed to WSDOT and the other members of the State tech team. That revised existing conditions model forms the basis for the alternatives analyses described below.

Final Model Refinements

As described above, the Chehalis River HEC-RAS model was developed through an open and participatory process involving the Flood Authority, the Corps, WSDOT, and other members of the State tech team. The model was widely distributed facilitating review by basin stakeholders and key agencies. The intent of this process was that the model would provide a broadly accepted and shared tool for making future decisions regarding flood relief in the basin. A number of general and specific refinements were made to the model in response to the detailed reviews. Several of these warrant additional detailed descriptions as provided below:

WSDOT 2012 Survey (WSE and WEST)

Considering their desire to have as accurate a calibration as possible in the Twin Cities area, to facilitate detailed planning and design of I-5 flood protection projects, WSDOT collected additional field topographic survey in April 2012 for Interstate 5 and the Chehalis-Centralia Airport levee for use in updating the model. The original data for these features were derived from the remote sensed topographic data sets (LiDAR and/or photogrammetric mapping). As such, the accuracy of the data was generally limited to plus or minus 1 foot (although the data are often more accurate for "hard" surfaces in open terrain (roads, railroads, etc)). The new survey data were used to update the model, thus improving its ability to accurately simulate existing conditions flooding.

Dillenbaugh Creek Area (WSE)

To better approximate December 2007 flood conditions near the Dillenbaugh Creek/Chehalis Junction, two lateral weirs (0.120 and 0.092) were added along Dillenbaugh to model flow entering the north- and southbound lanes of I-5 and flowing under the Highway 6 overpass. Weir elevations were based on the April 2012 survey completed by WSDOT. Additionally, the weir coefficient (C_d) for Main Street was reduced from 2.0 to 1.5 to approximate losses as water exiting Dillenbaugh flows through vegetation and around buildings on its path to Storage Area #303.

A section of the I-5 weir (LS 74.41) was then lowered (as discussed during the March 27th meeting with WSDOT and NHC) to simulate the portion of I-5 that does not have a jersey barrier along its east side, and the failure of the centerline jersey barrier that occurred during the Dec 2007 flood event. With these changes the maximum simulated depth of flow over I-5 in between SR-6 and NW West Street was about 2.0 ft, which may be somewhat high based on photographs from the 2007 flood. Additional model refinement might reduce the peak stages over the freeway in this area but it is not clear that there is enough information to definitively state how high the flow may have gotten and/or the direction and magnitude of breakout flows from Dillenbaugh Creek during the event. As such, no additional model refinement was completed.

Bridges and Revised Calibration (WSE)

Following the incorporation of the revised I-5 and airport levee survey data and the refinements to the modeling of Dillenbaugh Creek the model calibration in the Twin Cities area was reviewed. This review showed that model calibration at several locations, particularly just upstream of Mellen Street and in the reach between the airport levee and the Newaukum River confluence, could be improved. The model configuration was refined by adjusting ineffective flow limits and modifying "n" values to improve calibration. While the model changes were generally minor, improvements in calibration by up to 0.5 feet were attained at some locations. The revised calibration focused on the December 2007 flood event due to the fact that this event was significantly larger in the Twin Cities area and there were more observed high water marks distributed throughout the Twin Cities than for any other event. However, the other calibration events, February 1996 and January 2009 were also simulated to verify that the revisions also improved model calibration for those events.

MTB Project (NHC for WSDOT)

WSDOT has received permit approvals and obtained funding to construct a series of improvements collectively known as the Mellen to Blakeslee Bridge (MTB) Junction Project. The $155 million project, which broke ground in late May, will provide access to medical and other critical community facilities in Centralia during flood events up to the 2007 flood level. The first stage of the projects is expected to be completed in spring 2013; the second will begin in the summer of 2013 and finish late in 2014 or early 2015. The project includes connecting Louisiana Avenue and Airport Road, constructing a "shared use" path for pedestrians and cyclists, and re-constructing the Mellen Street interchange. Another element of the project is the addition of collector-distributor (CD) lanes alongside of the freeway between Mellen Street and Blakeslee Junction. The CD lanes will allow drivers to pass from Centralia to Chehalis without using I-5.

Because the MTB project is being actively implemented at present, it was decided that the Chehalis River existing conditions hydraulic model should be updated to include this project. NHC used the existing conditions geometry distributed by WSE on May 2, 2012 and updated it to reflect the planned MTB project. The modified geometry produced by NHC forms the "Baseline" geometry being used by all parties for purposes of evaluation of impacts and benefits of flood relief alternatives.

Lower Basin Model Refinements (WSE)

In coordination with the Flood Authority, the Ruckelshaus Center, and the Washington Dairy Federation, a series of meetings and workshops were held in Porter and Montesano in June 2012 to discuss specific flooding problems in the lower Chehalis River basin. During those workshops additional calibration information was obtained including high water marks for the December 2007 flood and anecdotal information about flooding during the January 2009 and February 1996 events. Using these new data the lower Chehalis River model calibration was refined, specifically with respect to the modeling of the Porter Creek Road and Wakefield Road (South Elma) bridges and approach fills. Ineffective flow limits and Manning's roughness values in the model were adjusted to reflect observations and to allow a better match to the high water mark data. The model was also modified in a manner that facilitates evaluation of several lower basin flood relief alternatives that were discussed at the workshops, specifically modifications to the overflow bridges on Porter Creek Road and/or Wakefield Road. The model refinements were incorporated into all earlier versions of the model and all previously modeled alternatives were re-simulated.

Final Model Calibration Summary

The Flood Authority Chehalis River HEC-RAS model was calibrated to the February 1996 and January 2009 storm events, with the storm event of December 2007 used for model validation. The calibration and validation data used were the observed stage and discharge hydrographs and rating curves at Doty on the Chehalis River, RM 101.549, Grand Mound on the Chehalis River, RM 59.909, Porter on the Chehalis River, RM 33.22, the Newaukum River near Chehalis, RM 4.11, the Skookumchuck River below Bloody Run, RM 20.7, the Skookumchuck River near Bucoda, RM 6.4, and the Skookumchuck River at Centralia, RM 2.41.

Model calibration was achieved by adjusting channel and overbank values of the Manning's n bottom roughness coefficient, flow roughness factors, and the placement of ineffective flow areas, until good agreement was found between the computed and observed stage and flow hydrographs and computed and observed rating curves at the gages listed above.

Results

The following discussion provides an overview / summary of calibration results for each of the calibration events (February 1996, and January 2009) and the validation event (December 2007) – a more comprehensive discussion of model calibration can be found in the GI Study report (USACE 2012a).

February 1996 Calibration

Table 2 shows the comparison between modeled and observed peak flows at various locations on the Chehalis, Newaukum, and Skookumchuck Rivers for the February 1996 event. For illustration, plots of simulated and observed stage and flow hydrographs at Grand Mound are included in Figures 5 and 6.

Table 2. Summary of model calibration for flow for February 1996 event

Location	Computed Peak Flow (cfs)	Observed Peak Flow (cfs)	Difference in Peak Flow Magnitude (%)	Difference in Event Volume (%)	Peak Time Difference (hours)*
Chehalis River at Doty	28,055	28,900	-2.9	-0.3	0
Chehalis River at Grand Mound	74,485	74,800	-1	15.3	5
Chehalis River at Porter	82,420	80,700	2.1	39.3	10
Newaukum River near Chehalis	11,960	13,300	-10.1	-0.3	2.5
Skookumchuck River below Bloody Run	9,053	N/A	N/A	N/A	N/A
Skookumchuck River near Bucoda	11,635	11,300	3	-5.7	-2

*A negative time difference denotes the simulated peak occurring before the observed peak

Though the estimated inflows produce hydrograph volumes that are high compared to the observed data, the flow magnitudes are within 10 percent and the timing of the peak flows are within a few hours of observed data - with the exception of the simulated peak at Porter, which is 10 hours early. Further investigation suggests that this is likely an anomaly within the gaged data at Porter (USACE 2012a).

In general, the flow hydrograph calibrations look reasonable. At gages where the majority of the upstream contributing flow is gaged (Chehalis at Doty, Newaukum near Chehalis, Skookumchuck below Bloody Run and near Bucoda), the calibration of the flow hydrographs appear relatively tight. At the gages where the majority of the contributing flow is ungaged (Chehalis River at Grand Mound and Porter), the simulated flows tend to be high compared to the observed. This in turn yields stage hydrograph calibrations that look reasonable for the

Chehalis River at Doty and the Skookumchuck gages. The stage hydrographs for the Chehalis River at Grand Mound and Porter are slightly high, which is to be expected due to the high simulated flow peaks.

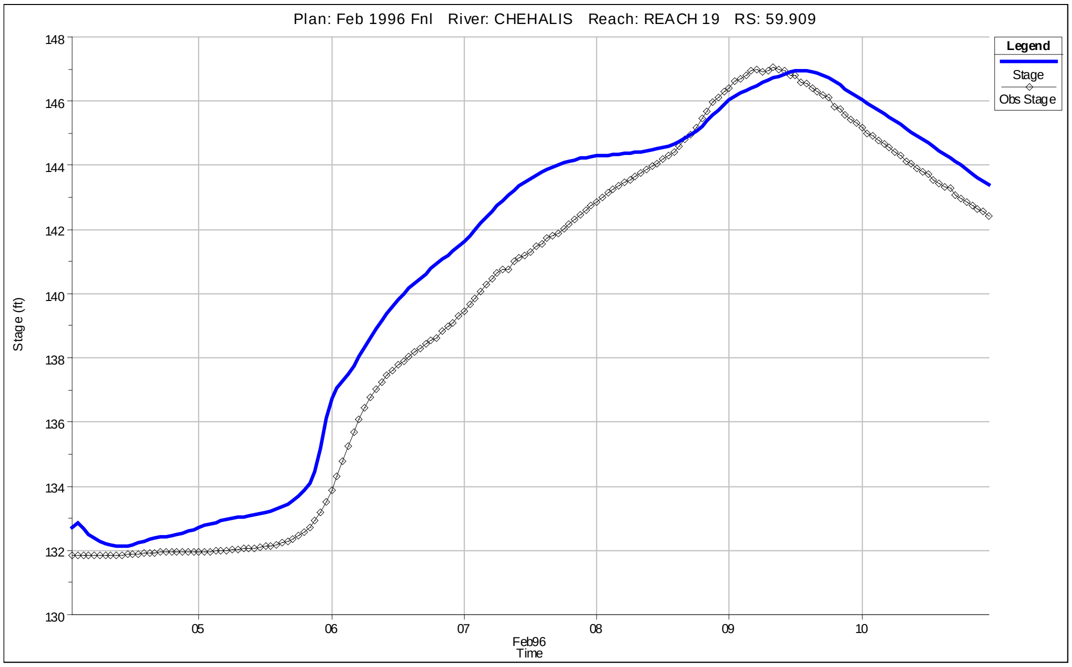

Figure 5. Stage hydrographs for Chehalis River at Grand Mound– February 1996

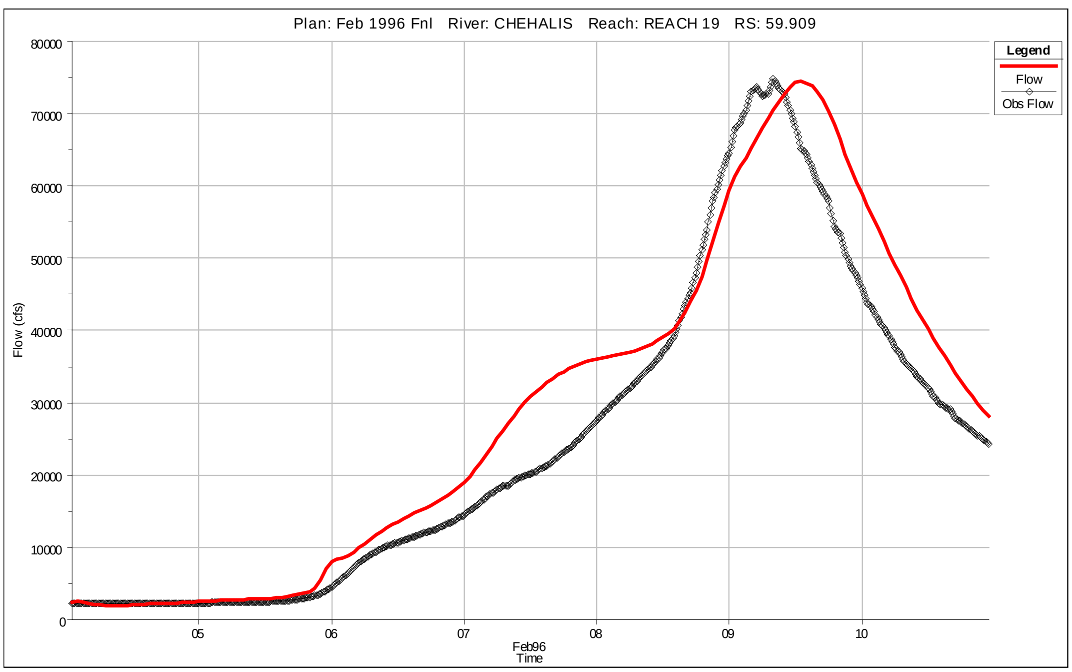

Figure 6. Flow hydrographs for Chehalis River at Grand Mound– February 1996

In addition to the stream gage data that were available for calibration, high water mark data are also available in specific locations throughout the basin. A comparison of simulated water surface elevations to recorded high water marks for the February 1996 event is shown in Table 3.

Table 3. Summary of high water mark data – February 1996

River	HEC-RAS River Station (RM)	Simulated Water Surface Elevation (feet NAVD88)	Observed High Water Mark (feet NAVD88)	Difference (feet NAVD88)
Black River	9.09	112.56	113	-0.44
Black River	4.62	101.04	100.95	0.09
Black River	3.44	97.43	97.48	-0.05
Black River	2.5	95.1	96.12	-1.02
Chehalis River	81.03	199.93	199.37	0.56
Chehalis River	76.1	186.01	185.93	0.08
Chehalis River	75.09	184.77	185.75	-0.98
Chehalis River	74.82	183.66	184.9	-1.24
Chehalis River	74.02	182.3	183.4	-1.1
Chehalis River	72.8	181.57	181.9	-0.33
Chehalis River	67.86	178.8	179.61	-0.81
Chehalis River	67.43	177.26	177.7	-0.44
Chehalis River	66.88	175.59	176.54	-0.95
Chehalis River	66.73	175.2	175.61	-0.41
Chehalis River	66.36	172.71	173.12	-0.41
Chehalis River	64.2	162.69	164.53	-1.84
Chehalis River	63.2	158.19	158.9	-0.71
Chehalis River	61.96	155.27	156.73	-1.46
Chehalis River	59.909	146.95	147	-0.05
Chehalis River	54.476	123.75	124.43	-0.68
Chehalis River	54.045	120.08	120.11	-0.03
Chehalis River	51.158	104.04	106.36	-2.32
Chehalis River	50.022	100.89	99.72	1.17
Chehalis River	45.217	88.17	87.21	0.96
Chehalis River	42.283	77.79	71.2	6.59
Dillenbaugh Creek	1.25	185.95	187.1	-1.15
Dillenbaugh Creek	0.09	183.79	185.41	-1.62
Newaukum River	4.11	204.59	206.69	-2.1
Newaukum River	1.66	186.84	187.9	-1.06
Salzer Creek	1.56	180.32	180.4	-0.08
Salzer Creek	1.28	180.32	180.4	-0.08
Salzer Creek	0.36	179.92	180.12	-0.2
Skookumchuck River	20.7	334.58	333.98	0.6
Skookumchuck River	6.4	216.29	216.2	0.09
Skookumchuck River	3.84	201.42	201.66	-0.24
Skookumchuck River	2.42	191.47	190.69	0.78
Skookumchuck River	2.21	189.33	188.4	0.93
Skookumchuck River	2	187.99	187.7	0.29

January 2009 Event

Table 4 shows the comparison between modeled and observed peak flows at various locations on the Chehalis, Newaukum, and Skookumchuck Rivers for the January 2009 event. For illustration, a plot of simulated and observed stage and flow hydrographs at Grand Mound are included in Figures 7 and 8.

Table 4. Summary of model calibration for flow for January 2009 event

Location	Computed Peak Flow (cfs)	Observed Peak Flow (cfs)	Difference in Peak Flow (%)	Difference in Event Volume (%)	Peak Time Difference (hours)*
Chehalis River at Doty	19,602	20,100	-2.5	-0.2	0.0
Chehalis River at Grand Mound	57,928	50,700	14.3	17.3	0.5
Chehalis River at Porter	66,992	68,100	-1.6	6.9	-0.5
Newaukum River near Chehalis	12,629	13,000	-1.7	6.5	1.0
Skookumchuck River below Bloody Run	7,018	6,900	1.7	3.5	-0.75
Skookumchuck River near Bucoda	9,962	10,500	-5.1	-4.2	1.0

*A negative time difference denotes the simulated peak occurring before the observed peak

Flow volumes in the Chehalis River tend to be slightly higher than observed data, especially in the lower Chehalis River. The majority of the contributing area between the gage at Doty and the gage at Grand Mound is ungaged; therefore, the majority of the contributing flow between Doty and Grand Mound is estimated using procedures discussed the GI Report (USACE 2012a). These results suggest that the inflow estimates between Doty and Grand Mound are high. Although the estimated inflows produce hydrograph volumes that are high compared to the observed data, the flow magnitudes are generally within 10 percent.

At the Newaukum River and Skookumchuck River gages, both the simulated flow volumes and peak flow magnitudes are within 10 percent of the observed volumes and magnitudes for the 2009 event. Simulated and observed peak times also agree well; all differences are within one hour.

In general, the flow hydrograph calibrations look reasonable. For observed flow hydrographs where the majority of the upstream contributing flow is gaged (Chehalis at Doty, Newaukum near Chehalis, Skookumchuck below Bloody Run and near Bucoda), the calibration of the flow hydrographs appear relatively tight. At the gages where the majority of the contributing flow is ungaged (Chehalis River at Grand Mound and Porter), the simulated flows tend to be high compared to the observed, as noted previously. This in turn yields stage hydrograph calibrations that look reasonable for the Chehalis River at Doty and the Skookumchuck gages. The stage hydrographs for the Chehalis River at Grand Mound and Porter are slightly high which is to be expected due to the high simulated flow peaks.

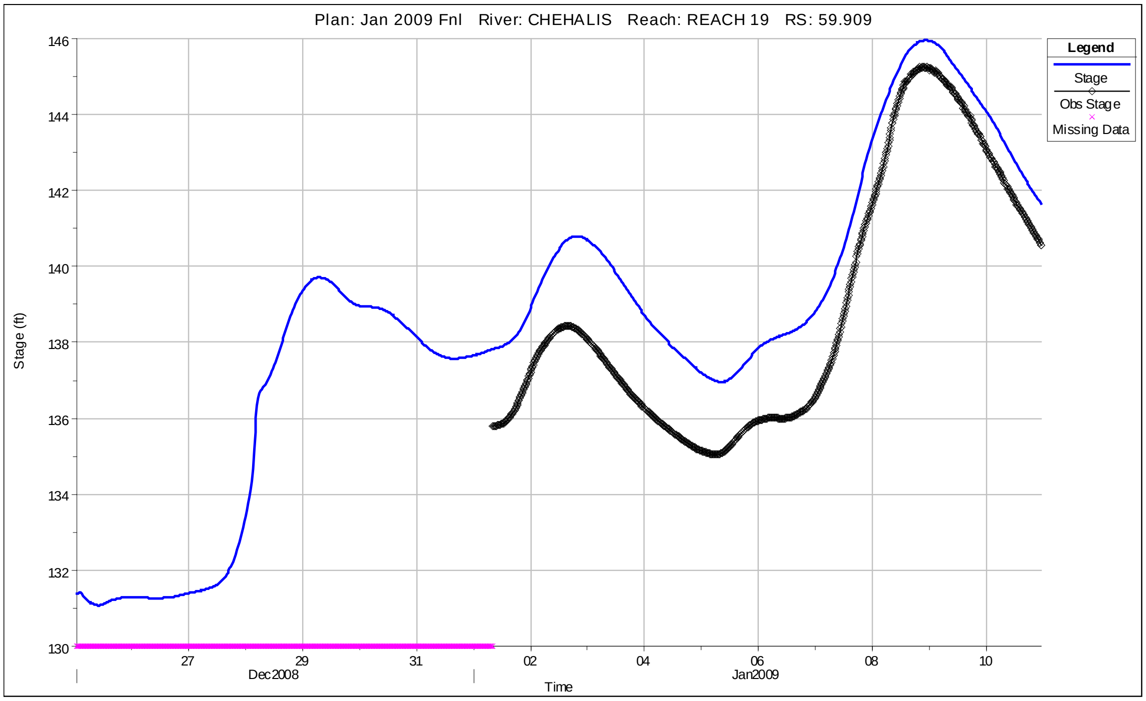

Figure 7. Stage hydrographs for Chehalis River at Grand Mound– January 2009

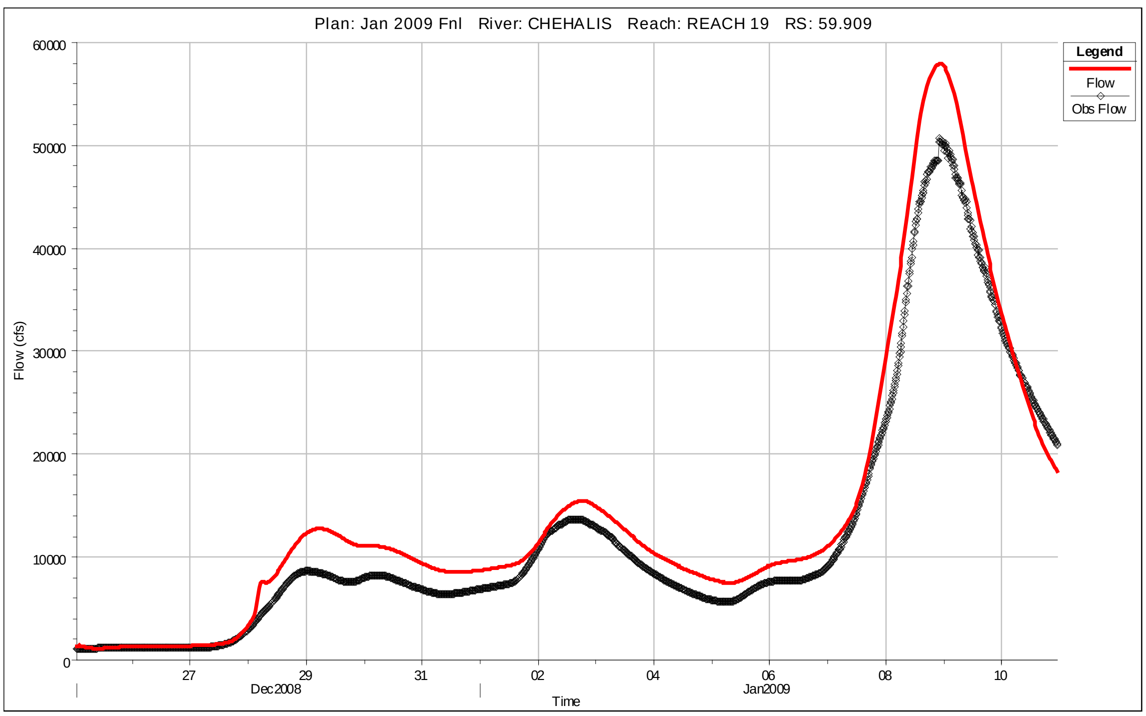

Figure 8. Flow hydrographs for Chehalis River at Grand Mound– January 2009

In addition to the stream gage data that were available for calibration, high water mark data are also available in specific locations throughout the basin. A comparison of simulated water surface elevations to recorded high water marks for the January 2009 event is shown in Table 5.

Table 5 Summary of high water mark data – January 2009

River	HEC-RAS River Station (RM)	Simulated Water Surface Elevation (feet NAVD88)	Observed High Water Mark (feet NAVD88)	Difference (feet NAVD88)
Chehalis River	85.99	213.22	211.1	2.12
Chehalis River	74.57	181.43	181.95	-0.52
Chehalis River	72.58	180.01	179.3	0.71
Chehalis River	64.25	161.51	163.11	-1.6
Chehalis River	64.2	161.33	163.11	-1.78
Dillenbaugh Creek	1	185.67	185.4	0.27
Dillenbaugh Creek	0.792	185.64	185.4	0.24
Dillenbaugh Creek	0.155	183.45	182.4	1.05
Dillenbaugh Creek	0.142	183.39	182.4	0.99
Newaukum River	1.3	185.26	185.4	-0.14
Salzer Creek	2.32	178.06	181.7	-3.64
Salzer Creek	2.25	177.98	181.7	-3.72
Salzer Creek	2.05	177.39	181.2	-3.81
Salzer Creek	1.15	177.26	176.4	0.86
Skookumchuck River	4	201.43	199.8	1.63
Skookumchuck River	2.41	190.54	190.46	0.08

December 2007 Event

Table 6 shows the comparison between modeled and observed peak flows at various locations on the Chehalis, Newaukum, and Skookumchuck Rivers for the January 2009 event. For illustration, a plot of simulated and observed stage and flow hydrographs at Grand Mound are included in Figures 9 and 10.

Table 6. Summary of model validation for flow for December 2007 event

Location	Computed Peak Flow (cfs)	Observed Peak Flow (cfs)	Difference in Peak Flow Magnitude (%)	Difference in Event Volume (%)	Peak Time Difference (hours)*
Chehalis River at Doty	62,215	63,100**	-1.4**	-0.1	0.0**
Chehalis River at Grand Mound	82,690	79,100	4.5	28.3	3.0
Chehalis River at Porter	84,790	102,000	-16.9	2.7	3.0
Newaukum River near Chehalis	12,458	12,900	-3.4	0.5	1.0
Skookumchuck River below Bloody Run	2,223	2,210	0.6	2.0	0.25
Skookumchuck River near Bucoda	3,494	3,600	2.9	0.9	-2.25

* A negative time difference denotes the simulated peak occurring before the observed peak

** Stream gage record ends near peak, values for comparison may be missing.

As seen in the table, most of the simulated and observed flow magnitude and volume differences are within 10 percent. The notable exceptions are the flow volume in the Chehalis River at Grand Mound and the peak flow magnitude in the Chehalis River at Porter. Similar to the 2009 calibration event, the simulated flow volume at Grand Mound is high compared to the observed volume. However, to "correct" this issue, the inflows upstream of Grand Mound would have to be dramatically reduced, and the inflows between Grand Mound and Porter would have to increase by about a multiple of three. We felt that this distribution of inflows would be unrealistic.

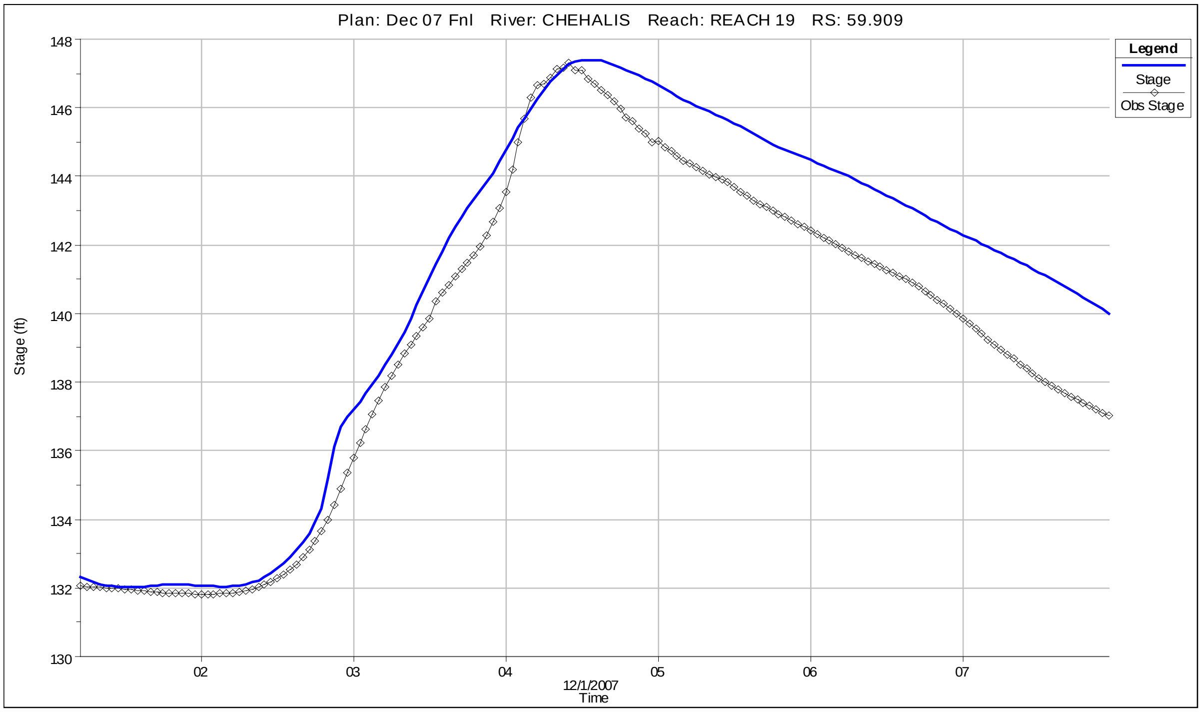

Figure 9.

Stage hydrographs for Chehalis River at Grand Mound– December 2007

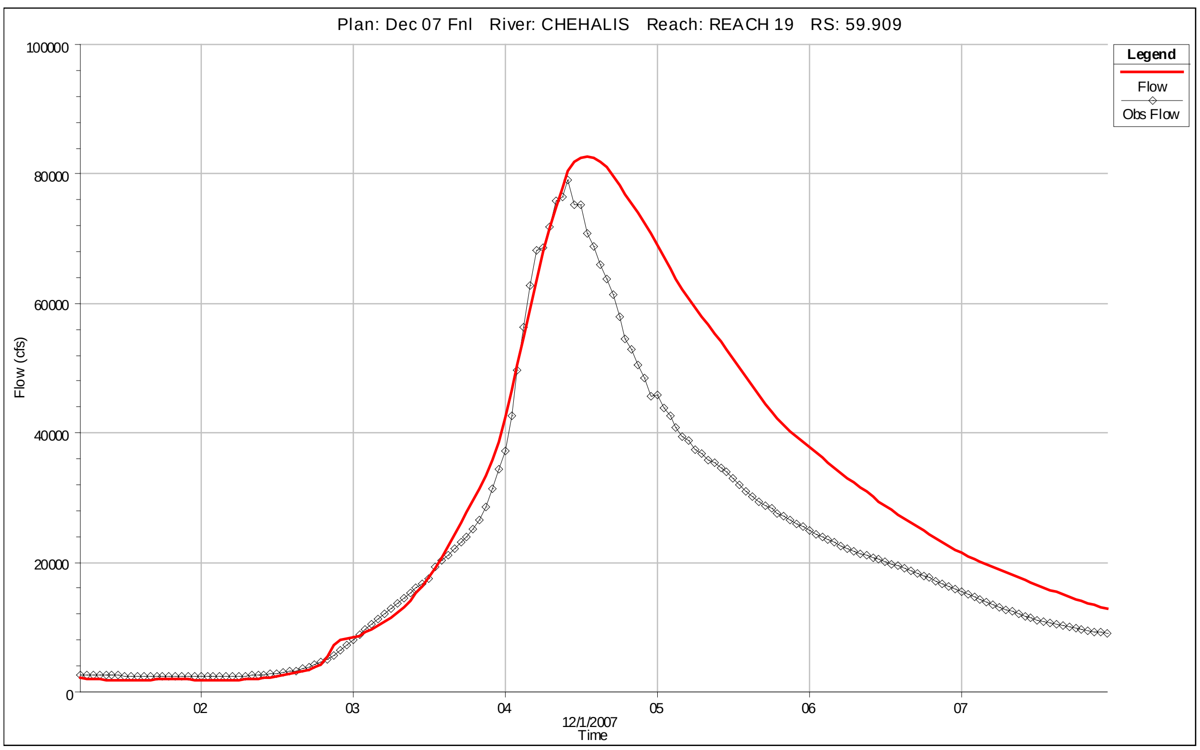

Figure 10. Flow hydrographs for Chehalis River at Grand Mound– December 2007

In addition to the stream gage data that were available for calibration, high water mark data are also available in specific locations throughout the basin. A comparison of simulated water surface elevations to recorded high water marks for the December 2007 event is shown in Table 7.

Table 7. Summary of high water mark data – December 2007

River	HEC-RAS River Station (RM)	Simulated Water Surface Elevation (feet NAVD88)	Observed High Water Mark (feet NAVD88)	Difference (feet NAVD88)
Black River	7.07	107.65	104.26	3.39
Black River	5.64	102.96	103.92	-0.96
Chehalis River	86.01	223.05	223.2	-0.15
Chehalis River	84.3	210.19	212.1	-1.91
Chehalis River	78.97	195.25	196.4	-1.15
Chehalis River	77.959	193.89	194	-0.11
Chehalis River	77.65	192.61	193.2	-0.59
Chehalis River	77.39	188.92	188.2	0.72
Chehalis River	75.2	186.62	187.65	-1.03
Chehalis River	74.73	185.03	185.48	-0.45
Chehalis River	74.25	183.9	184	-0.1
Chehalis River	74.02	183.65	184.1	-0.45
Chehalis River	73.73	183.37	183.1	0.27
Chehalis River	72.8	182.83	182.9	-0.07
Chehalis River	72.22	182.34	182.4	-0.06
Chehalis River	69.22	181.34	181.6	-0.26
Chehalis River	68.67	181.23	181.3	-0.07
Chehalis River	67.86	180.67	179.8	0.87
Chehalis River	66.95	176.5	175.5	1.00
Chehalis River	65.8	171.65	171.93	-0.28
Chehalis River	64.9	168.29	168.2	0.09
Chehalis River	61.96	155.75	157.9	-2.15
Chehalis River	61.7	155.75	153.13	2.62
Chehalis River	60.22	150.29	151.8	-1.51
Chehalis River	54.045	120.44	117.83	2.61
Chehalis River	53.264	115.33	115.42	-0.09
Chehalis River	52.947	113.98	114.72	-0.74
Chehalis River	51.499	106.03	111.34	-5.31
Dillenbaugh Creek	0.321	186.32	187	-0.68
Dillenbaugh Creek	0	185.03	185.48	-0.45
Newaukum River	0.1	186.97	187.65	-0.68
Salzer Creek	3.4	182.02	181.5	0.52
Salzer Creek	2.22	182.01	181.8	0.21
Salzer Creek	1.32	182.01	181.9	0.11
Salzer Creek	1.05	182.01	182.1	-0.09
Salzer Creek	0.65	182.01	181.8	0.21
Skookumchuck River	0.49	177.44	177.5	-0.06

Areas of concern

The development and calibration of the HEC-RAS hydraulic model developed for this project has followed the highest technical standards for a project such as this. The use of new channel and overbank topographic and bathymetric survey data to refine the model clearly improves the model's ability to capture physical conditions in the basin. Detailed calibration of the model to three large floods including numerous high water marks and flow and stage hydrographs improves our confidence in the model's ability to accurately simulate large flood events. Technical review of the model by three respected consulting firms, the Corps, WSDOT, WDFW, WADOE, and others helps ensure that the model is appropriately configured and well defined. However, despite all of these considerations, it must be remembered that any model is simply a representation of the actual system being investigated and any model is subject to uncertainty and error. In the case of the Chehalis River basin, the most significant issues leading to uncertainty in the results include the hydrologic data used to develop inputs to the model, potential anomalies during past flood events, and whether the hypothetical design flow events are adequately representative of the wide range of potential conditions. Each of these is discussed briefly below:

USGS Gage data

The USGS maintains a number of key streamflow gages in the Chehalis River basin. The USGS is the preeminent agency for streamflow gaging in the United States and data collected by the USGS is generally the best information available for gaining an understanding basin hydrology. Data from these gages is essential to developing inputs to basin wide hydraulic modeling. However, it must be acknowledged that accurately estimating flows from extreme events is particularly difficult and the inherent uncertainties (errors) in gage data need to be considered when evaluating and using hydraulic model results. Several key streamflow gages in the Chehalis River basin, including the Chehalis River at Grand Mound, Chehalis River at Porter, and Newaukum River at Labree Road are subject to flows bypassing the gages during extreme flood events. Since the rating curves for these gages are generally developed using stage-discharge measurements made when flow is contained within the main channel (i.e. with no overbank bypass flows) it is unlikely that the extensions of these rating curves reflect the bypass flows. It is not clear, but discussions with the USGS and our review of the USGS data indicate that modifications to streamflow data to directly account for bypass flows are not made. As such, the data for periods when flows are bypassing the gage site are especially uncertain.

In addition to general difficulties in estimating high flows and particular concerns with gages that have bypass flows the data for several gages for the December 2007 flood are particularly difficult to use due to problems with the gages. The USGS gage at Doty was inoperable at the time of the peak of the December 2007 flood. The gage on the South Fork Chehalis River at Wildwood, while operable throughout the event had such large changes in bed level due to sediment movement during the event that the data is not felt to be useful at the peak of the flood. Because these gages measure runoff from the area where the storm was centered, and the mainstem and South Fork Chehalis were likely the source for 60% or more of the flow seen in the Twin Cities during the December flood, accurate modeling of that event is particularly problematic. However, considering the large number of calibration points throughout the basin, the availability of a continuous flow hydrograph at Grand Mound, and the work done by the USGS, the Corps, and FEMA/NHC to accurately re-create flood flow hydrographs for the upper basin for the December 2007 flood, we are confident that modeling and analysis of that flood is still appropriate for the current project. We would simply caveat the results that there is probably greater uncertainty in the flow values during that event than in other, less severe events.

Doty Flows – debris jams, volumes

Residents in the Upper Chehalis River, upstream of the South Fork confluence, have suggested that debris jams and or damming of the river caused by failed bridges during the December 2007 flood event were significant factors in the magnitude of the observed flows. The USGS has reviewed this issue and has determined that their estimate of the flood peak at Doty is reasonable. However there remains significant uncertainty in the flows reported for all gages in the upper basin during that flood event due to the fact that the discharges were higher than any previously seen and that there were significant debris and sediment issues throughout the watershed. The analyses documented herein include simulations of three extreme flood events, in addition to the December 2007 flood, and as such the conclusions reached regarding flood relief alternatives should hold regardless of the uncertainty in the hydrologic data for that particular flood.

"Representativeness" of 100-year flood

As discussed above, some reviewers felt that the Chehalis River Basin is too large and flood flows are too variable to model using only one or a few design storm events. Some reviewers suggested that the only way to adequately evaluate flood relief projects would be to develop a calibrated basin-wide hydrologic model and use that model to derive inputs to the hydraulic modeling and analysis. Unfortunately, there is neither time nor budget to undertake such an effort within this project. We concur that the basin hydrology is diverse and that no two storms will look the same. We also acknowledge that the approach of using one theoretical design storm and three historic flood events is not perfect. For this reason it may be necessary to develop additional hydrologic data sets and make additional model runs to evaluate some projects, particularly projects on the tributaries. However, we feel that the approach taken in this study, as modified in consultation with the State tech team, is appropriate to meet the current needs of the Flood Authority. Future modeling efforts with different hydrologic data sets would be straightforward to model once the data were developed. These analyses could be conducted by any qualified hydraulic engineer on behalf of any stakeholder or agency using the HEC-RAS model. Again this highlights the benefit of a cooperatively developed and well vetted model.

Model Geometry versus Current Conditions

Although geometric (cross section) data used in the hydraulic model utilized the best available data sources, that data may not always accurately reflect current conditions. Notable data sets include topography from 1999 (in the Twin Cities floodplain area), 2002 (between Grand Mound and Montesano and along the Skookumchuck River), and 2005 and 2006 in Centralia and Chehalis. On the lower Satsop River, for example, significant channel adjustments have occurred since the 2002 LiDAR used in the current model. However, without updated overbank LiDAR, Satsop channel changes could not be reliably incorporated into the current model.

Although the current effort included new channel survey for a significant portion of the Lower Chehalis River, in-channel and bridge structure data for much of the upper basin and tributaries is from existing model cross sections, which are based on older, often sparse, cross section survey. The representativeness of model geometry should be carefully considered by a qualified hydraulic engineer before the model is utilized for other purposes or projects.

New topographic data will be available soon for much of the basin (Chehalis River corridor from Lewis County line to Montesano) or is already available (Thurston County and portions of Lewis County). The new topographic data could be used to update the hydraulic models thus improving the model's ability to simulate overbank flooding. This effort, however, was beyond the scope and schedule of the current project.

Modeling Tidal Flooding in the Lower Chehalis

Extension of the Lower Chehalis Model from Montesano (RM 12) to Grays Harbor was completed and calibrated for large flood events, and therefore may not provide a good representation of low flow conditions. The model was set up to handle significant riverine flow in conjunction with tidal exchange but it does not attempt to model the effects of solely (or principally) tidal flooding. As such the daily filling and flushing of the intertidal channels and surge plain downstream of Montesano would not be particularly well modeled during times when the river is not flooding. Extension of the Flood Authority model into Grays Harbor was done through the inclusion of a tidal boundary (using observed and/or predicted tide data) to provide a tool for the evaluation of the downstream impact/benefit of upstream flood relief alternatives. The estuary; however, is a dynamic system with a large tidal surge plain and numerous overflow paths and tidal sloughs that behave much differently under low flow conditions, and a different tool (possibly a 2-D model) may be more well suited for low-flow or ecological studies downstream of Montesano.

Alternatives Analysis

Definition of Alternatives

WSE updated the Flood Authority HEC-RAS model in order to examine a number of flood reduction scenarios, including the Dam and Levee alternatives detailed in Task 8, and an additional thirteen alternatives and ten combinations of those alternatives. Descriptions of each model scenario are included below.

Mainstem Chehalis River Dam

Following the severe flood in 2007, the Chehalis Basin Flood Authority began to evaluate whether flood retention structures in the Chehalis River Basin might be part of a solution to basin-wide flooding. This built on early work by the Corps of Engineers and the Lewis County Public Utilities District. After reviewing several sites, the flood retention project site still under consideration is a multi-purpose dam located upstream of Pe Ell on the Upper Chehalis River. The structure would have 80,000 ac-ft of dedicated flood control storage, a structural height of 288 feet, flow augmentation/hydropower storage capacity of 65,000 ac-ft, and an estimated construction cost of $245 million (Phase IIB).

Using the calibrated baseline geometry, WSE modeled the impacts of the dam above Pe Ell by altering model inflow to include the hydrologic effect of the upstream retention facility.

Corps Twin City Levee Project

Beginning in the 1980s the US Army Corps of Engineers began to evaluate a plan to build 11 miles of new levees in the Chehalis River floodway through Chehalis and Centralia. The Corps presented a design to build miles of new levees to the Centralia City Council in 1980. This basic plan was authorized for further analysis, but not funded for construction, by Congress as the Centralia Flood Damage Reduction Project ("Twin Cities project"). Work on the Twin City plan was largely shelved by the Corps in 2011 after the Corps determined that the proposed project would not have protected I-5 during the 2007 flood, would have increased flooding upstream and downstream and, at a cost of over $200 million, would not pass the Corps cost-benefit test.

The Twin Cities Levee project includes:

- Construction of a levee system designed to provide protection along the Chehalis River from approximately river mile (RM) 75 to RM 64 and along most of the lower 2 miles of both Dillenbaugh Creek and Salzer Creek.
- Construction of a levee along the lower approximately 2 miles of Skookumchuck River to the confluence with Coffee Creek that would provide 100-year level of protection.
- Raising the elevation of approximately eight structures that would incur induced damages from increased inundation as a result of the project, located near the Airport, Interstate-5, Skookumchuck River, and Salzer Creek.
- Modification of Skookumchuck Dam to provide for an additional 11,000 acre-feet of flood storage. The project would limit outflows from the dam and attempt to keep the flow in the Skookumchuck River Channel at the Pearl Street Bridge at or below 5,000 cfs.
- Total estimated cost of $205 million.

Mellen Street Bypass

Historically, the bridge at Mellen Street has been suggested by some as a significant cause of flood impacts in the Twin Cities area. However, the Chehalis HEC-RAS model predicts that there would be little benefit from removing the bridge, in part because the natural topography, even without the bridge, acts as a constriction to flood waters. A different alternative would be to construct a high flow bypass from the left edge of the Chehalis River floodplain upstream of Mellen Street (RM 67.7) to downstream of the Skookumchuck River confluence (RM 66.16). The bypass channel would be approximately 700 feet wide and flow depths would be up to 10 feet deep in a flood such as December 2007.

Scheuber Bypass

The Chehalis River downstream of State Highway 603 flows parallel to Highway 6 for approximately 2.5 miles before turning north and flowing under the SR-6 highway bridge near the City of Chehalis. Water overtopping the highway upstream of the Newaukum River confluence enters the Scheuber Bypass reach that reconnects to the Chehalis River downstream of SR-6 near the Chehalis-Centralia Airport, effectively bypassing city of Chehalis. The Scheuber Bypass Alternative would provide culvert or bridge connections under the highway to pass additional flow downstream and into the bypass, with the goal of reducing peak flood levels within the City of Chehalis. A modeled connection was made by placing a large opening within a portion of the lateral structure representing Highway 6 near River mile 77.3.

Dredging/Channel Excavation

In the past, the Corps also evaluated a project to dredge or excavate the mainstem Chehalis River channel downstream of Mellen Street. WSE modeled a dredge/excavation project similar to the Corps investigated project, which would extend from just downstream of Mellen Street to just downstream of Lincoln Creek (RM 67.29 to RM 60.51). The modeled excavation had a 120-foot bottom width trapezoidal channel, and would lower the channel bottom by as much as 15 feet in some locations (tapering into the existing channel at the upstream and downstream ends). According to PIE's Chehalis River Basin Flood Reduction Report (1998), there is a natural rise in the river bottom in this area; the substrate is most likely bedrock that likely would require blasting for removal. Part of the area under consideration for dredging is fairly high quality riparian zone dominated by black cottonwood, red alder, Douglas fir, western red cedar, with an understory of salmonberry, snowberry, and other native shrubs and herbs. The portions of the area considered for dredging have good quality spawning habitat adjacent to it in the Chehalis River, and a high quality riparian zone with seasonally connected side channels. Habitat diversity, species diversity, wetlands and refugia are good quality (USACE 2012b).

Dredging of the Chehalis River would also require some dredging within the lower reaches of the Skookumchuck River. Model cross sections between the mouth of the Skookumchuck River and RM 3.32 were cut to create a 20 foot wide trapezoidal channel in order to tie the Skookumchuck River channel into the lowered Chehalis River channel and provide model stability.

Bridge Removal

Road and bridge restrictions throughout the Chehalis Basin can constrain the flow of the Chehalis River and its tributaries during flood events. Major floods have resulted in bridges overtopping and the inundation of access roads; damage has occurred in areas such as upstream of SR-6, Mellen Street, Galvin Road, the Sickman-Ford Bridge, Porter Creek Road, and Wakefield Road. Modifications of the SR-6 Bridge and Mellen St. Bridge were proposed in the PIE Chehalis River Basin Flood Reduction Report (1998), and projects involving modifications to Sickman-Ford Bridge and Galvin Road were referenced in the Comprehensive Flood Hazard Management Plan for Confederated Tribes of the Chehalis Reservation. In fact, the Chehalis Tribe has evaluated options for changes to the Sickman-Ford Bridge and developed a scope for additional engineering design. Modifications to the Porter Creek Road and Wakefield Road (South Elma Bridge) were suggested as possible flood relief projects during lower basin stakeholder meetings in June 2012.

To better understand the potential for reduced flood impacts, various road and bridge removal projects were modeled using the Chehalis HEC-RAS model, including:

- Removing all bridges and approach fills in the entire model
- Removing the bridge and approach fill of SR-6 alone
- Removing the bridge and approach fills of Mellen Street
- Removing the Bridge and approach fills of Galvin Road
- Removing the bridge and approach fills of Sickman-Ford Bridge
- Removing the bridge and approach fills of Porter Creek Road Bridge
- Removing the bridge and approach fills of Wakefield Road (South Elma) Bridge

Due to time and budget constraints bridge removals were modeled by simply removing the bridge structure, approach fills, and upstream and downstream ineffective flow areas from the model. That is, the entire bridge and approach was removed rather than modified. Obviously, this could create significant concerns for transportation and new bridges and approach roads would likely be necessary in some or all locations to replace the existing structures. The purpose of the current modeling effort was to identify the maximum possible benefit that could be derived from bridge removals so that future analysis efforts could be prioritized to structures that showed some possibility of reducing flooding rather than simply to bridges that have been previously identified as concerns.

I-5 Protection

Flooding in the Chehalis Basin has affected access to I-5, closing it for four days in 1996, four days in 2007, and two days in 2009. The Washington Department of Transportation (DOT) estimated the total loss in economic output to the state economy due to the closure of I-5 in 2007 at $47 million (DOT). The major costs from I-5 closure are freight delays, but closures also impact private operating companies by affecting logistical and scheduling costs, as well as indirect market costs.

The Mellen Street to Blakeslee Junction (MTB) project now underway will provide access to the hospital in Centralia during flood events from downtown Centralia. In addition, the 2011 Washington State Legislature and the Washington State Office of Finance Management (OFM) directed WSDOT to evaluate alternative projects that could protect I-5 and the municipal airport at Centralia and Chehalis. OFM contracted with WSDOT to perform the work on I-5 alternatives. Project alternatives evaluated include raising I-5 using fill material, raising I-5 using a viaduct, relocating I-5 outside the flood area, and protecting I-5 with walls and levees. The fill, viaduct, and relocation projects had cost estimates ranging from $350 million - $2 billion.

The option modeled by WSE would protect I-5 with walls and levees, which has a projected cost of $80-100 million. This project would involve building earthen levees and structural walls, replacing bridges with bottomless arches at Dillenbaugh and Salzer Creek, and providing stormwater treatment systems.

Localized I-5 Protection and Airport Levee Improvements

The Chehalis HEC-RAS model predicts that even if a water retention project in the upper watershed were constructed, it alone would not protect I-5 from flooding during the 2007 and 2009 flood events. Improvements near the south end of Centralia-Chehalis Airport, north of Salzer Creek and north of the 13th Street interchange would also need to be implemented to protect I-5 from flooding. Over the past few years the Chehalis-Centralia Airport has been working on a project for enhancing the Airport Levee. The airport levee enhancement project is designed to provide protection for the Airport and to a lesser degree I-5.

The airport levee project would involve raising the existing 2.3 miles of earthen levee to an elevation three feet above the 100-year flood level as recently identified by FEMA. This is accomplished by widening the base of the levee and constructing it higher in a way that maintains existing side slopes. In addition to the improvements to the existing levee, the project would elevate Airport Road along the south side of the Airport and replace all utility infrastructure. The cost estimate for this project is approximately $3.2 million, with the roadway improvements responsible for the majority of the cost.

However, to achieve protection of the airport area in a 100-year event, some additional localized flood protection improvements would be needed along I-5 north of Salzer Creek and south by Dillenbaugh Creek. This alternative would include those improvements, designed to a level to eliminate I-5 flooding in an event such as the December 2007 Flood.

Skookumchuck Levees

The Corps Twin Cities Levee Project described previously includes levee segments throughout the Twin Cities area in addition to modifications to operations at Skookumchuck Dam. As documented in the Corps Project Closeout Report (2012b) the Corps has determined that the Twin Cities Project is not viable given federal benefit cost criteria. A modified proposal was developed which would include only the levees along the Skookumchuck River (Corps Levee Reaches 12 through 16) and the levee downstream of the Skookumchuck River confluence (Corps Reach 1). This proposal would not include any modifications to Skookumchuck Dam but would assume that the levees were constructed sufficiently high to prevent overtopping in any of the simulated flood events.

Potential Combinations of Alternatives

Following the initial run of flood reduction projects, WSE was asked to model a number of projects in combination to determine the additive impact on flood levels. The following alternatives were simulated in an initial phase of this work:

1) with mainstem dam and airport levee improvements
2) with WSDOT floodwalls/berms and airport levee improvements
3) with Scheuber bypass, Mellen Street bypass, and airport levee improvements
4) with dam, airport levee improvements, WSDOT floodwalls/berms
5) with dam, airport levee improvements, WSDOT floodwalls/berms, downstream bridge removals
6) with Scheuber bypass, Mellen Street bypass, airport levee improvements, WSDOT floodwalls/berms, downstream bridge removals

7) with Scheuber bypass, Mellen Street bypass, airport levee improvements, small floodwall along I-5 near Dillenbaugh Creek

The results of these alternatives were presented at a workshop held in early June in Grand Mound. The participants at that workshop reviewed the results of the preliminary modeling of the combination alternatives and provided feedback on which of these should be developed and evaluated further. The following alternatives were selected for additional modeling and analysis:

A. Mainstem Dam on the Chehalis River, Airport levee improvements, small floodwall along I-5 near Dillenbaugh Creek, Skookumchuck Levees, Sickman Ford Bridge modification, and Wakefield Road (South Elma) Bridge Modification.

B. Same as Alternative "A" with the addition of WSDOT's proposed I-5 berms and floodwall protection project.

C. WSDOT's I-5 berms and floodwalls, Airport levee improvements, Mellen Street and Scheuber Road Bypasses, Skookumchuck Levees, Sickman Ford Bridge modification, and Wakefield Road (South Elma) Bridge Modification.

Results

Results of the simulation of basin wide flood relief alternatives are presented below. Tabular results are included for every alternative and combination of alternatives listed above. Additional, more detailed analyses have also been prepared for some alternatives. These include inundation mapping for the Twin Cities area, detailed evaluation of flooding of I-5, and bar charts comparing the results at various locations throughout the basin for the December 2007 and 100-year events. These more detailed analyses were completed for several of the individual alternatives and each of the groupings described above. While only the results for combination alternatives A, B, and C are presented herein, many others were presented at workshops or Flood Authority meetings over the course of this project. The additional interim results will be included in the final products submitted by WSE to the Flood Authority.

Tabular Summary

Tables 8, 9, and 10 compare the simulated water surface elevations under each of the modeled alternatives with baseline conditions. Comparisons are made at 26 representative locations distributed throughout the basin. These were focused primarily along the main stem Chehalis River but include points along the South Fork Chehalis, Newaukum, and Skookumchuck Rivers. Table 8 includes data for the December 2007 and 100-year flood events for the individual project elements while Table 9 shows the same alternatives for the February 1996 and January 2009 events. Table 10 compares the effect on water surface elevations of combinations of flood relief elements for all four modeled events. The broad distribution of points provides a basin-wide picture of the effects of each alternative and the data for the four simulated floods allows evaluation of the effects under different types of floods.

Table 8: Comparison of Water Surface Elevation Changes with Flood Relief Alternatives – December 2007 and 100-year Storm Events

Alternatives Analysis Summary for December 2007 Flood Event

Location		Max Water Surface Elevation (feet NAVD) or Change in Flood Water Surface (feet)																
		Dec 07	Dec w/Dam	Change	Dec w/Lev	Change	Dec Ph1Lev	Change	Dec w/Dam&Lev	Change	Dec MellenBP	Change	Dec Dredge	Change	Dec ScheuberBP	Change	Dec Sc-AP-Mel	Change
Description	X-section	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)
Near Doty	100.95	328.1	315.8	-12.3	328.1	0.0	328.1	0.0	315.8	-12.3	328.1	0.0	328.1	0.0	328.1	0.0	328.1	0.0
Curtis Store (on S Fork Chehalis)	1.81	238.9	232.8	-6.1	238.9	0.0	238.9	0.0	232.8	-6.1	238.9	0.0	238.9	0.0	238.9	0.0	238.9	0.0
Downstream of South Fork	86.42	227.7	222.1	-5.6	227.6	0.0	227.7	0.0	222.1	-5.6	227.7	0.0	227.7	0.0	227.7	0.0	227.7	0.0
Near Adna	80.23	197.9	196.3	-1.6	197.9	0.0	197.9	0.0	196.3	-1.6	197.9	0.0	197.9	0.0	197.9	0.0	197.9	0.0
Labree Road (on Newaukum R)	4.11	204.7	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0
Newaukum Confluence	75.2	186.6	184.4	-2.2	187.1	0.5	186.6	0.0	184.5	-2.2	186.6	0.0	186.6	0.0	185.1	-1.5	185.6	-1.0
Along Airport Levee	71.49	182.1	179.2	-2.9	183.4	1.3	182.1	0.0	179.7	-2.4	180.4	-1.7	181.5	-0.7	182.1	-0.1	181.2	-0.9
Dillenbaugh Storage Area	SA #301	186.6	184.2	-2.3	187.0	0.5	186.6	0.0	184.4	-2.2	186.6	0.0	186.6	0.0	185.2	-1.4	185.7	-0.9
Airport Storage Area	SA #2	182.2	178.4	-3.7	159.4	-22.8	182.2	0.0	159.4	-22.8	180.6	-1.6	181.5	-0.7	182.1	-0.1	159.4	-22.8
Long Road Storage Area	SA #5	179.1	169.4	-9.7	178.0	-1.1	179.2	0.0	169.4	-9.7	177.7	-1.4	178.5	-0.6	179.1	-0.1	169.4	-9.7
Centralia Storage Area	SA #610	178.5	174.5	-4.0	176.8	-1.7	178.5	0.0	174.5	-3.9	175.8	-2.7	177.2	-1.3	178.4	-0.1	174.7	-3.8
Mellen St	67.43	178.6	175.7	-2.9	178.9	0.3	178.6	0.0	176.0	-2.6	175.4	-3.2	176.9	-1.7	178.6	-0.1	175.5	-3.1
Bucoda (Skookumchuck R)	11.1	244.3	244.3	0.0	244.3	0.0	244.3	0.0	244.3	0.0	244.3	0.0	244.3	0.0	244.3	0.0	244.3	0.0
Pearl Street (Skookumchuck R)	2.43	186.6	186.6	0.0	186.6	0.0	186.6	0.0	186.6	0.0	186.6	0.0	179.6	-7.0	186.6	0.0	186.6	0.0
Skookumchuck Confluence	66.88	176.4	173.4	-3.0	176.4	0.0	176.4	0.0	173.7	-2.7	174.5	-1.9	174.5	-2.0	176.4	-0.1	174.5	-1.9
Upstream of Galvin Road	64.9	168.2	164.6	-3.6	168.2	0.0	168.2	0.0	164.9	-3.3	168.5	0.3	166.6	-1.6	168.1	-0.1	168.6	0.3
Grand Mound (Prather Road)	59.909	147.4	145.7	-1.7	147.4	0.0	147.4	0.0	145.8	-1.5	147.5	0.1	147.4	0.0	147.3	0.0	147.6	0.2
Near Rochester	54.476	124.2	122.0	-2.2	124.2	0.0	124.2	0.0	122.2	-2.0	124.4	0.2	124.2	0.0	124.2	0.0	124.5	0.3
Anderson Road	51.499	106.0	105.3	-0.7	106.0	0.0	106.0	0.0	105.4	-0.6	106.1	0.1	106.0	0.0	106.0	0.0	106.1	0.1
Black River Confluence	46.937	92.9	90.9	-2.0	92.9	0.0	92.9	0.0	91.1	-1.9	93.1	0.2	92.9	0.0	92.9	0.0	93.2	0.3
Sickman Ford Bridge	44.175	85.5	83.0	-2.5	85.5	0.0	85.5	0.0	83.2	-2.3	85.7	0.2	85.5	0.0	85.5	0.0	85.8	0.3
Porter Creek Road	34.497	57.0	54.7	-2.3	57.0	0.0	57.0	0.0	54.9	-2.1	57.2	0.2	57.0	0.0	57.0	0.0	57.3	0.3
Wakefield Road	24.52	40.2	37.7	-2.5	40.3	0.1	40.2	0.0	37.9	-2.3	40.4	0.3	40.2	0.0	40.2	0.1	40.6	0.4
Satsop Confluence	19.89	34.5	33.1	-1.4	34.5	0.0	34.5	0.0	33.2	-1.3	34.6	0.1	34.5	0.0	34.5	0.0	34.7	0.2
Montesano	12.5	17.3	15.6	-1.7	17.4	0.1	17.3	0.0	15.7	-1.6	17.5	0.2	17.2	-0.1	17.3	0.1	17.6	0.4
Cosmopolis	1.99	10.9	10.9	0.0	10.9	0.0	10.9	0.0	10.9	0.0	10.9	0.0	11.0	0.1	10.9	0.0	10.9	0.0

Note: Negative change means that the alternative has lower simulated water levels, positive change indicates the alternative raises water levels.

Alternatives Analysis Summary for 100-year Design Event

Location		Max Water Surface Elevation (feet NAVD) or Change in Flood Water Surface (feet)																
		100 Year	100 w/Dam	Change	100 w/Lev	Change	100 Ph1Lev	Change	100 w/Dam&Lev	Change	100 w/MellenBP	Change	100 w/Dredge	Change	100 w/ScheuberBP	Change	100 w/Sc-AP-Mel	Change
Description	X-section	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)
Near Doty	100.95	323.2	313.0	-10.3	323.2	0.0	323.2	0.0	313.0	-10.3	323.2	0.0	323.2	0.0	323.2	0.0	323.2	0.0
Curtis Store (on S Fork Chehalis)	1.81	233.6	230.2	-3.3	233.6	0.0	233.6	0.0	230.2	-3.3	233.6	0.0	233.6	0.0	233.6	0.0	233.6	0.0
Downstream of South Fork	86.42	223.2	219.1	-4.1	223.2	0.0	223.2	0.0	219.1	-4.1	223.2	0.0	223.2	0.0	223.2	0.0	223.2	0.0
Near Adna	80.23	197.1	195.5	-1.6	197.1	0.0	197.1	0.0	195.5	-1.6	197.1	0.0	197.1	0.0	197.1	-0.1	197.1	-0.1
Labree Road (on Newaukum R)	4.11	204.9	204.9	0.0	204.9	0.0	204.9	0.0	204.9	0.0	204.9	0.0	204.9	0.0	204.9	0.0	204.9	0.0
Newaukum Confluence	75.2	185.7	184.1	-1.6	186.0	0.3	185.7	0.0	184.1	-1.6	185.7	0.0	185.6	-0.1	183.8	-1.9	184.0	-1.7
Along Airport Levee	71.49	180.8	179.1	-1.7	181.7	0.9	180.8	0.0	179.3	-1.4	179.4	-1.4	180.0	-0.8	180.8	0.0	179.9	-0.9
Dillenbaugh Storage Area	SA #301	185.8	184.3	-1.5	186.1	0.2	185.8	0.0	184.3	-1.5	185.8	0.0	185.8	0.0	184.2	-1.6	184.4	-1.4
Airport Storage Area	SA #2	180.8	177.2	-3.6	159.4	-21.4	180.8	0.0	159.4	-21.4	179.4	-1.3	179.9	-0.9	180.8	0.0	159.4	-21.4
Long Road Storage Area	SA #5	177.9	169.4	-8.5	176.7	-1.3	177.9	0.0	169.4	-8.5	169.4	-8.5	176.7	-1.2	177.9	0.0	169.4	-8.5
Centralia Storage Area	SA #610	176.7	174.7	-1.9	176.1	-0.6	176.7	0.0	174.8	-1.8	174.3	-2.3	175.1	-1.6	176.6	0.0	174.3	-2.3
Mellen St	67.43	177.6	175.8	-1.8	177.8	0.2	177.6	0.0	176.0	-1.6	174.3	-3.3	175.5	-2.1	177.6	0.0	174.5	-3.1
Bucoda (Skookumchuck R)	11.1	252.0	252.0	0.0	252.0	0.0	252.0	0.0	252.0	0.0	252.0	0.0	252.0	0.0	252.0	0.0	252.0	0.0
Pearl Street (Skookumchuck R)	2.43	191.7	191.7	0.0	191.7	0.0	191.7	0.0	191.7	0.0	191.7	0.0	189.4	-2.3	191.7	0.0	191.7	0.0
Skookumchuck Confluence	66.88	175.7	174.0	-1.7	175.8	0.1	175.7	0.0	174.2	-1.5	173.8	-1.9	173.5	-2.2	175.7	0.0	173.9	-1.8
Upstream of Galvin Road	64.9	167.3	165.2	-2.1	167.4	0.1	167.3	0.0	165.4	-2.0	167.6	0.2	165.5	-1.8	167.3	0.0	167.8	0.4
Grand Mound (Prather Road)	59.909	147.1	146.2	-0.9	147.1	0.0	147.1	0.0	146.3	-0.8	147.2	0.1	147.1	0.0	147.1	0.0	147.3	0.2
Near Rochester	54.476	124.0	122.8	-1.2	124.1	0.1	124.0	0.0	122.9	-1.1	124.2	0.2	124.0	0.0	124.0	0.0	124.4	0.4
Anderson Road	51.499	106.1	105.7	-0.3	106.1	0.0	106.1	0.0	105.8	-0.3	106.1	0.1	106.1	0.0	106.1	0.0	106.2	0.1
Black River Confluence	46.937	93.0	92.0	-1.1	93.1	0.1	93.0	0.0	92.1	-0.9	93.2	0.2	93.0	0.0	93.0	0.0	93.4	0.4
Sickman Ford Bridge	44.175	85.6	84.3	-1.3	85.7	0.1	85.6	0.0	84.4	-1.2	85.8	0.2	85.6	0.0	85.7	0.0	86.1	0.4
Porter Creek Road	34.497	57.4	56.2	-1.2	57.5	0.1	57.4	0.0	56.3	-1.1	57.5	0.2	57.4	0.0	57.4	0.0	57.8	0.5
Wakefield Road	24.52	41.6	40.1	-1.5	41.7	0.1	41.6	0.0	40.2	-1.4	41.8	0.2	41.6	0.0	41.7	0.1	42.1	0.5
Satsop Confluence	19.89	35.4	34.8	-0.6	35.5	0.1	35.4	0.0	34.9	-0.6	35.5	0.1	35.4	0.0	35.5	0.1	35.7	0.2
Montesano	12.5	18.8	18.1	-0.7	18.9	0.1	18.8	0.0	18.2	-0.7	19.0	0.1	18.9	0.0	18.9	0.1	19.2	0.3
Cosmopolis	1.99	11.0	10.6	-0.4	11.1	0.1	11.0	0.0	10.6	-0.4	11.1	0.1	11.0	0.0	11.1	0.1	11.2	0.2

Note: Negative change means that the alternative has lower simulated water levels, positive change indicates the alternative raises water levels.

Table 8 (continued): Comparison of Water Surface Elevation Changes with Flood Relief Alternatives – December 2007 and 100-year Storm Events

Alternatives Analysis Summary for December 2007 Flood Event

		Max Water Surface Elevation (feet NAVD) or Change in Flood Water Surface (feet)														
Location		Dec 07	Dec WSDOT I5	Change	Dec WSDOT-AP	Change	Dec I5-Dam	Change	Dec I5-Dam-Br	Change	Dec I5-2BP-Br	Change	Dec Twin Cities	Change	Dec Skook Lev	Change
Description	X-section	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)
Near Doty	100.95	328.1	328.1	0.0	328.1	0.0	315.8	-12.3	315.8	-12.3	328.1	0.0	328.1	0.0	328.1	0.0
Curtis Store (on S Fork Chehalis)	1.81	238.9	238.9	0.0	238.9	0.0	232.8	-6.1	232.8	-6.1	238.9	0.0	238.9	0.0	238.9	0.0
Downstream of South Fork	86.42	227.7	227.7	0.0	227.7	0.0	222.1	-5.6	222.1	-5.6	227.7	0.0	227.7	0.0	227.7	0.0
Near Adna	80.23	197.9	197.9	0.0	197.9	0.0	196.3	-1.6	196.3	-1.6	197.9	0.0	197.9	0.0	197.9	0.0
Labree Road (on Newaukum R)	4.11	204.7	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0
Newaukum Confluence	75.2	186.6	186.7	0.1	187.2	0.6	184.5	-2.1	184.5	-2.1	185.6	-1.0	187.7	1.1	186.6	0.0
Along Airport Levee	71.49	182.1	183.0	0.8	183.4	1.2	179.7	-2.4	179.7	-2.4	181.3	-0.8	184.1	2.0	182.2	0.1
Dillenbaugh Storage Area	SA #301	186.6	186.8	0.3	187.3	0.8	184.4	-2.2	184.4	-2.2	185.8	-0.8	173.4	-13.2	186.6	0.0
Airport Storage Area	SA #2	182.2	183.1	0.9	159.4	-22.8	159.4	-22.8	159.4	-22.8	159.4	-22.8	175.0	-7.2	182.3	0.1
Long Road Storage Area	SA #5	179.1	177.9	-1.2	177.9	-1.2	169.4	-9.7	169.4	-9.7	169.4	-9.7	181.9	2.7	181.6	2.5
Centralia Storage Area	SA #610	178.5	176.6	-1.9	176.7	-1.8	174.5	-3.9	174.5	-3.9	174.6	-3.8	181.9	3.4	181.6	3.1
Mellen St	67.43	178.6	178.9	0.2	178.9	0.2	176.0	-2.6	176.0	-2.6	175.5	-3.2	179.4	0.8	179.0	0.4
Bucoda (Skookumchuck R)	11.1	244.3	244.3	0.0	244.3	0.0	244.3	0.0	244.3	0.0	244.3	0.0	245.5	1.3	244.3	0.0
Pearl Street (Skookumchuck R)	2.43	186.6	186.6	0.0	186.6	0.0	186.6	0.0	186.6	0.0	186.6	0.0	187.1	0.5	186.6	0.0
Skookumchuck Confluence	66.88	176.4	176.4	0.0	176.4	0.0	173.7	-2.7	173.7	-2.7	174.5	-2.0	177.1	0.7	176.6	0.2
Upstream of Galvin Road	64.9	168.2	168.2	-0.1	168.2	-0.1	164.9	-3.3	164.8	-3.5	168.1	-0.1	168.5	0.3	168.0	-0.3
Grand Mound (Prather Road)	59.909	147.4	147.3	-0.1	147.3	0.0	145.9	-1.5	146.7	-0.7	148.4	1.0	147.6	0.2	147.3	-0.1
Near Rochester	54.476	124.2	124.1	-0.1	124.2	0.0	122.2	-2.0	122.2	-2.1	124.4	0.2	124.5	0.3	124.1	-0.1
Anderson Road	51.499	106.0	106.0	0.0	106.0	0.0	105.4	-0.6	105.4	-0.6	106.1	0.1	106.1	0.1	106.0	0.0
Black River Confluence	46.937	92.9	92.9	0.0	92.9	0.0	91.1	-1.9	90.9	-2.0	92.9	0.0	93.2	0.3	92.8	-0.1
Sickman Ford Bridge	44.175	85.5	85.4	-0.1	85.5	0.0	83.2	-2.3	82.1	-3.4	84.4	-1.1	85.9	0.4	85.3	-0.1
Porter Creek Road	34.497	57.0	56.9	0.0	57.0	0.0	54.9	-2.1	54.8	-2.2	57.2	0.2	57.4	0.4	58.5	1.5
Wakefield Road	24.52	40.2	40.2	0.0	40.2	0.0	37.9	-2.3	37.8	-2.4	40.7	0.5	40.7	0.5	40.7	0.5
Satsop Confluence	19.89	34.5	34.5	0.0	34.5	0.0	33.2	-1.3	33.2	-1.3	34.7	0.2	34.7	0.2	34.4	-0.1
Montesano	12.5	17.3	17.3	0.0	17.3	0.1	15.7	-1.6	15.7	-1.6	17.7	0.4	17.5	0.2	17.2	-0.1
Cosmopolis	1.99	10.9	10.9	0.0	10.9	0.0	10.9	0.0	10.9	0.0	10.9	0.0	11.0	0.1	10.9	0.0

Note: Negative change means that the alternative has lower simulated water levels, positive change indicates the alternative raises water levels.

Alternatives Analysis Summary for 100-year Design Event

		Max Water Surface Elevation (feet NAVD) or Change in Flood Water Surface (feet)														
Location		100 Year	100 WSDOT I5	Change	100 WSDOT-AP	Change	100 I5-Dam	Change	100 I5-Dam-Br	Change	100 I5-2BP-Br	Change	100 Twin Cities	Change	100 Skook Lev	Change
Description	X-section	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)
Near Doty	100.95	323.2	323.2	0.0	323.2	0.0	313.0	-10.3	313.0	-10.3	323.2	0.0	323.2	0.0	323.2	0.0
Curtis Store (on S Fork Chehalis)	1.81	233.6	233.6	0.0	233.6	0.0	230.2	-3.3	230.2	-3.3	233.6	0.0	233.6	0.0	233.6	0.0
Downstream of South Fork	86.42	223.2	223.2	0.0	223.2	0.0	219.1	-4.1	219.1	-4.1	223.2	0.0	223.2	0.0	223.2	0.0
Near Adna	80.23	197.1	197.1	0.0	197.1	0.0	195.5	-1.6	195.5	-1.6	197.1	-0.1	197.1	0.0	197.1	0.0
Labree Road (on Newaukum R)	4.11	204.9	204.9	0.0	204.9	0.0	204.9	0.0	204.9	0.0	204.9	0.0	204.9	0.0	204.9	0.0
Newaukum Confluence	75.2	185.7	185.7	0.1	186.0	0.3	184.1	-1.6	184.1	-1.6	184.0	-1.7	186.2	0.5	185.7	0.0
Along Airport Levee	71.49	180.8	181.3	0.5	181.6	0.9	179.4	-1.4	179.4	-1.4	179.9	-0.9	182.5	1.7	180.8	0.1
Dillenbaugh Storage Area	SA #301	185.8	185.9	0.1	186.2	0.4	184.3	-1.5	184.3	-1.5	184.4	-1.4	173.7	-12.2	185.8	0.0
Airport Storage Area	SA #2	180.8	181.4	0.6	159.4	-21.4	159.4	-21.4	159.4	-21.4	159.4	-21.4	159.4	-21.4	180.8	0.1
Long Road Storage Area	SA #5	177.9	176.0	-2.0	176.6	-1.3	169.4	-8.5	169.4	-8.5	169.4	-8.5	177.6	-0.3	180.4	2.4
Centralia Storage Area	SA #610	176.7	176.0	-0.6	176.1	-0.6	174.8	-1.8	174.8	-1.8	174.3	-2.3	177.6	0.9	180.4	3.7
Mellen St	67.43	177.6	177.7	0.2	177.8	0.2	176.0	-1.6	176.0	-1.6	174.5	-3.1	178.5	0.9	177.7	0.1
Bucoda (Skookumchuck R)	11.1	252.0	252.0	0.0	252.0	0.0	252.0	0.0	252.0	0.0	252.0	0.0	250.6	-1.4	251.9	0.0
Pearl Street (Skookumchuck R)	2.43	191.7	191.7	0.0	191.7	0.0	191.7	0.0	191.7	0.0	191.7	0.0	190.2	-1.4	192.4	0.7
Skookumchuck Confluence	66.88	175.7	175.7	0.0	175.8	0.1	174.2	-1.5	174.2	-1.5	173.9	-1.8	176.5	0.8	175.8	0.1
Upstream of Galvin Road	64.9	167.3	167.4	0.0	167.4	0.1	165.4	-2.0	165.2	-2.1	167.5	0.1	167.8	0.5	167.1	-0.2
Grand Mound (Prather Road)	59.909	147.1	147.1	0.0	147.1	0.0	146.3	-0.8	147.1	0.0	148.1	1.0	147.4	0.3	147.0	-0.1
Near Rochester	54.476	124.0	124.0	0.0	124.1	0.1	122.9	-1.1	122.9	-1.1	124.3	0.3	124.4	0.4	123.9	-0.1
Anderson Road	51.499	106.1	106.1	0.0	106.1	0.0	105.8	-0.3	105.8	-0.3	106.2	0.1	106.2	0.1	106.0	0.0
Black River Confluence	46.937	93.0	93.0	0.0	93.1	0.1	92.1	-0.9	91.9	-1.1	93.1	0.1	93.4	0.4	92.9	-0.1
Sickman Ford Bridge	44.175	85.6	85.7	0.0	85.7	0.1	84.5	-1.2	83.2	-2.4	84.7	-0.9	86.1	0.4	85.5	-0.1
Porter Creek Road	34.497	57.4	57.4	0.0	57.5	0.1	56.3	-1.1	56.2	-1.2	57.7	0.4	57.8	0.4	59.0	1.7
Wakefield Road	24.52	41.6	41.6	0.0	41.7	0.1	40.2	-1.4	40.2	-1.3	42.0	0.4	41.9	0.3	41.7	0.2
Satsop Confluence	19.89	35.4	35.4	0.0	35.5	0.1	34.9	-0.5	34.9	-0.5	35.7	0.3	35.6	0.2	35.4	0.0
Montesano	12.5	18.8	18.9	0.0	18.9	0.1	18.2	-0.7	18.2	-0.7	19.2	0.3	19.0	0.2	18.8	0.0
Cosmopolis	1.99	11.0	11.0	0.0	11.0	0.0	10.6	-0.4	10.6	-0.4	11.2	0.2	11.1	0.1	11.0	0.0

Note: Negative change means that the alternative has lower simulated water levels, positive change indicates the alternative raises water levels.

Table 9: Comparison of Water Surface Elevation Changes with Flood Relief Alternatives – February 1996 and January 2009 Storm Events

Alternatives Analysis Summary for February 1996 Flood Event

Location		Max Water Surface Elevation (feet NAVD) or Change in Flood Water Surface (feet)																
		Feb 96	Feb w/Dam	Change	Feb w/Lev	Change	Feb Ph1 Lev	Change	Feb w/Dam&Lev	Change	Feb MellenBP	Change	Feb Dredge	Change	Feb ScheuberBP	Change	Feb Sc-AP-Mel	Change
Description	X-section	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)
Near Doty	100.95	318.1	307.2	-10.9	318.1	0.0	318.1	0.0	307.2	-10.9	318.1	0.0	318.1	0.0	318.1	0.0	318.1	0.0
Curtis Store (on S Fork Chehalis)	1.81	233.1	231.1	-2.1	233.1	0.0	233.1	0.0	231.1	-2.1	233.2	0.0	233.2	0.0	233.2	0.0	233.1	0.0
Downstream of South Fork	86.42	222.4	219.0	-3.5	222.4	0.0	222.4	0.0	219.0	-3.5	222.4	0.0	222.4	0.0	222.4	0.0	222.4	0.0
Near Adna	80.23	196.6	195.0	-1.6	196.6	0.0	196.6	0.0	195.0	-1.6	196.6	0.0	196.6	0.0	196.4	-0.2	196.4	-0.2
Labree Road (on Newaukum R)	4.11	204.6	204.6	0.0	204.6	0.0	204.6	0.0	204.6	0.0	204.6	0.0	204.6	0.0	204.6	0.0	204.6	0.0
Newaukum Confluence	75.2	185.1	183.8	-1.3	185.3	0.2	185.1	0.0	183.9	-1.3	185.1	-0.1	185.1	0.0	183.2	-1.9	183.3	-1.8
Along Airport Levee	71.49	180.3	179.0	-1.3	181.0	0.7	180.3	0.0	179.2	-1.1	179.0	-1.3	179.6	-0.8	180.4	0.0	179.4	-0.9
Dillenbaugh Storage Area	SA #301	185.1	183.8	-1.4	185.4	0.3	185.1	0.0	183.8	-1.3	185.1	-0.1	185.1	0.0	183.4	-1.8	183.5	-1.7
Airport Storage Area	SA #2	180.3	175.9	-4.4	159.4	-20.9	180.3	0.0	159.4	-20.9	178.9	-1.4	179.3	-1.0	180.4	0.0	159.4	-20.9
Long Road Storage Area	SA #5	177.5	169.4	-8.1	175.2	-2.3	177.5	0.0	169.4	-8.1	169.4	-8.1	170.3	-7.2	177.6	0.1	169.4	-8.1
Centralia Storage Area	SA #610	176.1	174.8	-1.3	176.1	-0.1	176.1	0.0	174.9	-1.2	174.1	-2.0	174.7	-1.5	176.2	0.1	174.3	-1.8
Mellen St	67.43	177.3	175.9	-1.4	177.5	0.2	177.3	0.0	176.1	-1.2	174.0	-3.3	175.2	-2.0	177.3	0.0	174.2	-3.0
Bucoda (Skookumchuck R)	11.1	251.4	251.4	0.0	251.4	0.0	251.4	0.0	251.4	0.0	251.4	0.0	251.4	0.0	251.4	0.0	251.4	0.0
Pearl Street (Skookumchuck R)	2.43	191.3	191.3	0.0	191.3	0.0	191.3	0.0	191.3	0.0	191.3	0.0	188.8	-2.5	191.3	0.0	191.3	0.0
Skookumchuck Confluence	66.88	175.5	174.2	-1.3	175.6	0.1	175.5	0.0	174.4	-1.1	173.6	-1.9	173.3	-2.2	175.6	0.1	173.8	-1.7
Upstream of Galvin Road	64.9	167.1	165.4	-1.7	167.3	0.2	167.2	0.0	165.6	-1.6	167.4	0.2	165.3	-1.8	167.2	0.1	167.6	0.5
Grand Mound (Prather Road)	59.909	146.9	146.2	-0.7	147.0	0.1	146.9	0.0	146.3	-0.6	147.0	0.1	146.9	0.0	146.9	0.0	147.2	0.3
Near Rochester	54.476	123.7	122.8	-0.9	123.8	0.1	123.7	0.0	122.9	-0.8	123.8	0.2	123.7	0.0	123.7	0.0	124.0	0.4
Anderson Road	51.499	105.9	105.6	-0.3	105.9	0.0	105.9	0.0	105.7	-0.2	106.0	0.0	105.9	0.0	105.9	0.0	106.0	0.1
Black River Confluence	46.937	92.6	91.8	-0.8	92.7	0.1	92.6	0.0	91.9	-0.7	92.7	0.2	92.6	0.0	92.6	0.1	92.9	0.4
Sickman Ford Bridge	44.175	85.0	84.1	-0.9	85.2	0.2	85.0	0.0	84.2	-0.8	85.2	0.2	85.1	0.0	85.1	0.1	85.5	0.5
Porter Creek Road	34.497	56.7	55.8	-0.9	56.8	0.1	56.7	0.0	55.9	-0.8	56.9	0.2	56.7	0.0	56.7	0.1	57.1	0.4
Wakefield Road	24.52	40.1	39.2	-0.9	40.3	0.2	40.1	0.0	39.3	-0.8	40.3	0.2	40.1	0.0	40.2	0.1	40.7	0.6
Satsop Confluence	19.89	34.7	34.5	-0.2	34.7	0.0	34.7	0.0	34.5	-0.2	34.8	0.1	34.8	0.1	34.8	0.1	34.9	0.2
Montesano	12.5	17.6	17.3	-0.3	17.6	0.0	17.6	0.0	17.3	-0.3	17.7	0.2	17.8	0.2	17.7	0.2	17.9	0.3
Cosmopolis	1.99	9.3	9.2	-0.1	9.3	0.0	9.3	0.0	9.2	-0.1	9.4	0.1	9.4	0.0	9.4	0.1	9.5	0.1

Note: Negative change means that the alternative has lower simulated water levels, positive change indicates the alternative raises water levels.

Alternatives Analysis Summary for January 2009 Flood Event

Location		Max Water Surface Elevation (feet NAVD) or Change in Flood Water Surface (feet)																
		Jan 09	Jan w/Dam	Change	Jan w/Lev	Change	Jan Ph1 Lev	Change	Jan w/Dam&Lev	Change	Jan w/MellenBP	Change	Jan w/Dredge	Change	Jan w/ScheuberBP	Change	Jan w/Sc-AP-Mel	Change
Description	X-section	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)
Near Doty	100.95	314.4	306.7	-7.7	314.4	0.0	314.4	0.0	306.7	-7.7	314.4	0.0	314.4	0.0	314.4	0.0	314.4	0.0
Curtis Store (on S Fork Chehalis)	1.81	228.1	227.7	-0.5	228.1	0.0	228.1	0.0	227.7	-0.5	228.1	0.0	228.1	0.0	228.1	0.0	228.1	0.0
Downstream of South Fork	86.42	216.9	213.3	-3.7	216.9	0.0	216.9	0.0	213.3	-3.6	216.9	0.0	216.9	0.0	216.9	0.0	216.9	0.0
Near Adna	80.23	193.9	191.7	-2.2	193.9	0.0	193.9	0.0	191.7	-2.2	193.9	0.0	193.9	0.0	193.6	-0.3	193.6	-0.3
Labree Road (on Newaukum R)	4.11	204.7	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0
Newaukum Confluence	75.2	183.5	182.1	-1.4	183.5	0.0	183.5	0.0	182.1	-1.4	183.4	-0.1	183.4	-0.1	181.8	-1.7	181.5	-2.0
Along Airport Levee	71.49	178.8	177.4	-1.3	178.8	0.1	178.8	0.0	177.4	-1.3	177.7	-1.1	178.1	-0.7	178.9	0.2	177.9	-0.8
Dillenbaugh Storage Area	SA #301	184.1	183.7	-0.4	184.1	0.0	184.1	0.0	183.7	-0.4	184.1	0.0	184.0	0.0	183.8	-0.3	183.7	-0.4
Airport Storage Area	SA #2	172.0	159.4	-12.6	159.4	-12.6	172.0	0.0	159.4	-12.6	167.2	-4.8	169.1	-2.9	174.5	2.6	159.4	-12.6
Long Road Storage Area	SA #5	169.4	169.4	0.0	169.4	0.0	169.4	0.0	169.4	0.0	169.4	0.0	169.4	0.0	169.4	0.0	169.4	0.0
Centralia Storage Area	SA #610	174.5	174.0	-0.5	174.6	0.0	174.5	0.0	174.0	-0.5	172.4	-2.1	172.9	-1.7	174.6	0.1	172.7	-1.9
Mellen St	67.43	175.6	174.5	-1.2	175.7	0.1	175.6	0.0	174.5	-1.2	172.4	-3.2	173.2	-2.5	175.7	0.1	172.6	-3.0
Bucoda (Skookumchuck R)	11.1	250.9	250.9	0.0	250.9	0.0	250.9	0.0	250.9	0.0	250.9	0.0	250.9	0.0	250.9	0.0	250.9	0.0
Pearl Street (Skookumchuck R)	2.43	190.5	190.5	0.0	190.5	0.0	190.5	0.0	190.5	0.0	190.5	0.0	188.1	-2.4	190.5	0.0	190.5	0.0
Skookumchuck Confluence	66.88	173.9	172.9	-1.0	174.0	0.1	173.9	0.0	172.9	-1.0	172.0	-1.9	171.3	-2.6	174.0	0.1	172.2	-1.7
Upstream of Galvin Road	64.9	165.1	164.1	-1.0	165.1	0.0	165.1	0.0	164.1	-1.0	165.3	0.2	163.6	-1.5	165.2	0.1	165.5	0.4
Grand Mound (Prather Road)	59.909	146.0	145.5	-0.5	146.0	0.0	146.0	0.0	145.5	-0.5	146.1	0.1	146.0	0.0	146.1	0.1	146.2	0.2
Near Rochester	54.476	122.5	121.8	-0.7	122.5	0.0	122.5	0.0	121.8	-0.7	122.7	0.2	122.5	0.0	122.6	0.1	122.8	0.3
Anderson Road	51.499	105.5	105.3	-0.3	105.6	0.0	105.5	0.0	105.3	-0.3	105.6	0.0	105.5	0.0	105.6	0.0	105.6	0.1
Black River Confluence	46.937	91.6	91.0	-0.7	91.7	0.0	91.6	0.0	91.0	-0.7	91.8	0.1	91.6	0.0	91.8	0.1	92.0	0.3
Sickman Ford Bridge	44.175	83.8	83.0	-0.9	83.9	0.0	83.8	0.0	83.0	-0.9	84.0	0.2	83.8	0.0	84.0	0.2	84.3	0.4
Porter Creek Road	34.497	55.6	54.8	-0.8	55.7	0.0	55.6	0.0	54.8	-0.8	55.8	0.2	55.6	0.0	55.8	0.2	56.0	0.4
Wakefield Road	24.52	38.8	37.9	-0.9	38.8	0.0	38.8	0.0	37.9	-0.9	39.0	0.2	38.8	0.0	39.0	0.2	39.3	0.5
Satsop Confluence	19.89	33.7	33.4	-0.3	33.7	0.0	33.7	0.0	33.4	-0.3	33.8	0.1	33.7	0.0	33.8	0.2	34.0	0.4
Montesano	12.5	17.7	17.6	-0.1	17.7	0.0	17.7	0.0	17.6	-0.1	17.8	0.0	17.8	0.1	17.7	0.0	17.8	0.0
Cosmopolis	1.99	11.7	11.7	0.0	11.7	0.0	11.7	0.0	11.7	0.0	11.7	0.0	11.7	0.0	11.7	0.0	11.7	0.0

Note: Negative change means that the alternative has lower simulated water levels, positive change indicates the alternative raises water levels.

Table 9 (continued): Comparison of Water Surface Elevation Changes with Flood Relief Alternatives – February 1996 and January 2009 Storm Events

Alternatives Analysis Summary for February 1996 Flood Event

								Max Water Surface Elevation (feet NAVD) or Change in Flood Water Surface (feet)								
Location		Feb 96	Feb WSDOT I5	Change	Feb WSDOT-AP	Change	Feb I5-Dam	Change	Feb I5-Dam-Br	Change	Feb I5-2BP-Br	Change	Feb Twin Cities	Change	Feb Skook Lev	Change
Description	X-section	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)
Near Doty	100.95	318.1	318.1	0.0	318.1	0.0	307.2	-10.9	307.2	-11.0	318.1	0.0	318.1	0.0	318.1	0.0
Curtis Store (on S Fork Chehalis)	1.81	233.1	233.2	0.0	233.2	0.0	231.1	-2.1	231.1	-2.1	233.2	0.0	233.2	0.0	233.2	0.0
Downstream of South Fork	86.42	222.4	222.4	0.0	222.4	0.0	219.0	-3.5	219.0	-3.5	222.4	0.0	222.4	0.0	222.4	0.0
Near Adna	80.23	196.6	196.6	0.0	196.6	0.0	195.0	-1.6	195.0	-1.6	196.4	-0.2	196.6	0.0	196.6	0.0
Labree Road (on Newaukum R)	4.11	204.6	204.6	0.0	204.6	0.0	204.6	0.0	204.6	0.0	204.6	0.0	204.6	0.0	204.6	0.0
Newaukum Confluence	75.2	185.1	185.1	0.0	185.4	0.3	183.9	-1.3	183.9	-1.3	183.4	-1.8	185.4	0.3	185.1	0.0
Along Airport Levee	71.49	180.3	180.7	0.4	181.0	0.7	179.3	-1.1	179.2	-1.1	179.4	-0.9	181.3	1.0	180.4	0.1
Dillenbaugh Storage Area	SA #301	185.1	185.2	0.1	185.5	0.4	183.8	-1.3	183.8	-1.3	183.5	-1.7	173.4	-11.7	185.2	0.0
Airport Storage Area	SA #2	180.3	180.8	0.5	159.4	-20.9	159.4	-20.9	159.4	-20.9	159.4	-20.9	159.4	-20.9	180.4	0.1
Long Road Storage Area	SA #5	177.5	174.3	-3.2	175.4	-2.1	169.4	-8.1	169.4	-8.1	169.4	-8.1	176.4	-1.1	179.5	2.0
Centralia Storage Area	SA #610	176.1	176.0	-0.1	176.1	-0.1	174.9	-1.2	174.9	-1.2	174.3	-1.8	177.2	1.0	179.5	3.4
Mellen St	67.43	177.3	177.4	0.1	177.5	0.2	176.1	-1.2	176.1	-1.2	174.2	-3.0	177.7	0.4	177.4	0.2
Bucoda (Skookumchuck R)	11.1	251.4	251.4	0.0	251.4	0.0	251.4	0.0	251.4	0.0	251.4	0.0	249.0	-2.4	251.4	0.0
Pearl Street (Skookumchuck R)	2.43	191.3	191.3	0.0	191.3	0.0	191.3	0.0	191.3	0.0	191.3	0.0	190.1	-1.2	191.4	0.2
Skookumchuck Confluence	66.88	175.5	175.6	0.1	175.7	0.2	174.4	-1.1	174.4	-1.1	173.8	-1.7	175.6	0.1	175.6	0.1
Upstream of Galvin Road	64.9	167.1	167.2	0.1	167.3	0.2	165.6	-1.6	165.4	-1.7	167.4	0.2	166.9	-0.3	166.9	-0.3
Grand Mound (Prather Road)	59.909	146.9	146.9	0.0	147.0	0.1	146.3	-0.6	147.1	0.2	148.0	1.1	146.9	-0.1	146.8	-0.1
Near Rochester	54.476	123.7	123.7	0.1	123.8	0.1	122.9	-0.8	122.8	-0.8	124.0	0.3	123.6	0.0	123.6	-0.1
Anderson Road	51.499	105.9	105.9	0.0	105.9	0.0	105.7	-0.2	105.7	-0.2	106.0	0.1	105.9	0.0	105.9	0.0
Black River Confluence	46.937	92.6	92.6	0.1	92.7	0.2	91.9	-0.7	91.7	-0.8	92.7	0.1	92.5	0.0	92.5	-0.1
Sickman Ford Bridge	44.175	85.0	85.1	0.1	85.2	0.2	84.2	-0.8	83.0	-2.0	84.2	-0.9	85.0	0.0	85.0	-0.1
Porter Creek Road	34.497	56.7	56.7	0.1	56.8	0.2	55.9	-0.8	55.8	-0.9	57.0	0.3	56.7	0.0	58.2	1.5
Wakefield Road	24.52	40.1	40.2	0.1	40.3	0.2	39.3	-0.8	39.2	-0.9	40.7	0.6	40.1	0.0	40.7	0.6
Satsop Confluence	19.89	34.7	34.7	0.0	34.7	0.0	34.5	-0.2	34.5	-0.2	34.9	0.2	34.7	0.0	34.7	0.0
Montesano	12.5	17.6	17.6	0.0	17.6	0.0	17.3	-0.3	17.3	-0.3	17.9	0.3	17.7	0.1	17.6	0.0
Cosmopolis	1.99	9.3	9.3	0.0	9.3	0.0	9.2	-0.1	9.2	-0.1	9.5	0.1	9.3	0.0	9.3	0.0

Note: Negative change means that the alternative has lower simulated water levels, positive change indicates the alternative raises water levels.

Alternatives Analysis Summary for January 2009 Flood Event

								Max Water Surface Elevation (feet NAVD) or Change in Flood Water Surface (feet)								
Location		Jan 09	Jan WSDOT I5	Change	Jan WSDOT-AP	Change	Jan I5-Dam	Change	Jan I5-Dam-Br	Change	Jan I5-2BP-Br	Change	Jan Twin Cities	Change	Jan Skook Lev	Change
Description	X-section	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)	(ft NAVD)
Near Doty	100.95	314.4	314.4	0.0	314.4	0.0	306.7	-7.7	306.7	-7.7	314.4	0.0	314.4	0.0	314.4	0.0
Curtis Store (on S Fork Chehalis)	1.81	228.1	228.1	0.0	228.1	0.0	227.7	-0.5	227.7	-0.5	228.1	0.0	228.1	0.0	228.1	0.0
Downstream of South Fork	86.42	216.9	216.9	0.0	216.9	0.0	213.3	-3.6	213.3	-3.7	216.9	0.0	216.9	0.0	216.9	0.0
Near Adna	80.23	193.9	193.9	0.0	193.9	0.0	191.7	-2.2	191.7	-2.2	193.6	-0.3	193.9	0.0	193.9	0.0
Labree Road (on Newaukum R)	4.11	204.7	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0	204.7	0.0
Newaukum Confluence	75.2	183.5	183.5	0.0	183.5	0.0	182.1	-1.4	182.1	-1.4	181.6	-1.9	183.4	-0.1	183.5	0.0
Along Airport Levee	71.49	178.8	178.8	0.0	178.9	0.1	177.4	-1.3	177.4	-1.3	177.9	-0.8	178.8	0.1	178.8	0.0
Dillenbaugh Storage Area	SA #301	184.1	184.1	0.0	184.1	0.0	183.7	-0.3	183.7	-0.3	183.7	-0.3	173.4	-10.7	184.1	0.0
Airport Storage Area	SA #2	172.0	172.2	0.2	159.4	-12.6	159.4	-12.6	159.4	-12.6	159.4	-12.6	159.4	-12.6	172.0	0.1
Long Road Storage Area	SA #5	169.4	169.4	0.0	169.4	0.0	169.4	0.0	169.4	0.0	169.4	0.0	169.4	0.0	169.4	0.0
Centralia Storage Area	SA #610	174.5	174.5	0.0	174.6	0.0	174.0	-0.5	174.0	-0.5	172.7	-1.9	175.4	0.8	175.5	1.0
Mellen St	67.43	175.6	175.6	0.0	175.7	0.1	174.5	-1.2	174.5	-1.2	172.6	-3.0	175.6	0.0	175.7	0.1
Bucoda (Skookumchuck R)	11.1	250.9	250.9	0.0	250.9	0.0	250.9	0.0	250.9	0.0	250.9	0.0	247.5	-3.3	250.9	0.0
Pearl Street (Skookumchuck R)	2.43	190.5	190.5	0.0	190.5	0.0	190.5	0.0	190.5	0.0	190.5	0.0	188.9	-1.6	190.6	0.1
Skookumchuck Confluence	66.88	173.9	173.9	0.0	174.0	0.1	172.9	-1.0	172.9	-1.0	172.2	-1.7	173.7	-0.2	174.0	0.1
Upstream of Galvin Road	64.9	165.1	165.1	0.0	165.2	0.1	164.1	-1.0	164.0	-1.1	165.4	0.3	164.8	-0.3	165.0	-0.1
Grand Mound (Prather Road)	59.909	146.0	146.0	0.0	146.0	0.0	145.5	-0.5	146.3	0.3	147.1	1.1	145.8	-0.2	146.0	0.0
Near Rochester	54.476	122.5	122.5	0.0	122.5	0.0	121.8	-0.7	121.8	-0.7	122.8	0.3	122.3	-0.2	122.5	0.0
Anderson Road	51.499	105.5	105.5	0.0	105.6	0.0	105.3	-0.3	105.3	-0.2	105.7	0.1	105.5	-0.1	105.5	0.0
Black River Confluence	46.937	91.6	91.6	0.0	91.7	0.0	91.0	-0.7	90.8	-0.8	91.8	0.2	91.4	-0.2	91.6	0.0
Sickman Ford Bridge	44.175	83.8	83.8	0.0	83.9	0.0	83.0	-0.9	82.0	-1.9	83.1	-0.8	83.6	-0.2	83.8	0.0
Porter Creek Road	34.497	55.6	55.6	0.0	55.7	0.0	54.8	-0.8	54.8	-0.9	55.9	0.3	55.4	-0.2	56.7	1.1
Wakefield Road	24.52	38.8	38.8	0.0	38.8	0.0	37.9	-0.9	37.8	-0.9	39.2	0.5	38.6	-0.2	39.4	0.7
Satsop Confluence	19.89	33.7	33.7	0.0	33.7	0.0	33.4	-0.3	33.4	-0.2	34.0	0.4	33.6	0.0	33.6	0.0
Montesano	12.5	17.7	17.7	0.0	17.7	0.0	17.6	-0.1	17.6	-0.1	17.8	0.0	17.8	0.0	17.7	0.0
Cosmopolis	1.99	11.7	11.7	0.0	11.7	0.0	11.7	0.0	11.7	0.0	11.7	0.0	11.7	0.0	11.7	0.0

Note: Negative change means that the alternative has lower simulated water levels, positive change indicates the alternative raises water levels.

Table 10: Comparison of Water Surface Elevation Changes with Flood Relief Alternatives A, B, and C – February 1996, December 2007, January 2009 and 100-year Design Storm Events

		Max Water Surface Elevation (feet NAVD) or Change in Flood Water Surface (feet)											
		February 1996 Flood Event						December 2007 Flood Event					
Location		Baseline	Alt A	Change	Alt B	Change	Alt C	Change	Baseline	Alt A	Change	Alt B	Change	Alt C	Change
Description	X-section	(ft NAVD)	(ft NAVD)	(ft)	(ft NAVD)	(ft)	(ft NAVD)	(ft)	(ft NAVD)	(ft NAVD)	(ft)	(ft NAVD)	(ft)	(ft NAVD)	(ft)
Near Doty	100.95	318.1	307.2	-10.9	307.2	-10.9	318.1	0.0	328.1	315.8	-12.3	315.8	-12.3	328.1	0.0
Curtis Store (on S Fork Chehalis)	1.81	233.1	231.1	-2.1	231.1	-2.1	233.2	0.0	238.9	232.8	-6.1	232.8	-6.1	238.9	0.0
Downstream of South Fork	86.42	222.4	219.0	-3.5	219.0	-3.5	222.4	0.0	227.7	222.1	-5.6	222.1	-5.6	227.7	0.0
Near Adna	80.23	196.6	195.0	-1.6	195.0	-1.6	196.4	-0.2	197.9	196.3	-1.6	196.3	-1.6	197.9	0.0
Labree Road (on Newaukum R)	4.11	204.6	204.6	0.0	204.6	0.0	204.6	0.0	204.7	204.7	0.0	204.7	0.0	204.7	0.0
Newaukum Confluence	75.2	185.1	183.9	-1.3	183.9	-1.2	183.4	-1.8	186.6	184.5	-2.2	184.5	-2.1	185.6	-1.0
Along Airport Levee	71.49	180.3	179.3	-1.1	179.3	-1.0	179.5	-0.8	182.1	179.7	-2.4	179.7	-2.4	181.3	-0.8
Dillenbaugh Storage Area	SA #301	185.1	183.8	-1.3	183.8	-1.3	183.5	-1.7	186.6	184.4	-2.2	184.4	-2.2	185.8	-0.8
Airport Storage Area	SA #2	180.3	159.4	-20.9	159.4	-20.9	159.4	-20.9	182.2	159.4	-22.8	159.4	-22.8	159.4	-22.8
Long Road Storage Area	SA #5	177.5	169.4	-8.1	169.4	-8.1	169.4	-8.1	179.1	169.4	-9.7	169.4	-9.7	169.4	-9.7
Centralia Storage Area	SA #610	176.1	175.9	-0.2	176.1	-0.1	174.7	-1.5	178.5	175.8	-2.7	175.9	-2.6	175.8	-2.7
Mellen St	67.43	177.3	176.2	-1.1	176.2	-1.1	174.7	-2.6	178.6	176.1	-2.5	176.1	-2.5	175.8	-2.8
Bucoda (Skookumchuck R)	11.1	251.4	251.4	0.0	251.4	0.0	251.4	0.0	244.3	244.3	0.0	244.3	0.0	244.3	0.0
Pearl Street (Skookumchuck R)	2.43	191.3	191.4	0.2	191.4	0.2	191.4	0.2	186.6	186.6	0.0	186.6	0.0	186.6	0.0
Skookumchuck Confluence	66.88	175.5	174.5	-1.0	174.5	-1.0	174.3	-1.2	176.4	173.8	-2.7	173.8	-2.6	175.0	-1.4
Upstream of Galvin Road	64.9	167.1	165.5	-1.6	165.5	-1.6	167.5	0.4	168.2	164.8	-3.4	164.9	-3.4	168.4	0.2
Grand Mound (Prather Road)	59.909	146.9	146.3	-0.6	146.3	-0.6	147.2	0.3	147.4	145.8	-1.6	145.8	-1.5	147.5	0.1
Near Rochester	54.476	123.7	122.9	-0.8	122.9	-0.8	124.0	0.4	124.2	122.1	-2.1	122.2	-2.1	124.4	0.2
Anderson Road	51.499	105.9	105.7	-0.2	105.7	-0.2	106.0	0.1	106.0	105.4	-0.7	105.4	-0.6	106.1	0.1
Black River Confluence	46.937	92.6	91.7	-0.9	91.7	-0.9	92.6	0.1	92.9	90.9	-2.0	90.9	-2.0	92.8	-0.1
Sickman Ford Bridge	44.175	85.0	83.0	-2.1	83.0	-2.0	84.1	-0.9	85.5	82.1	-3.4	82.1	-3.4	84.4	-1.1
Porter Creek Road	34.497	56.7	55.9	-0.8	55.9	-0.8	57.1	0.4	57.0	54.8	-2.1	54.9	-2.1	57.2	0.3
Wakefield Road	24.52	40.1	38.4	-1.7	38.5	-1.6	39.6	-0.5	40.2	37.2	-3.0	37.2	-3.0	39.6	-0.6
Satsop Confluence	19.89	34.7	34.5	-0.2	34.5	-0.2	35.0	0.3	34.5	33.2	-1.3	33.2	-1.3	34.7	0.3
Montesano	12.5	17.6	17.4	-0.2	17.4	-0.2	18.0	0.4	17.3	15.7	-1.6	15.7	-1.6	17.7	0.4
Cosmopolis	1.99	9.3	9.2	-0.1	9.2	-0.1	9.5	0.2	10.9	10.9	0.0	10.9	0.0	10.9	0.0

Note: Negative change means that the alternative has lower simulated water levels, positive change indicates the alternative raises water levels.

		Max Water Surface Elevation (feet NAVD) or Change in Flood Water Surface (feet)											
		January 2009 Flood Event						100-Year Design Flood Event					
Location		Jan 09	Alt A	Change	Alt B	Change	Alt C	Change	100-year	Alt A	Change	Alt B	Change	Alt C	Change
Description	X-section	(ft NAVD)	(ft NAVD)	(ft)	(ft NAVD)	(ft)	(ft NAVD)	(ft)	(ft NAVD)	(ft NAVD)	(ft)	(ft NAVD)	(ft)	(ft NAVD)	(ft)
Near Doty	100.95	314.4	306.7	-7.7	306.7	-7.7	314.4	0.0	323.2	313.0	-10.3	313.0	-10.3	323.2	0.0
Curtis Store (on S Fork Chehalis)	1.81	228.1	227.7	-0.5	227.7	-0.5	228.1	0.0	233.6	230.2	-3.3	230.2	-3.3	233.6	0.0
Downstream of South Fork	86.42	216.9	213.3	-3.7	213.3	-3.7	216.9	0.0	223.2	219.1	-4.1	219.1	-4.1	223.2	0.0
Near Adna	80.23	193.9	191.7	-2.2	191.7	-2.2	193.6	-0.3	197.1	195.5	-1.6	195.5	-1.6	197.1	-0.1
Labree Road (on Newaukum R)	4.11	204.7	204.7	0.0	204.7	0.0	204.7	0.0	204.9	204.9	0.0	204.9	0.0	204.9	0.0
Newaukum Confluence	75.2	183.5	182.1	-1.4	182.1	-1.4	181.6	-1.9	185.7	184.1	-1.6	184.1	-1.6	184.0	-1.7
Along Airport Levee	71.49	178.8	177.4	-1.3	177.4	-1.3	178.0	-0.8	180.8	179.4	-1.4	179.4	-1.4	179.9	-0.8
Dillenbaugh Storage Area	SA #301	184.1	183.7	-0.4	183.7	-0.3	183.7	-0.3	185.8	184.3	-1.5	184.3	-1.5	184.4	-1.4
Airport Storage Area	SA #2	172.0	159.4	-12.6	159.4	-12.6	159.4	-12.6	180.8	159.4	-21.4	159.4	-21.4	159.4	-21.4
Long Road Storage Area	SA #5	169.4	169.4	0.0	169.4	0.0	169.4	0.0	177.9	169.4	-8.5	169.4	-8.5	169.4	-8.5
Centralia Storage Area	SA #610	174.5	174.3	-0.2	174.3	-0.2	172.8	-1.7	176.7	175.9	-0.8	176.1	-0.6	175.0	-1.7
Mellen St	67.43	175.6	174.5	-1.1	174.5	-1.1	172.8	-2.8	177.6	176.1	-1.5	176.1	-1.5	174.9	-2.7
Bucoda (Skookumchuck R)	11.1	250.9	250.9	0.0	250.9	0.0	250.9	0.0	252.0	251.9	0.0	251.9	-0.1	251.9	0.0
Pearl Street (Skookumchuck R)	2.43	190.5	190.6	0.1	190.6	0.1	190.6	0.1	191.7	192.4	0.7	192.4	0.7	192.4	0.7
Skookumchuck Confluence	66.88	173.9	173.0	-0.9	173.0	-0.9	172.5	-1.5	175.7	174.3	-1.4	174.3	-1.4	174.4	-1.3
Upstream of Galvin Road	64.9	165.1	164.1	-1.0	164.1	-1.0	165.5	0.4	167.3	165.3	-2.0	165.3	-2.0	167.6	0.3
Grand Mound (Prather Road)	59.909	146.0	145.5	-0.5	145.5	-0.5	146.2	0.2	147.1	146.2	-0.8	146.2	-0.8	147.3	0.2
Near Rochester	54.476	122.5	121.8	-0.7	121.8	-0.7	122.8	0.3	124.0	122.9	-1.1	122.9	-1.1	124.3	0.3
Anderson Road	51.499	105.5	105.3	-0.3	105.3	-0.3	105.6	0.1	106.1	105.8	-0.3	105.8	-0.3	106.2	0.1
Black River Confluence	46.937	91.6	90.8	-0.8	90.8	-0.8	91.8	0.1	93.0	91.9	-1.2	91.9	-1.2	93.1	0.0
Sickman Ford Bridge	44.175	83.8	81.9	-1.9	81.9	-1.9	83.1	-0.8	85.6	83.2	-2.4	83.2	-2.4	84.7	-1.0
Porter Creek Road	34.497	55.6	54.8	-0.8	54.8	-0.8	56.0	0.4	57.4	56.3	-1.1	56.3	-1.1	57.8	0.5
Wakefield Road	24.52	38.8	37.2	-1.5	37.2	-1.5	38.5	-0.3	41.6	39.3	-2.3	39.3	-2.3	40.8	-0.7
Satsop Confluence	19.89	33.7	33.4	-0.2	33.4	-0.2	34.1	0.4	35.4	34.9	-0.5	34.9	-0.5	35.7	0.2
Montesano	12.5	17.7	17.7	-0.1	17.7	-0.1	17.8	0.1	18.8	18.2	-0.7	18.2	-0.7	19.2	0.3
Cosmopolis	1.99	11.7	11.7	0.0	10.6	-0.4	11.7	0.0	11.0	10.6	-0.4	10.6	-0.4	11.2	0.2

Note: Negative change means that the alternative has lower simulated water levels, positive change indicates the alternative raises water levels.

Basin-wide bar charts

Figures 11 through 13 show the effects on water surface elevations of the combination alternatives at the same locations as shown in Table 10. This graphical presentation of results for the four simulated floods facilitates quick comparisons between the alternatives. As can be seen in the bar charts, Alternatives A and B, which include the mainstem dam, result in lower flood water levels throughout the basin for all of the floods. Other proposed elements of these flood relief alternatives have more localized effects. Alternative C, which does not include the main stem dam, would have no effect on water levels upstream of Highway 603 and would have less overall benefit on reaches within the Twin Cities. Downstream water levels would also be generally increased under this alternative with the exception of near the downstream bridge replacement projects.

Twin Cities Inundation Mapping

Figures 14 through 16 show inundation maps for the three basin wide flood relief alternatives (A, B, and C) for the December 2007 flood event. As shown in these figures, the inundated area would be reduced significantly under Alternatives A and B (with the main stem dam). Alternative C, without the dam, tends to increase water levels in some locations while lowering water levels at other locations within the Twin Cities.

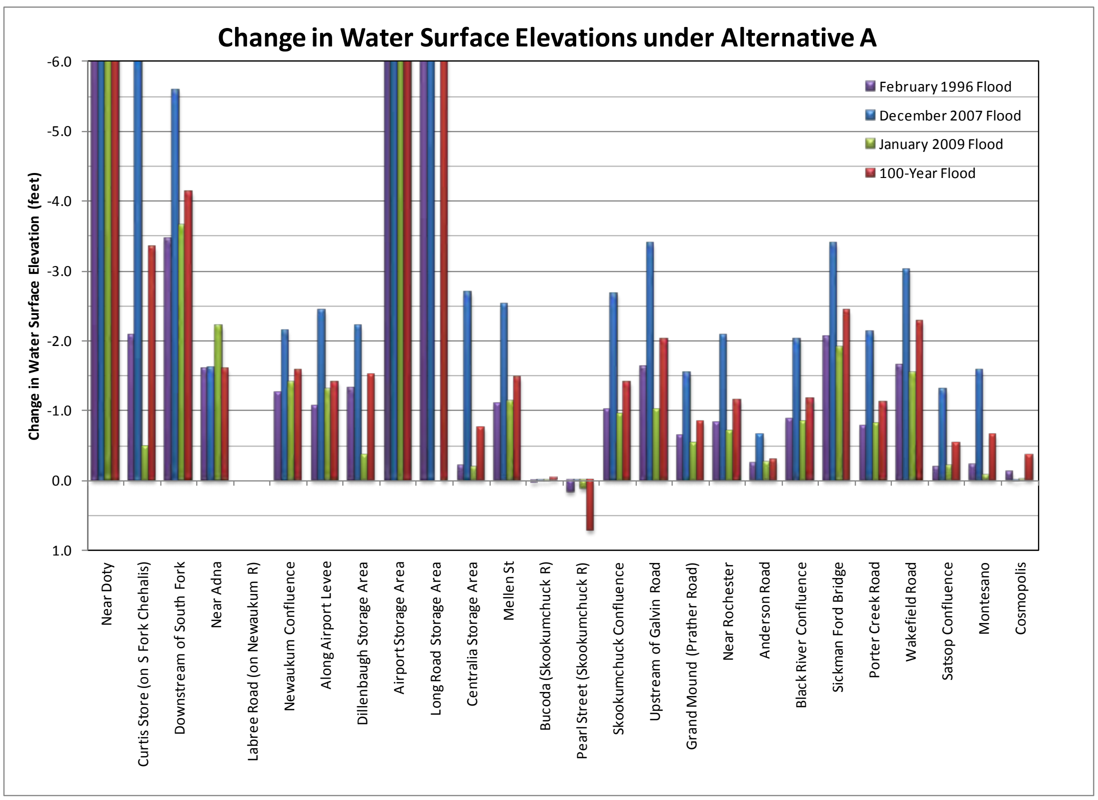

Figure 11. Change in Water Surface Elevation under Alternative A

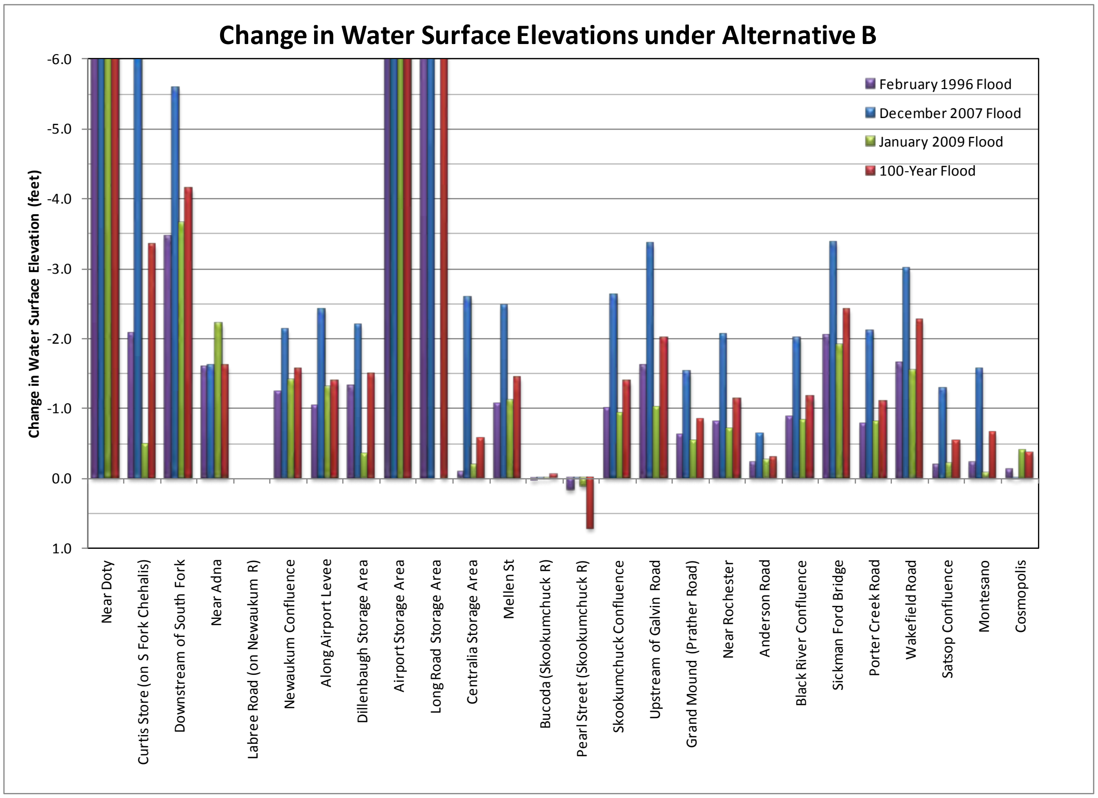

Figure 12. Change in Water Surface Elevation under Alternative B

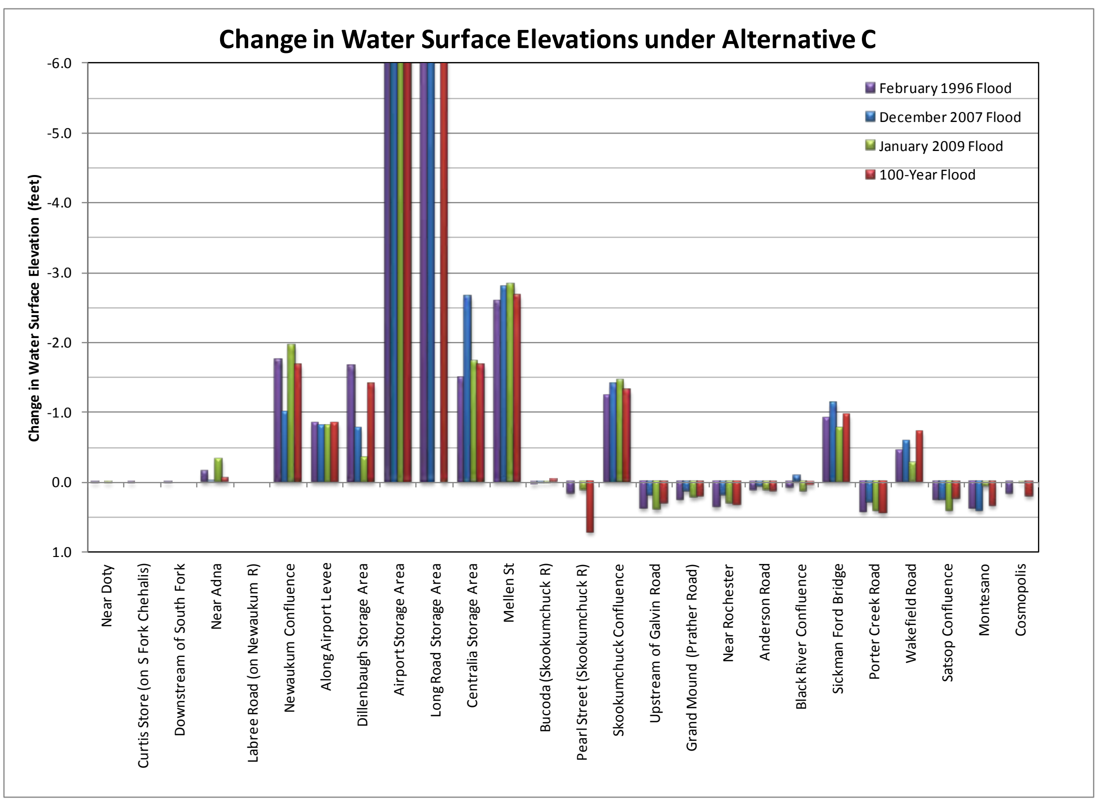

Figure 13. Change in Water Surface Elevation under Alternative C

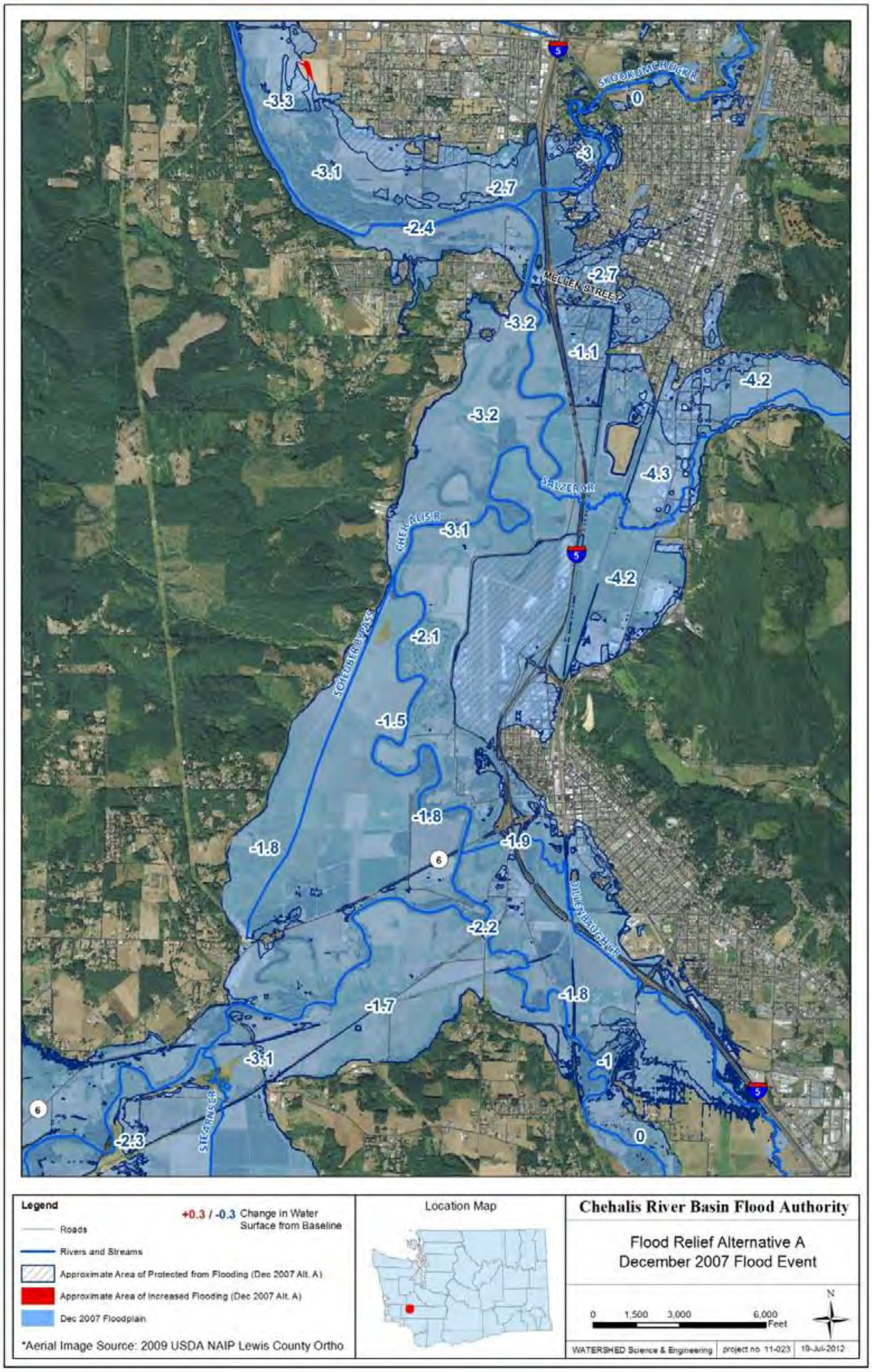

Figure 14. Twin Cities Inundation Map and Flood WSEL Changes for Alternative A

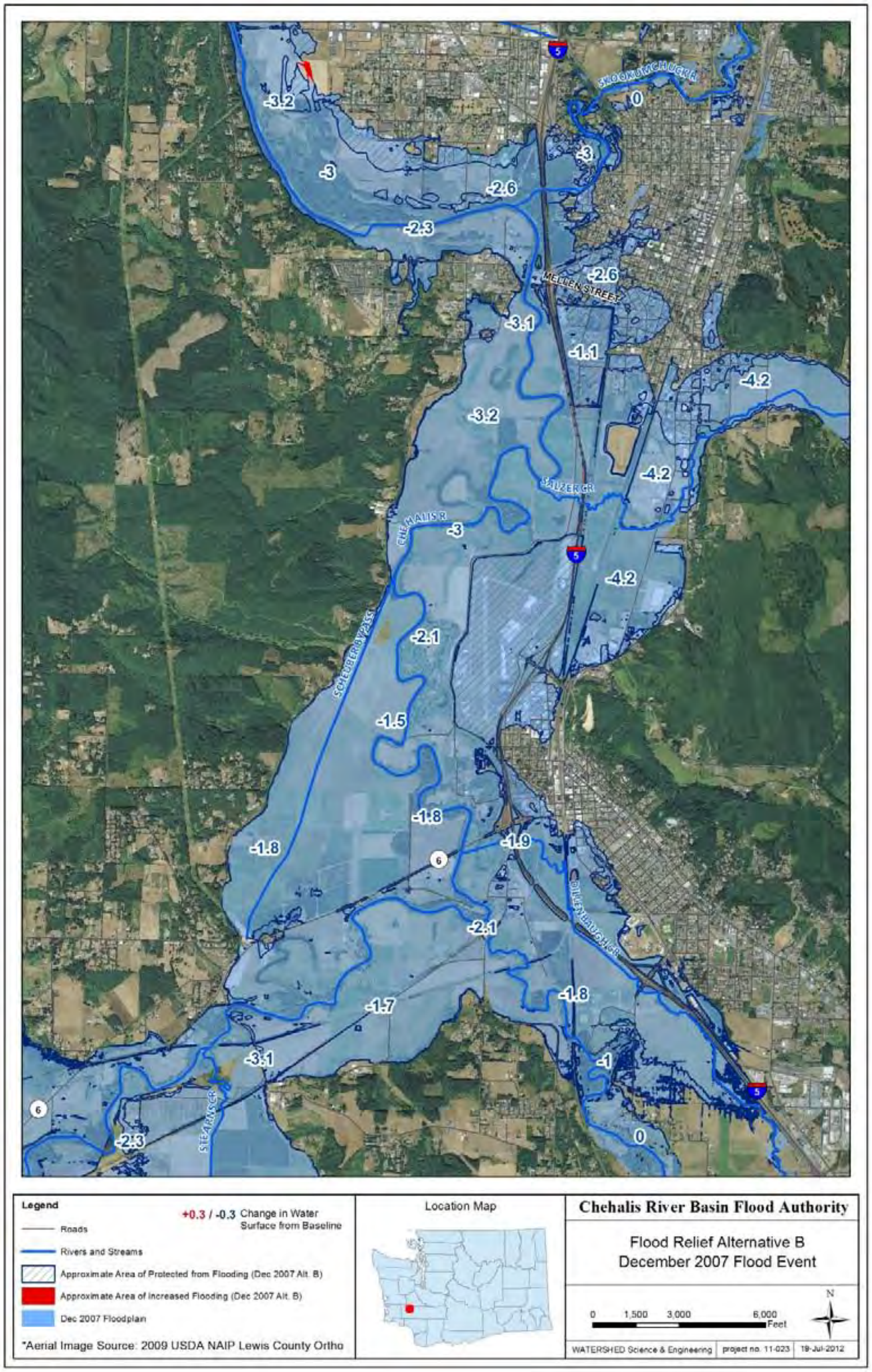

Figure 15. Twin Cities Inundation Map and Flood WSEL Changes for Alternative B

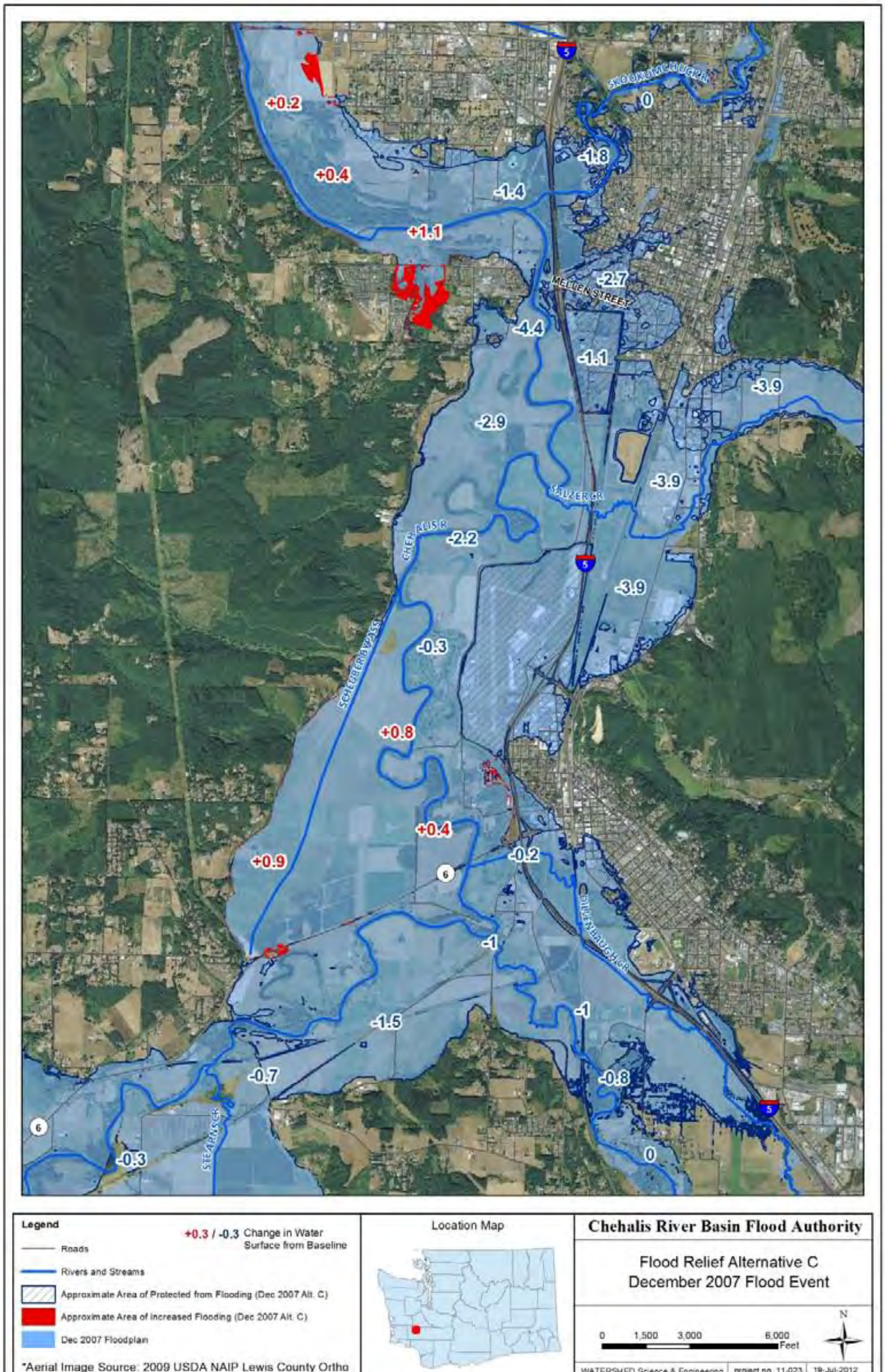

Figure 16. Twin Cities Inundation Map and Flood WSEL Changes for Alternative C

I-5 Protection Summary

Table 11 compares the simulated water surface elevations and minimum roadway elevations for 33 locations along I-5. These locations include each cross section that contacts the interstate as well as the major modeled storage areas. Some of the points are on the west side of the freeway along the main stem Chehalis River, the Newaukum River, and/or Dillenbaugh Creek. Other points are along the east side of the freeway on Dillenbaugh Creek near Chehalis. The road surface elevations for I-5 were taken from the April 2012 field survey by WSDOT, where available, or from LiDAR data where field survey were not available. These data are intended to represent the lowest elevation of the roadway surface, which in many cases is on the shoulder outside the traffic lanes. In some locations the elevations of I-5 are significantly higher than the floodplain because the freeway is elevated where it approaches an overpass.

Table 11: Comparison of Effects on I-5 Flooding for Flood Relief Alternatives for December 2007 Event

River	Reach	River Sta	I-5 Elev WSDOT		Description	December 2007 Flood											
							Baseline			Alternative A			Alternative B			Alternative C	
			(NGVD 29)	NAVD 88		WSEL	Change	Result	WSEL	Change	Result	WSEL	Change	Result	WSEL	Change	Result
CHEHALIS	REACH 13	68.98	174.62	178.02	1600 feet N of Salzer Creek culvert	181.4	3.4	Floods	178.2	0.2	Floods	178.3	0.3	Wall	178.7	0.6	Wall
CHEHALIS	REACH 13	69.22	175.65	179.05	280 feet N of Salzer Creek culvert	181.5	2.4	Floods	178.3	-0.8		178.3	-0.7		178.8	-0.3	
CHEHALIS	REACH 11	69.9	175.65	179.05	at Salzer Creek culvert	181.5	2.5	Floods	178.4	-0.7		178.4	-0.6		179.0	-0.1	
CHEHALIS	REACH 11	70.18	175.8	179.2	Between airport levee and Salzer Cr	181.6	2.4	Floods	178.4	-0.8		178.5	-0.8		179.0	-0.2	
Airport Storage Area	SA #2	SA #2		176.3	Low Point From RM 70.25 to RM 73.73	182.2	5.9	Floods	159.4	-16.9		159.4	-16.9		159.4	-16.9	
CHEHALIS	REACH 9	73.73	179.7	183.1	near NW West Street	183.4	0.3	Floods	181.8	-1.3		181.8	-1.3		184.1	1.0	Wall
CHEHALIS	REACH 9	74.02	179.9	183.3	just north of SR6 Interchange	183.7	0.4	Floods	181.9	-1.4		181.9	-1.4		184.2	0.9	Wall
CHEHALIS	REACH 9	74.25	179.5	182.9		183.9	1.0	Floods	182.1	-0.8		182.1	-0.8		184.3	1.4	Wall
CHEHALIS	REACH 9	74.57	183.8	187.2	On southbound off ramp	184.2	-3.0		182.4	-4.8		182.4	-4.8		184.5	-2.8	
DILLENBAUGH CR	REACH 8	0.094	180.46	183.86	dillenbaugh I-5 Weir	185.2	1.3	Floods	183.3	-0.6		183.3	-0.6		184.9	1.1	Wall
DILLENBAUGH CR	REACH 8	0.122	180.46	183.86	dillenbaugh I-5 Weir	186.1	2.2	Floods	183.9	0.1	Floods	184.0	0.1	Wall	185.4	1.6	Wall
DILLENBAUGH CR	REACH 8	0.142	178.16	181.56	low point on I-5 N on-ramp	186.2	4.7	Floods	184.1	2.5	Floods	184.1	2.5	Wall	185.6	4.0	Wall
CHEHALIS	REACH 7	74.95	187.4	190.8	On Chehalis (west) side of I-5. Road superelevated, sloping to low of 186.4 (NAVD) on East side of I-5	185.7	-5.1		183.6	-7.2		183.6	-7.2		185.1	-5.7	
DILLENBAUGH CR	REACH 8	0.155	194.7	198.1	East side of I-5	186.3	-11.8		184.1	-14.0		184.1	-14.0		185.6	-12.5	
CHEHALIS	REACH 7	75.08	204.1	207.5	West side of I-5	186.3	-21.2		184.1	-23.4		184.1	-23.4		185.4	-22.1	
DILLENBAUGH CR	REACH 8	0.219	204.2	207.6	East side of I-5	186.3	-21.3		184.1	-23.5		184.1	-23.5		185.6	-22.0	
CHEHALIS	REACH 7	75.085	204.7	208.1	West side of I-5	186.3	-21.8		184.1	-24.0		184.1	-24.0		185.4	-22.7	
DILLENBAUGH CR	REACH 8	0.239	205.5	208.9	East side of I-5	186.3	-22.6		184.1	-24.8		184.2	-24.8		185.6	-23.3	
NEWAUKUM	REACH 6	0.1	206.07	209.47	West side of I-5	187.0	-22.5		184.7	-24.7		184.8	-24.7		185.9	-23.6	
DILLENBAUGH CR	REACH 8	0.321	208	211.4	East side of I-5	186.3	-25.1		184.2	-27.3		184.2	-27.2		185.6	-25.8	
DILLENBAUGH CR	REACH 8	0.385	209.1	212.5	East side of I-5	186.3	-26.2		184.2	-28.4		184.2	-28.3		185.6	-26.9	
NEWAUKUM	REACH 6	0.553	211.45	214.85	West side of I-5	187.2	-27.6		184.9	-29.9		184.9	-29.9		186.1	-28.8	
DILLENBAUGH CR	REACH 8	0.478	211.4	214.8	East side of I-5	186.4	-28.4		184.2	-30.6		184.2	-30.6		185.7	-29.1	
DILLENBAUGH CR	REACH 8	0.495	211	214.4	East side of I-5	186.4	-28.0		184.3	-30.1		184.3	-30.1		185.7	-28.7	
DILLENBAUGH CR	REACH 8	0.511	211	214.4	East side of I-5	186.5	-27.9		184.3	-30.1		184.3	-30.1		185.8	-28.6	
DILLENBAUGH CR	REACH 8	0.583	207.8	211.2	West side of I-5	186.6	-24.6		184.4	-26.8		184.4	-26.8		185.8	-25.4	
DILLENBAUGH CR	REACH 8	0.623	205.8	209.2	West side of I-5	186.7	-22.5		184.5	-24.8		184.5	-24.7		185.9	-23.3	
DILLENBAUGH CR	REACH 8	0.792	182.4	185.8	West side of I-5	187.6	1.8	Floods	184.9	-0.9		184.9	-0.9		186.3	0.5	Wall
DILLENBAUGH CR	REACH 8	1.00001	181.65	185.05	West side of I-5	187.6	2.6	Floods	184.9	-0.2		184.9	-0.2		186.3	1.3	Wall
DILLENBAUGH CR	REACH 8	1.25	183.2	186.6	West side of I-5	187.6	1.0	Floods	184.9	-1.7		184.9	-1.7		186.3	-0.3	
DILLENBAUGH CR	REACH 8	1.29	183.4	186.8	West side of I-5	187.6	0.8	Floods	184.9	-1.9		184.9	-1.9		186.3	-0.5	
DILLENBAUGH CR	REACH 8	1.32	183.5	186.9	West side of I-5	187.6	0.7	Floods	185.0	-2.0		185.0	-2.0		186.3	-0.6	
DILLENBAUGH CR	REACH 8	1.5	184.8	188.2	West side of I-5	187.6	-0.6		185.0	-3.3		185.0	-3.2		186.3	-1.9	

Discussion of Results

The results presented above show the level of flood water level reduction that can be achieved through individual flood relief projects and combinations of those projects. Data are presented for four flood events to show how each project or alternative performs in each different types of storm events. The data show benefits and potential water surface elevation impact of each project. Given this information, projects can be refined and alternatives can be configured to address specific flood damage problem areas. The data presented herein is limited to water surface elevation comparisons. Information on depths of flooding can be generated using the model output but this level of analysis was beyond the scope of this study. Ultimately, conclusions regarding flood impacts would need to consider changes in water surface elevation in conjunction with actual depths of flooding. In some cases, a small decrease in flood depth could have significant benefits while in other cases even large reductions might not have much effect. The same is true for water level increases – some locations may not be particularly sensitive to increases (for example areas where flooding is already very deep) while other areas might be particularly problematic. That level of analysis and evaluation of the results will need to be undertaken in combination with information on project costs to define a preferred package of flood relief projects for the basin. The model developed for this study will be helpful to generate the hydraulic data needed to inform that effort.

Caveats and further work required

The results and data described herein were developed using the Chehalis River Basin HEC-RAS hydraulic model. As discussed above there are always uncertainties involved in modeling extreme flood events, and the large floods on the Chehalis River are particularly difficult to model accurately due to problems with some flow gages during these events. Significant efforts were made to calibrate the model to all available high water marks and anecdotal information on past flooding. While the modeling is felt to be entirely appropriate for the analyses described herein, use of the model for other purposes should be done with caution.

In particular, caution is necessary when considering very small differences in water surface elevations downstream of the Twin Cities area under some alternatives. The FEMA Twin Cities HEC-RAS model was configured with river reaches on the west side of Interstate 5 (the main flow path) and a network of linked storage areas on the east side of the freeway. The linked storage areas are appropriate for representing the 2-dimensional nature of flow on the east side of the freeway. Unfortunately, RAS routes water differently between storage areas as opposed to river reaches. In some of the alternatives, for example the WSDOT I-5 Protection project, a primary effect of the alternative is that flow from the west to the east across the freeway is reduced, thus reducing the flow in the storage areas and increasing the flow in the main river channel. This change in flow pattern results in more flow attenuation under the alternative than in the existing condition. It is not clear whether this is a real effect of the alternative or simply a modeling effect. As such, the reporting of very small downstream reductions in water surface elevations should be viewed with some skepticism. To be clear the HEC-RAS model is set up in an acceptable manner and provides a good representation of existing conditions. However, under some alternatives (the ones that dramatically alter flow paths in the Twin Cities area) the model may be producing downstream results at very small increments that are not altogether accurate. Unfortunately, there is no simple way to fix this and perhaps no better way to configure the model for the complex flow splits in the Twin Cities area.

It should also be noted that inundation maps prepared to document changes in the extent and depths of flooding under the alternatives were developed using automated mapping techniques, which are appropriate for preliminary evaluations. The maps were also based on the best available topographic data, which in some cases is more than 10 years old. As such, the maps may not be entirely accurate in some locations and should be used with caution. These inundation maps were not intended to replace other flood hazard maps such as those available from FEMA since the preparation of those maps requires significant manual post-processing of the data that is well beyond the scope of this study. Detailed inundation mapping for flood hazard evaluation could be done using the new modeling but that would require additional efforts not currently scoped.

Finally it must be understood that the geometric (cross section) data used in the hydraulic model were derived from available topographic data sources including data from 1999 (in the Twin Cities floodplain area), 2002 (between Grand Mound and Montesano and along the Skookumchuck River), and 2005 and 2006 in Centralia and Chehalis. New topographic data will be available soon for much of the basin (Chehalis River corridor from Lewis County line to Montesano) or is already available (Thurston County and portions of Lewis County). The new topographic data could be used to update the hydraulic models thus improving the model's ability to simulate overbank flooding. That effort, however, is beyond the scope and schedule of the current project.

Summary and Recommendations

The Chehalis River Basin Flood Authority recognized the need for detailed hydraulic modeling and analysis of potential flood relief alternatives in the Chehalis River basin. In particular extending the existing hydraulic modeling downstream to the mouth of the river and using the model to evaluate a broad range of possible flood relief projects. Through a budget proviso in Engrossed Substitute House Bill (ESHB) 2020 the Washington State Legislature provided funding to "complete the hydraulic model for the Chehalis River to calculate flood levels, flood damages, and benefits of proposed flood mitigation projects for the lower portions of the river." WATERSHED Science & Engineering, together with subconsultant WEST Consultants, was retained by the Flood Authority to develop the hydraulic model and apply it to the evaluation of more than 25 potential flood relief projects or combinations of projects. The results of those evaluations are presented above.

Concurrent with the Flood Authority's efforts to evaluate basin wide flood relief alternatives the Corps is conducting hydraulic analyses related to ecosystem restoration planning and WSDOT is designing and evaluating several alternatives to mitigate the effects of flooding to Interstate 5. WSE and WEST worked with those agencies to ensure that the model development work for the Flood Authority leveraged those agencies work and resulted in single baseline hydraulic model that was accepted by all. The comprehensive basin wide model described above has been provided to the Corps for review and is being used by WSDOT for their analyses. The use of a consistent hydraulic analysis tool by all three groups should facilitate agreement on the potential benefits and impacts of various alternatives and as such should improve collaborative efforts to address basin flood problems.

The hydraulic model developed for this study extends from the mouth of the Chehalis River to upstream of Pe Ell, a distance of more than 108 miles. The model also includes significant portions of key tributaries including the following: Wynoochee River (54 miles), Satsop River (2 miles), Black River (10 miles), Lincoln Creek (4 miles), Skookumchuck River (21 miles), Hanford Creek (6 miles), Salzer Creek (5 miles), Newaukum River (10 miles), Dillenbaugh Creek (3.5 miles), and South Fork Chehalis River (5.8 miles). While the model was developed primarily to evaluate the effects on the main stem Chehalis River of large-scale flood relief projects it can also serve as a tool for the evaluation of hydraulic conditions and flooding on these tributaries. In fact, the model has already been used by WSE to evaluate the effects of potential modifications to the railroad bridge downstream of Bucoda on the Skookumchuck River.

The baseline hydraulic model developed for this study represents the best available information on hydraulic conditions in the modeled reaches. However, it must be recognized that the model includes both newly modeled reaches (e.g. Chehalis River between Porter and Aberdeen) and reaches where existing models were incorporated. In some of the older model reaches new cross sections surveys were collected and used (e.g. Skookumchuck River at Bucoda, Chehalis River between Grand Mound and Porter) while in other reaches (e.g. the Chehalis River between Grand Doty and Grand Mound, South Fork Chehalis) the model is using cross sections collected as long ago as 2001, or in some cases 1989. Similarly, in some portions of the model (e.g. Newaukum River) floodplain topographic data were updated to reflect more recently available LiDAR data while in other reaches (e.g. Satsop River, Black River) the topographic data dates back to 2002, or in some cases earlier. Obviously, it would have been preferable to update the entire model with new field surveyed cross sections and up to date overbank topographic data. Furthermore, it would have been preferable to be able to thoroughly review, refine, and validate all of the exiting model reaches that were incorporated into the final model. However, the efforts are simply beyond the scope and resources of the current project. That said the model is still a significant improvement over any tool that has been previously available and its availability should enhance flood relief investigations throughout the basin.

As time and resources allow it is recommended that the model be updated to use new topographic and survey data, that the updated model be refined to address any new infrastructure that has been built since the original model development, and that the updated model be calibrated to available flood information. It is further recommended that any future application of the model be preceded by an assessment by a qualified hydraulic engineer to see if the model as developed herein is appropriate for the intended use.

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WATERSHED Science & Engineering (2012c). "Newaukum River Model Extension and Refinement" Technical Memorandum, March 13, 2012.

WATERSHED Science & Engineering (2012d). "Response to State Team comments on Chehalis River Hydraulic Model" Technical Memorandum, April 11, 2012.

Appendices

Appendix A

WSE Responses to State Tech Team Comments on Work Plan (Oct 21, 2011)

Reviewer	Comment	Response	Task
Guy Hoyle-Dodson, DOE	The assumption that this tidally influenced flood plain can be even marginally modeled with HEC-RAS is highly optimistic. The matrix solutions in HEC-RAS within the unsteady-state flow simulation is highly unstable in these situations and has difficulty forming a solution.	Both WSE and WEST staff have significant experience applying HEC-RAS in a tidal environment and we do not believe that it's application is as "optimistic" as the reviewer suggests. We can point to numerous instances of HEC-RAS being successfully applied to hydraulic modeling in tidal environments including significant modeling applications on the Green and Snohomish Rivers and Tillamook Bay. We can also cite literature supporting the appropriateness of HEC-RAS in these situations including the FHWA website at http://www.fhwa.dot.gov/engineering/hydraulics/hydrology/hec25c4.cfm and the attached draft paper submitted to the Journal of Hydraulic Engineering (I don't have access to the final version).	Task 5c
Guy Hoyle-Dodson, DOE	The inclusion of tidal influences would require a downstream boundary hydrograph , and measurements.	It is the intent of this study to develop a downstream boundary condition using the NOAA tide gage data available for the Aberdeen station.	Task 5c
Guy Hoyle-Dodson, DOE	Theta Weighting Factor. Theta is a weighting applied to the finite difference approximations when solving the unsteady flow equations. Theoretically Theta can vary from 0.5 to 1.0. However, as practical limit is from 0.6 to 1.0 Theta of 1.0 provides the most stability, but less numerical accuracy. Theta of 0.6 provides the most accuracy, but less numerical stability. The default in HEC-RAS is 1.0. Once you have your model developed, reduce theta towards 0.6, as long as the model stays stable. For rivers with tidal boundaries, in which the rising tide will propagate upstream, the user should always try to use a theta value as close to 0.6 as possible. Tidal waves are very dynamic. In order for the solution to be able to accurately model a tidal surge, theta must be close to 0.6. Thus accuracy is sacrificed for stability.	We don't envision Theta being a big concern The reviewer cites a "textbook" concern but practically speaking we've never had much issue with it nor have we seen it have a tremendous effect on results (except possibly for dam break or other flash flooding type simulations). Usually we are also looking at peak results, whereas Theta is more likely to have an effect on the shape of computed stage/flow hydrographs. But we feel other inputs and uncertainties -- geometry, roughness, boundary conditions -- have a greater effect. The current Twin Cities model already has Theta set to unity, which is the default. For a model this large, plus extended all the way to Grays Harbor, it might be difficult to reduce that down to 0.6 without some instability arising somewhere. Also, if the present model is already calibrated, we probably don't want to change this parameter if it might compromise (however minor) the upstream calibration. Our suggestion would be to initially build a truncated version of the model, from Monteseno downstream, that is both more manageable to run (using inflows taken from the larger model) but can also be used for some sensitivity tests to the lower tidal region of the study. We can modify Theta just for the lower end see if we observe significant change, and do some other sensitivity tests just related to the tidal area. We assume the reviewer is not talking about surface tidal waves, as neither RAS nor any other typical 2D model for rivers simulates those. More likely storm surges, as reflected in the downstream stage hydrograph boundary. HEC-RAS should be able to handle these OK, they don't rise THAT fast or dynamically. And the diffusive effects of using the fully implicit solution (Theta=1) should be minimal.	Task 5c

Reviewer	Comment	Response	Task
Guy Hoyle-Dodson, DOE	It might be easier and more cost effective just to use a 2-D model.	Notwithstanding our opinion that a useful HEC-RAS model can be developed for this reach I share Guy's opinion that a well developed 2-D model would provide a more robust tool for a wide range of purposes. One problem, however, is that we don't have adequate time or budget to do the detailed bathymetric data collection that would be required to support a robust 2-D model. Furthermore, model development costs and run times would also be significantly greater for a detailed 2-D model, pushing them beyond the time and budget resources of the current project. Finally, since the preeminent task in our current work plan is to provide a tool that can be used to evaluate the downstream impact/benefit of upstream flood relief alternatives we need to recognize that modeling for the remainder of the system, from Pe Ell to Montesano, is being performed in HEC-RAS. The intent here is to append the downstream reach to the Corps model to allow the Flood Authority to evaluate basin wide flood relief alternatives in a single tool.	Task 5c
Guy Hoyle-Dodson, DOE	They should ensure that modeling for all tributaries has the QA/QC and level of detail and accuracy that is commensurate with the other modeling being performed for the Corp, otherwise the continuity across the entire model will suffer.	Modeling of the tributaries will be scoped in detail in coordination with the Flood Authority and Stakeholders to ensure their needs are met. There may be benefit in modeling the tributaries at a lower level of detail than the main stem, simply to allow more miles of trib to be modeled. This is still to be determined.	Task 6b
Guy Hoyle-Dodson, DOE	This may require more resources that currently allocated.	The work plan will be tailored to the available funds	Task 5d
Guy Hoyle-Dodson, DOE	Consultant should consider 2-D modeling on the lower reach	See previous response	None
Paul Pickett, DOE	The work plan states that they will be using the hydrologic statistical events developed by the Corps and not adding any more. How will hydrologic statistical events and boundary conditions be developed for the tributary modeling?	WEST's work for the Corps is developing hydrologic data for all major tributaries in the Chehalis basin at up to 78 locations including more than 50 ungaged sites. WEST is also developing flows for the major tributaries for use in the modeling of the main stem Chehalis River. These data will be used for tributary modeling either independently of the main stem or using the main stem model to provide a downstream boundary condition. More detail on WEST's work for the Corps is available in their scope for that project.	Task 6a

Reviewer	Comment	Response	Task
Paul Pickett, DOE	One of the issues that has come up in the past has been the timing of storm events and the orientation of the storm events to the basin. Peak flow events from the tributaries won't occur at the same time. Different scenarios based on historical events would have a sequencing of peak events across the basin and maximum intensity hitting in different locations. How will this be addressed in the modeling?	Assumptions about coincidence of tributary flows, as necessary for modeling the main stem Chehalis River will be implicit in the WEST work for the Corps. Analysis of the fall range of possible spatial precipitation patterns is beyond the scope of either the Corps study or this study and will not be investigated in either study.	Task 6a
Paul Pickett, DOE	I think Guy is correct that using the HEC-RAS 1-D model could result in significant uncertainty in the results and a 2-D model would be more reliable. I also agree with Hal that it is acceptable, at least as a first-cut analysis. But as part of the study report, the success of using HEC-RAS at the downstream end should be evaluated to determine the limitations and uncertainty of the 1-D model and the benefits of using a 2-D model for an improved analysis in the future. On the other hand, if a 2-D model could be developed with a reasonable amount of additional effort, that would be preferable. Greg Pelletier (Department of Ecology) developed a 2-D hydrodynamic model of Grays Harbor and the Chehalis River from Montesano downstream. He used the "Wetland Dynamic Water Budget Model", which is an Army Corps of Engineers model similar to DYNHYD. Ray Walton is very familiar with it - he "wrote the book" on it, literally. Greg Pelletier says the model input information is available, possibly on the Ecology website. Could the existing WDWBM model be upgraded to serve the purposes of this study? Here are links to Greg's work: • Project page: http://www.ecy.wa.gov/programs/wq/tmdl/ChehalisBasin/GraysHbrTMDL.html • Computer simulation information: http://www.ecy.wa.gov/programs/eap/wrias/tmdl/ghfc/results.html	See previous discussion of 2-D model in response to comments from Guy Hoyle-Dodson. Note that the WDWBM model is not actually a 2-D model. It is a pseudo 2-D link-node model with the 2-D effect gained by branching flows off of and one node in multiple directions. This is structurally the same as the network branching available within HEC-RAS and considering the more sophisticated hydraulic routing available in RAS the RAS model would actually be a better option. Note also that the model developed by Greg Pelletier only has a single branch up the Chehalis River and thus the pseudo 2-D effect is limited to Grays Harbor in an area outside the current project boundary.	Task 5c
Paul Pickett, DOE	Does the workplan include time and funding for review by the state agencies and addressing any comments received?	The work plan will allow time for the Consultant team to discuss technical issues with agency reviewers at key milestones.	none

Reviewer	Comment	Response	Task
Paul Pickett, DOE	It would be better to brief state agency technical staff at regular intervals and incorporate their comments during the course of the project (rather than waiting until the draft report is out to brief state agencies and solicit comments)? Is this approach incorporated in the work plan, or could it be?	The work plan will allow time for the Consultant team to discuss technical issues with agency reviewers at key milestones. Note however that the tight timeframe for this project will require great flexibility and responsiveness on the part of the agencies if coordination is to be successful.	none
Hal Beecher, WDFW	If new channel survey data are obtained, they are presumed to be superior to 2001 data for cross sections. It would be useful to assess how the two data sets compare in maximal conveyance, width, difference between adjacent floodplain elevation and relevant channel bed elevations (probably not pool bottoms) to determine if conveyance in the river is changing or if the two data sets are complementary (two samples from the same population). Such information may shed some light on processes affecting channel conveyance (dynamic equilibrium or not).	The data will be available for these comparisons.	Task 5a
Hal Beecher, WDFW	The plan briefly discusses use of HEC-RAS vs. 2-dimensional modeling. Annear et al. (2002: 265) discussed HEC-RAS and their discussion is supportive of using HEC-RAS: “The model’s purpose is to provide information on river stages over a range of flows, particularly for floods.” “These situations include mixed flow regime calculations (i.e., hydraulic jumps), bridge hydraulics, and evaluation profiles at river confluences. … It has culvert and bridge routines. The program can model a single river reach, a dendritic system, or a full network (looped systems).” Thus, use of HEC-RAS appears reasonable.	Agreed	Task 5c
Hal Beecher, WDFW	This optional task includes developing hydrographs for “ecologically significant flows at up to 50 locations.” Natural resource agencies and interests should be consulted to determine what those flows are and what locations are modeled. A major consideration is stranding of fish as flows recede from a flood. Rate of stage decline should be addressed over the range of flows where overbank flows drop to within the channel.	See previous responses regarding the hydrology. At this point no additional hydrologic data development is planned under this contract.	Task 6a
Casey Kramer, WSDOT	Explain why deferred. Would like a brief discussion summarizing other previous and on-going LiDAR efforts within the project area.	Preliminary checks of the LIDAR data can be made using the area between Montesano and Aberdeen for which both 2009 and 2002 LiDAR data are available. Additional checks can be made using the topographic data collected during the cross section surveys. These checks should suffice for now given that FEMA is planning on collecting new LiDAR data in fall 2011.	Task 3

Reviewer	Comment	Response	Task
Casey Kramer, WSDOT	Last sentence in Task 5a seems to support Task 3.	The draft work plan was written prior to the collection of the data discussed above.	Task 5a
Casey Kramer, WSDOT	Refer to which Task you are referring to "topographic data described above".	Task 5a	Task 5b
Casey Kramer, WSDOT	What are the 50 locations West is looking at?	WEST has a map showing the hydrologic data development locations. This map can be provided upon request.	Task 6a
Casey Kramer, WSDOT	Also interested in China, Salzer, Dillenbaugh, etc. This may be upstream of the proposed work plan.	The available budget is not adequate to allow detailed modeling of the four tributaries already defined in the scope. It is understood that many more tributaries could benefit from hydraulic modeling and analysis. IF additional funds become available additional modeling may be conducted.	Task 6b
Casey Kramer, WSDOT	Explain why deferred.	At the request of the Flood Authority, to make the best use of available funds.	Task 6d
Casey Kramer, WSDOT	Seems like a minimal cost for an important task. Topography/bathymetry is the foundation for a accurate hydraulic model, not knowing the quality of the data could be viewed as a flaw in the modeling results.	See previous comment on checks that will be preformed.	Optional Task 3

Appendix B

WSE Response to State Tech Team Comments on Hydraulic Model (4/17/2012)

WATERSHED
Science & Engineering
110 Prefontaine Place South, Suite 508
Seattle, WA 98104
206-521-3000

Memorandum

To: Chehalis River Basin Flood Authority and State Technical Review Team

From: WATERSHED Science & Engineering (WSE) and WEST Consultants (WEST)

Date: 04/17/2012

Re: **Response to State team comments on Chehalis River Hydraulic Model**

Watershed Science & Engineering (WSE) and WEST Consultants (WEST) have developed an HEC-RAS hydraulic model of the Chehalis River, including portions of several significant tributaries (e.g. the Wynoochee, Satsop, Black, Skookumchuck, and Newaukum Rivers). Following a meeting on February 23rd, the model and available documentation were provided to a group of State technical staff for review and comment. Three State reviewers provided detailed written comments on the model: Paul Pickett (DOE), Casey Kramer (WSDOT), and Guy Hoyle-Dodson (DOE). These comments were well formed and generally helpful in identifying areas in the hydraulic model that required additional consideration and/or refinement. The three comment letters (attached) were reviewed and discussed by the WSE-WEST team and a number of modifications were made to the model to address significant concerns. In some cases, no changes to the model were necessary, either because the model was already configured appropriately or because the comment raised questions beyond the scope of the current study. Our general responses to the reviewer's comments are provided below. These responses will also be discussed further with the individual reviewers to ensure that we are all comfortable moving ahead with the Chehalis River Basin alternatives analysis using the resulting (refined) model.

RE: Paul Pickett comment letter of 3/30/2012:

Mr. Pickett's comments focused primarily on the hydrologic data proposed for use in the evaluation of flood relief alternatives. He noted that flood events in a basin as large and complex as the Chehalis Basin can come in many different forms and that a comprehensive analysis of flood relief alternatives would require a range of design events to be simulated. However, in our response below we provide data showing that the largest flood events (i.e. the top 10 floods) observed in the Chehalis basin in the past 80 years have similar enough characteristics to make the proposed design event modeling approach reasonable for the current effort. Furthermore, we note that the hydrology for the current study was done and widely reviewed as part of the concurrent Corps project and using the same hydrologic methodology as that study will maintain consistency between the modeling efforts. However, in an effort to provide a more robust and useful analysis, we offer a recommendation to use hydrologic data for the calibration events (1996, 2007, and 2009) to augment the design event evaluation.

In addition to comments on the proposed hydrologic data, Mr. Pickett offered a number of suggestions for improving the evaluation and presentation of "Model Quality" metrics. We have reviewed these comments and find them to be well stated and helpful. We will endeavor to provide additional information on model quality including expanded reporting of model uncertainties, as suggested, when reporting the results of the alternatives analysis.

Detailed Response to "Sensitivity to Hydrology"

Mr. Pickett presented a very useful analysis of the high variability in flood coincidence of contributions from major tributaries in the Upper Chehalis River (above the flow gage near Grand Mound). We agree that multiple hydrologic scenarios of inflows from the major tributaries are possible that would result in a similar magnitude of high flow event for the Chehalis River near Grand Mound.

The hydrologic methodology that WEST used to develop the synthetic flood events for their current U.S. Army Corps of Engineers (USACE) study is similar to the one used by the USACE in the 2003 General Reevaluation Study (updated in 2010). The essential feature of the approach was to develop synthetic flood hydrographs at various locations throughout the basin that together would generate 1.5- to 500-year flood events for the Chehalis River near Grand Mound. The flood magnitude (recurrence frequency) of the basin-wide synthetic events is evaluated using the flow gage site on the Chehalis River near Grand Mound. The coincident relationships for peak flows between the Grand Mound gage and upstream gages were determined using all concurrent annual peaks, which provide a systematic and objective method to define the long-term average coincidence between a synthetic peak discharge near Grand Mound and the coincident inflow from an upstream tributary or from the headwaters of the Upper Chehalis River.

In Mr. Pickett's comment letter he plots the correlation between the annual peak discharges near Grand Mound and near Doty with and without inclusion of the December 2007 event. The figure shows that for flows in the Chehalis River near Grand Mound less than about 45,000 cfs, roughly the peak discharge of a 10-year event (Table 2), the two regression curves are relatively close to each other. For flows that exceed about 45,000 cfs, the regression curves depart significantly. Mr. Pickett expressed concern that the higher ratio of flows near Doty to flows near Grand Mound might result in unreasonably large contributions from the upper watershed (above Doty), even though this is only seen in some of the observed flood events.

To evaluate and respond to Mr. Pickett's concern we analyzed data from the top 10 annual peaks at the Grand Mound gage and the corresponding peaks at major upstream gages. Our key finding is that a large flood event near Grand Mound cannot occur if a large event does not occur in the headwaters above Doty. Table 2 summarizes available USGS peak flow data for the Chehalis River basin. This table shows the top 10 flood events recorded by the USGS at the Grand Mound. Of these, two occurred in the 1930s when none of these other major USGS gages in the basin was in operation. Of the remaining eight largest flood events at Grand Mound:

1) All eight had a corresponding flood on the Chehalis at Doty that was in the top 10 of all time at that location.
2) Seven of the eight had a flood on the South Fork Chehalis River that was in the top 10 at that location.

3) Seven of the eight had a flood on the Newaukum River that was in the top 10 at that location.

4) Only four of the eight had a flood on the Skookumchuck River that was in the top 10 at that location.

Furthermore, review of the concurrent USGS gage records for Doty and Grand Mound shows that of the top 10 historical flood events at Doty, eight were also in the top 10 events of all time at Grand Mound. Similarly, of the top 10 events on the South Fork Chehalis River and the Newaukum River 7 were also among the top 10 events at Grand Mound. However, it can be seen that of the top 10 flood events on the Skookumchuck River only four were in the top 10 flood events at Grand Mound. Looking in more detail at the Skookumchuck gage records it can also be seen that the 2nd highest flow of all time on the Skookumchuck was only the 24th highest flow at Grand Mound and the 4th highest flow on the Skookumchuck was only the 23rd highest flow in the USGS record at Grand Mound.

From these data, we can make the following observations:

1) A large flow (herein defined as among the top 10 highest peaks recorded) on the Chehalis at Grand Mound has never happened without a correspondingly large flow on the Chehalis River at Doty.

2) A large flow at Doty is a reliable (although not perfect) indicator of a large flow at Grand Mound.

3) A large flow on the Chehalis at Grand Mound can happen with or without a significant flow contribution from the Skookumchuck River.

4) A large flow on the Skookumchuck is not a very good indicator of large flows at Grand Mound.

5) Peak flows on the Newaukum and South Fork are similarly correlated to the flows at Grand Mound, less so than the Doty flows but more so than the Skookumchuck flows.

Using the top 10 flows at Grand Mound as a representative and sufficiently large sample of basin wide flood events, we see that the average contributions from Doty, South Fork, Newaukum, and Skookumchuck during these events are 45%, 17%, 19%, and 14% of the Grand Mound peak. In his comments Mr. Pickett noted that the preliminary proposed design flow hydrology had ratios of 44%, xx% (South Fork is under review), 17%, and 14%, respectively, for these locations. The proposed design flow ratios appear to be very reasonable given the data in Table 2 and the observations listed above. Figure through Figure show the distributions of flood return periods across the entire basin for the February 1996, December 2007, and January 2009 events. For the January 2009 event, a flood event greater than the 100-year peak discharges occurred in the Skookumchuck and Newaukum Rivers. However, the corresponding flows near Doty and near Grand Mound are only a 12-, and 15-year event, respectively. Thus, while this event is a good example that portions of the basin can see extreme floods while other portions see smaller flood events it also supports the conclusion that a basin-wide extreme flood (as determined using the gage at Grand Mound) is only possible with a large contribution from the Upper Chehalis basin.

We feel that these additional analyses indicate that the coincident relationships determined from all concurrent annual peaks between the Grand Mound gage and the upstream gages provide a reasonable representation of the large flood events in the Upper Chehalis River basin. However, we agree with Mr. Pickett that a high variability in storm timing and magnitude exists in the Chehalis River basin. To evaluate the sensitivity of storm variability, we recommend that the hydraulic model evaluations of flood relief alternatives be run for both the synthetic hydrographs and for the observed February 1996, December 2007, and January 2009 flood events. While we believe that the design event does a reasonable job of characterizing large, basin wide, floods the addition of the historical flood events provides a range of alternative hydrologic conditions that have been seen in the recent past and are useful for a more robust evaluation of flood relief alternatives.

Table 2. Expected Probability Flood Frequency Natural or Unregulated Peak Discharges (in cfs) at Fully Gaged Active Sites

Recurrence Interval (yrs)		Chehalis River nr Doty	Newaukum River nr Chehalis	Skook. River nr Centralia	Chehalis River nr Grand Mound	Chehalis River at Porter	Satsop River nr Satsop	Wyn. River above Save Ck nr Aberdeen	Wyn. River above Black Ck nr Montesano
		12020000	**12025000**	**12026000***	**12027500**	**12031000**	**12035000**	**12036000**	**12037400**
Annual Peak Recurrence (yrs)	**1.5**	8,155	5,160	3,400	21,519	25,109	21,751	11,300	15,100
	2	9,900	6,206	4,230	25,659	29,651	25,936	13,000	17,700
	5	15,110	8,674	6,390	36,917	42,160	35,644	17,500	23,900
	10	19,412	10,253	7,920	45,352	51,678	41,742	20,700	28,000
	20	24,281	11,732	9,450	54,239	61,840	47,382	24,000	31,900
	50	31,906	13,607	11,500	67,091	76,794	54,432	28,400	37,000
	100	38,775	14,995	13,200	77,844	89,514	59,588	32,100	40,800
	200	46,828	16,370	15,000	89,674	103,733	64,642	36,000	44,800
	500	59,627	18,187	17,400	107,184	125,153	71,242	41,600	50,100

*A substitute for Station 12026150 for unregulated flood flow statistics only

Table 2: Comparison of USGS Recorded Peak Flows for Key Gages in the Chehalis River Basin

Chehalis at Porter				Chehalis near Grand Mound			Skookumchuck at Bucoda				Newaukum				SF Combined (extended w Doty)				Chehalis near Doty			
Date	Flow (cfs)	Rank [1]	% [2]	Date	Flow (cfs)	Rank [1]	Date	Flow (cfs)	Rank [1]	% [2]	Date	Flow (cfs)	Rank [1]	% [2]	Date	Flow (cfs)	Rank [1]	% [2]	Date	Flow (cfs)	Rank [1]	% [2]
12/05/2007	102000	1	129%	12/04/2007	79100	1	12/03/2007	3600	55	5%	12/03/2007	12900	3	16%	12/03/2007	20710	1	26%	12/03/2007	63100	1	80%
02/09/1996	80700	2	108%	02/09/1996	74800	2	02/08/1996	11300	1	15%	02/08/1996	13300	1	18%	02/08/1996	9540	4	13%	02/08/1996	28900	2	39%
01/11/1990	60400	4	88%	01/10/1990	68700	3	01/10/1990	8540	8	12%	01/09/1990	10400	6	15%	01/09/1990	9880	3	14%	01/09/1990	27500	3	40%
11/25/1986	45900	9	89%	11/25/1986	51600	4	02/01/1987	6470	22	13%	11/24/1986	10700	5	21%	11/24/1986	6430	12	12%	11/24/1986	17900	9	35%
01/09/2009	68100	3	134%	01/08/2009	50700	5	01/08/2009	10500	3	21%	01/07/2009	13000	2	26%	01/08/2009	11660	2	23%	01/08/2009	20100	7	40%
01/22/1972	55600	5	113%	01/21/1972	49200	6	01/21/1972	8190	11	17%	01/21/1972	9770	10	20%	01/20/1972	6540	10	13%	01/20/1972	22800	4	46%
Data not available				12/29/1937	48400	7	Data not available															
11/26/1990	43000	11	90%	11/25/1990	48000	8	11/25/1990	8400	9	18%	11/24/1990	10300	7	21%	11/24/1990	7400	7	15%	11/24/1990	20600	6	43%
Data not available				12/21/1933	45700	9	Data not available															
12/05/1975	48100	7	107%	12/05/1975	44800	10	12/04/1975	6110	27	14%	12/04/1975	8020	17	18%	12/04/1975	6590	9	15%	12/04/1975	17400	10	39%
		42	**107%**			**39**			**136**	**14%**			**51**	**19%**			**48**	**17%**			**42**	**45%**
01/27/1971	49600	6	11	01/26/1971	40800	11	12/09/1953	10930	2	24	11/07/2006	11200	4	26	11/06/2006	8130	5	26	02/07/1945	21400	5	32
01/02/1997	46000	8	12	12/30/1996	38700	12	12/11/1955	10150	4	23	12/02/1977	10300	7	17	11/25/1998	7420	6	17	01/18/1986	18100	8	27
01/13/2006	43200	10	15	01/23/1935	38000	13	01/25/1964	9760	5	22	11/26/1998	10000	9	17	01/30/2006	7080	8	15	12/16/2001	16600	11	
02/26/1999	42000	12		02/10/1951	38000	13	02/17/1949	9400	6	17	12/29/1996	9700	11		01/18/1986	6500	11		02/24/1999	16300	12	
12/19/2001	41200	13		01/31/2006	37900	15	12/28/1949	8710	7	36	01/31/2003	8940	12		12/15/1999	6350	13		01/30/2006	16000	13	
01/07/1954	40800	14		01/17/1974	37400	16	12/30/1996	8380	10	12	01/30/2006	8720	13		02/07/1945	5700	14		02/09/1951	15700	14	
01/17/1974	39100	15		02/18/1949	36500	17	12/13/1966	7270	12		01/15/1974	8440	14		12/16/2001	5620	15		12/20/1994	15300	15	
12/23/1955	38900	16		12/03/1977	36500	17	12/22/1964	7200	13		01/26/1971	8390	15		12/20/1994	5500	16		12/03/1982	15200	16	
12/15/1977	38900	16		11/26/1998	36500	17	12/02/1977	7170	14		12/16/1999	8100	16		12/03/1982	5460	17		12/15/1939	15100	17	
01/27/1964	38500	18		01/15/1936	36300	20	11/12/1958	6940	15		01/25/1964	7970	18		12/15/1939	5430	18		11/06/2006	14500	18	
12/17/1999	38100	19		12/21/1994	35900	21	11/20/1960	6680	16		02/23/1986	7960	19		12/09/1987	4960	19		12/09/1987	13800	19	
02/11/1951	36100	20		01/26/1964	35700	22	01/30/2006	6640	17		12/17/2001	7920	20		02/17/1949	4920	20		12/13/1966	13400	20	
12/15/1966	35700	21		12/22/1955	35100	23	01/26/1971	6630	18		12/09/1953	7880	21		12/13/1966	4650	21		02/22/1949	12800	21	
12/22/1994	35600	22		01/06/1954	34700	24	02/08/1955	6530	19		12/04/1982	7820	22		03/19/1997	4530	22		12/09/1956	12600	22	
01/31/1965	34000	23		12/14/1966	34400	25	11/20/1962	6520	20		01/18/2005	7740	23		01/25/1964	4330	23		03/19/1997	12600	22	
02/24/1949	33500	24		11/08/2006	32700	26	02/09/1951	6480	21		01/30/2004	7460	24		12/26/1980	4310	24		11/25/1962	12400	24	
01/26/1982	33300	25		01/20/1986	32100	27	12/11/1946	6320	23		01/14/1975	7400	25		12/30/1970	4250	25		12/15/1999	12400	24	
02/27/1950	32500	26		12/18/2001	31900	28	03/22/1948	6320	23		02/07/1979	7280	26		01/31/2003	4240	26		12/26/1980	12000	26	
01/16/1975	32100	27		12/17/1999	31000	29	11/22/1959	6290	25		12/12/1955	7200	27		11/27/1949	4040	27		12/07/1970	11700	27	
02/23/1961	32000	28		11/21/1962	29800	30	12/19/1941	6190	26		11/20/1962	6960	28		12/09/1956	3940	28		11/27/1949	11400	28	
12/28/1980	32000	28		01/25/1982	27300	31	12/17/2001	6060	28		02/17/1949	6950	29		12/23/1964	3780	29		02/04/1968	11200	29	
11/28/1962	31600	30		02/09/1945	27000	32	02/01/2003	5990	29		01/25/1984	6760	30		12/11/1955	3720	30		12/11/1955	11000	30	
11/23/1959	30100	31		02/22/1961	27000	32	01/16/1974	5950	30		04/01/1931	6750	31		02/09/1951	3690	31		02/02/1947	9980	31	
11/09/2006	29400	32		12/20/1941	26900	34	12/09/1956	5520	31		01/14/1998	6580	32		01/18/2005	3650	32		10/30/1997	9920	32	
01/28/1970	29200	33		01/15/1975	26900	34	01/24/1982	5250	32		12/23/1964	6500	33		10/30/1997	3560	33		11/17/2009	9460	33	
12/19/1979	28600	34		02/26/1950	26300	36	01/08/2007	5240	33		11/20/1960	6460	34		02/03/1963	3460	34		01/25/1964	9450	34	
12/28/1972	28100	35		12/24/1964	26200	37	03/09/1966	5160	34		12/11/1946	6350	35		02/04/1968	3450	35		02/04/1952	9320	35	

Notes: [1] Rank is the rank among the events at each individual gage, highlighted cells show events that were in the top 10 at Grand Mound but not in the top 10 at another gage

[2] % refers to percent of corresponding flow at Grand Mound seen at each of the other gages

[3] The table was truncated to show only events above a 2-year flow at Grand Mound

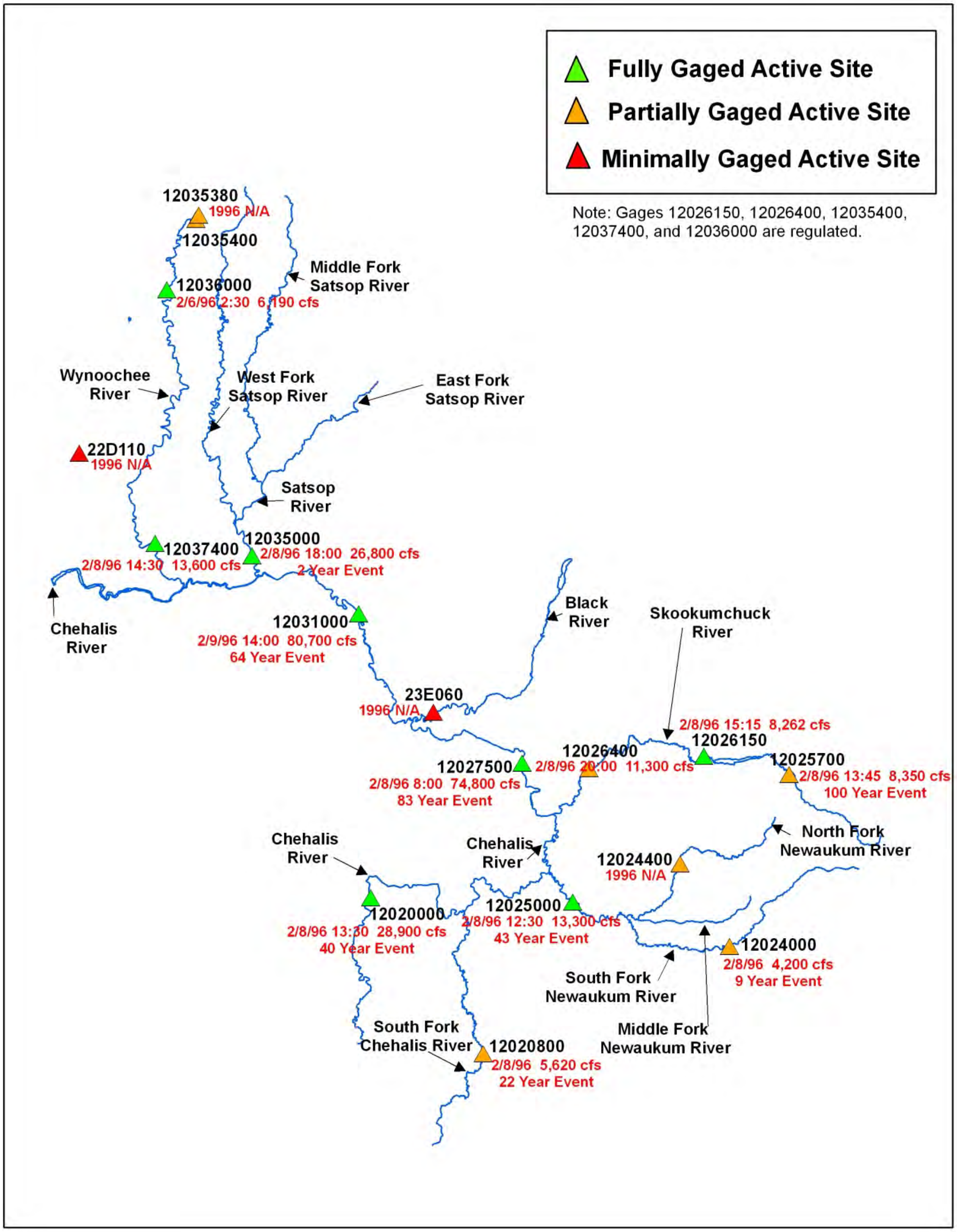

Figure 1. Flood Return Periods at Various Gaged Sites for the February 1996 Event

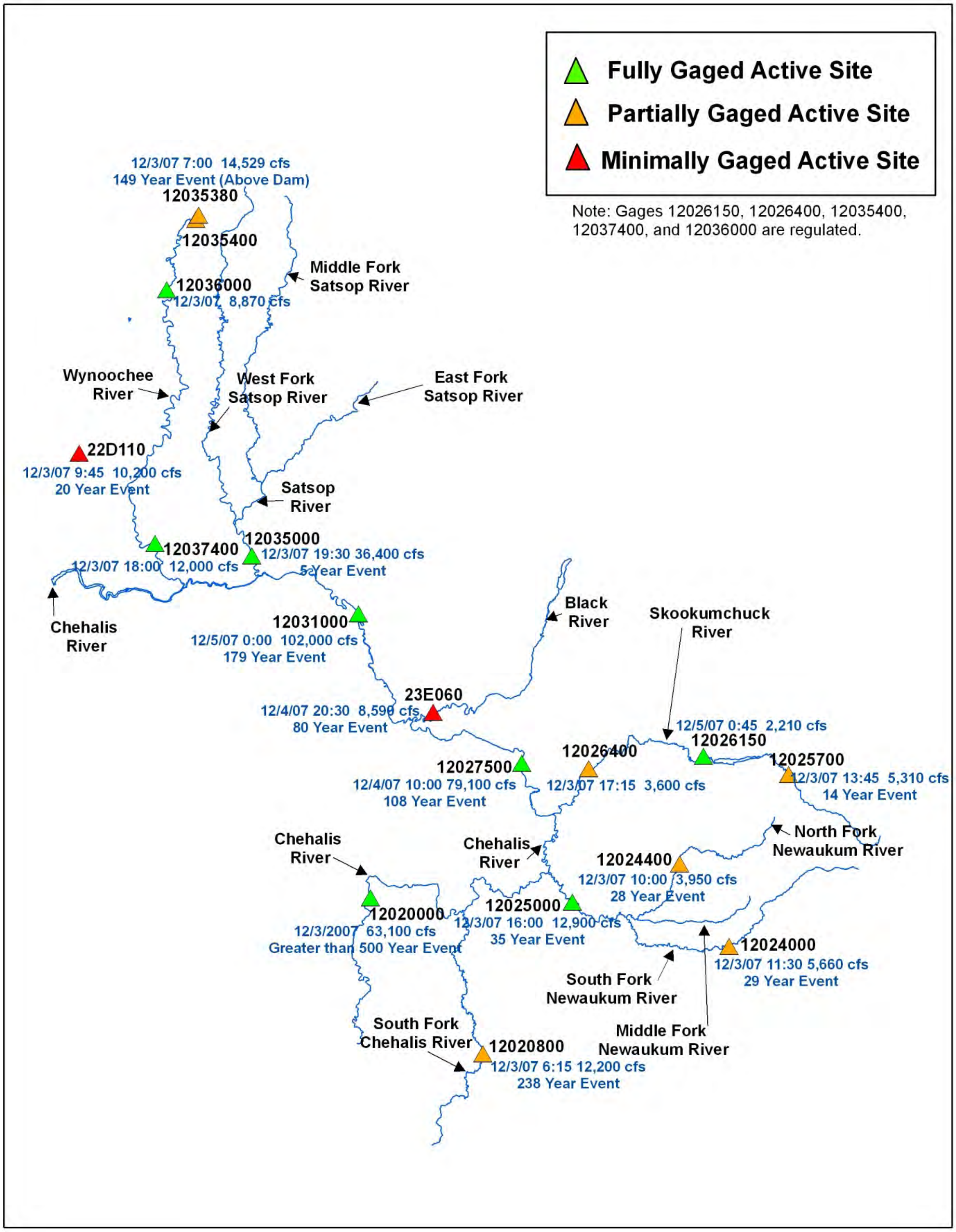

Figure 2. Flood Return Periods at Various Gaged Sites for the December 2007 Event

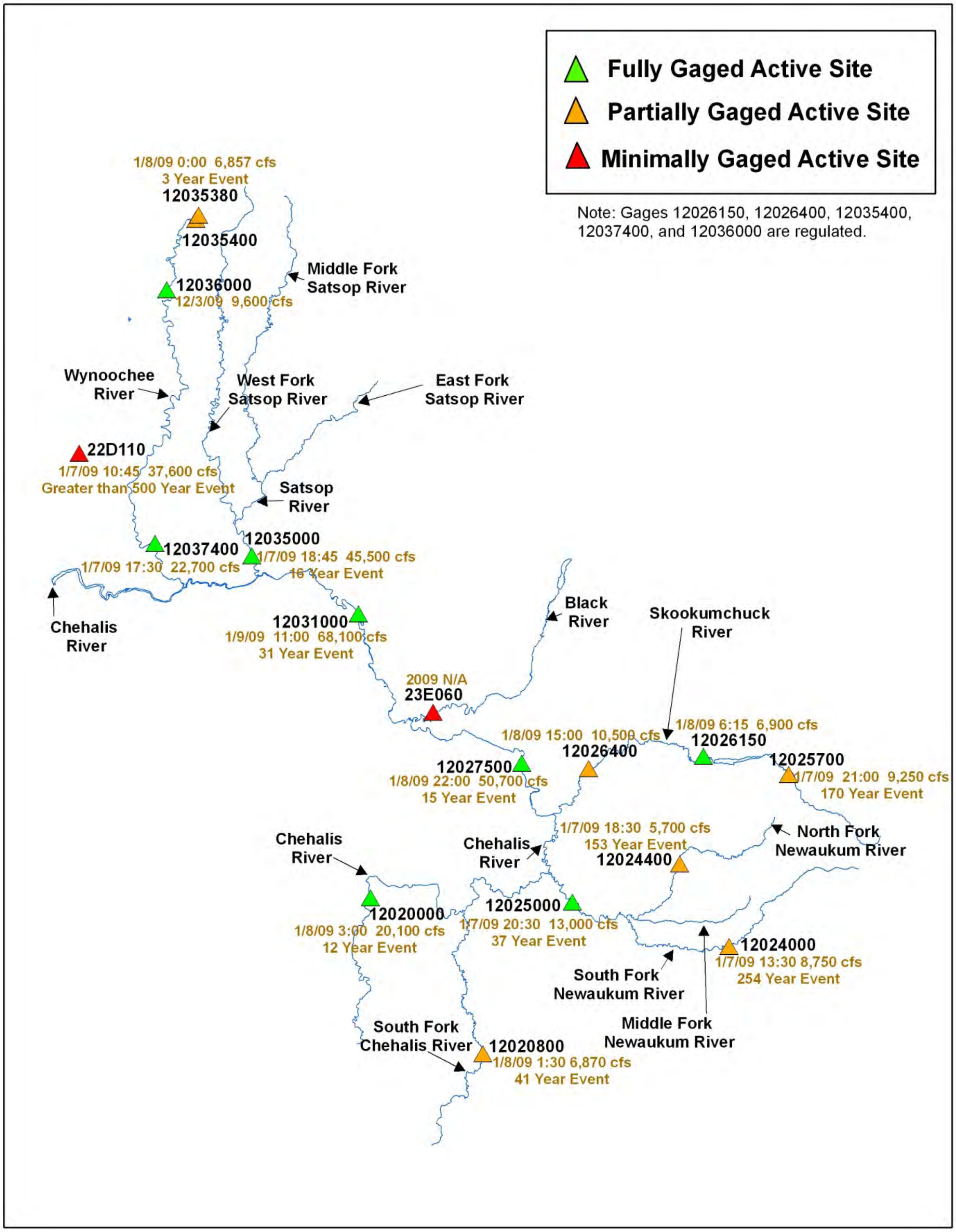

Figure 3. Flood Return Periods at Various Gaged Sites for the January 2009 Event

RE: Guy Hoyle-Dodson comment letter of 4/1/2012:

Mr. Hoyle Dodson's comments on the HEC-RAS model were particularly comprehensive including comments on general modeling approaches as well as a number of specific areas of concern or question. While many of these related to the new portions of the model being developed for this study, a large number were specifically related to the "Twin Cities" portion of the model previously developed by others. That said, and in an effort to make the model as robust and useful as possible, we have reviewed all of the comments and will attempt to address all of them as appropriate in refining the model. In addition to refinements to the model configuration we offer the following responses to key comments made by Guy:

- Regarding contraction and expansion losses, at bridges and elsewhere, note that the momentum equation which is solved under unsteady flow implicitly accounts for losses due to flow transitions. The original modeling by PIE and then by NHC, was carried out using unsteady-flow versions of UNET and HEC-RAS, that did not allow inputs of additional contraction and expansion losses. With the current HEC-RAS version 4.1, the USACE has now added a table to allow modeling of additional losses, for example at bridges with a particularly sharp contraction or expansion zone. For typical bridges, however, these losses are already accounted for in the unsteady (momentum) equation of motion. See HEC-RAS version 4.1 release notes, page 4: http://www.hec.usace.army.mil/software/hec-ras/documents/HEC-RAS_4.1_Release_Notes.pdf
- Regarding reach lengths, it should be noted that this model was developed (by PIE) generally following the 6 cross-section bridge modeling approach commonly called the Normal Bridge methodology in HEC-2 parlance. The two middle cross-sections were cut typically along the top of the roadway. The immediate upstream and downstream cross-sections were then cut close to the roadway but along natural ground (sometimes referred to as full valley sections). These are not intended to be the fully expanded or contracted sections, but are included so that floodplain storage is properly accounted for in the unsteady model. These should have appropriate ineffective areas to keep the majority of the floodplain from conveying flow, and have been checked accordingly. The fully expanded/contracted sections are generally the next downstream/upstream sections from the "full valley" sections, i.e. sections 1 and 6. These are further away from the bridge at a more acceptable distance for the flow transition.
- Regarding divided flow, it was generally assumed that this issue was dealt with appropriately in the original Twin Cities model. The current project did not include scope or budget to review or revise these in the existing FEMA model. That said, we took a quick look at the sections identified, and in some instances examined the amount of flow simulated on the floodplain to see if it would make any significant difference in the simulation results. Revisions were made to ineffective areas at some locations, as noted further below.
- On the Lower Chehalis tidal portion, the divided flow is more complex due to the tidal nature of this reach. Water does not have to exceed the channel bank elevation for flow to be in the side channels, as it comes up the channels from downstream due to the tide. Regarding the two bridges in the tidal reach, the Monte Bridge does not really have any flow contraction or expansion, in part because the upstream reach parallels the highway and does not overtop. The Hwy 101 bridge could have some ineffective areas added upstream and downstream, but it is not going to change the results any this close to the Aberdeen tidal boundary.
- Interpolated cross-sections on the Newaukum River were removed. These were added to reduce reach length and improve model stability, but HEC-RAS is unable to interpolate the blocked ineffective areas. Upon further review, the interpolations are not necessary for stability.

- Ineffective area limits (station, elevation) were revised at Newaukum cross-sections 9.84, 5.01, 2.97 and 1.03, as suggested. At other locations on the Newaukum, review of topography indicates ineffective area limits are appropriately set; i.e., divided flow would exist based upon upstream conditions.
- Regarding divided flow and ineffective limits on the main stem Chehalis in Reaches 19, 21, 23, and 24: These reaches downstream of Grand Mound tend to have significant remnant channels in some overbank areas. In addition to the general adjustments to ineffective limits discussed previously, in the areas where divided flow was noted and remnant channels are picked up in the cross section geometry, blocked, permanent ineffective areas were used where appropriate to make cut-off remnant channels ineffective.
- Regarding Right Overbank Manning's n values at cross sections 82.61 through 82.57: The overbank n values of 0.08 were a carryover from the Corps modeling. Although the aerial imagery shows what appear to be fields in the overbanks, there are also rows of trees in the right overbank at these cross sections. A Manning's n value of 0.08 does not seem to be overly conservative in this area.
- Regarding lateral structures where bounding channel cross sections have been recommended: HEC-RAS uses a linear interpolation of water surfaces between modeled cross sections to calculate flows over lateral structures. We believe the cross sections currently in the model appropriately estimate the overflows at the level of detail warranted in a regional model and that the addition of cross sections to refine the overflow estimates would not create large changes in water surface elevations in the modeled storage areas and the Chehalis River.
- Regarding Rainbow Falls Inline Weir (Reach 1): We will add a cross section closer to the upstream face of the weir to more accurately model the upstream head on the weir.
- Regarding comments related to the Skookumchuck River: Under the original Flood Authority contract, non-georeferenced areas of the Skookumchuck River model (Reach 14 of the PIE model above RS 6.44) were georeferenced by West, and 2002 LiDAR was used to update overbank geometry. The contract did not include time to investigate (or refine) modeling assumptions made during the original model development. The subsequent tributaries modeling amendment included budget for WSE to update cross section data and refine the model near the town of Bucoda (RS 9.69 to 11.8) While we agree that additional refinement to the remainder of the model would be beneficial, such refinement is generally outside the scope and budget of the current project. That said, the following summarizes the changes made to the Skookumchuck reach of the model to address Mr. Hoyle-Dodson's comments:
    - NHC Reach (River Mile 0.0 to River Mile 6.44) – this reach was refined by Northwest Hydraulic Consultants as part of the Lewis County FEMA study (2010). As such we did not feel that additional model changes, without detailed supporting investigations, were advisable.
    - Intermediate Reach (River Mile 6.44 to 9.39) – this reach, between the NHC reach and the Bucoda reach had some unusual ineffective flow and levee limits in the original PIE model (as georeferenced by WEST). In response to Mr. Hoyle-Dodson's comments and our own review of the topographic information for this reach we adjusted several ineffective and levee boundaries to better simulate expected conditions in this reach.
    - Bucoda Reach (River Mile 9.69 to 11.8) – The HEC-RAS configuration in this reach was developed and calibrated by WSE using new cross section surveys and available high water marks. Comments on this reach were reviewed and minor changes were made to levee and ineffective flow limits.
    - Upstream Reach (River mile 11.92 to 21.77) – We agree with Mr. Hoyle-Dodson that some of the ineffective limits in the PIE model of this reach appear unusual. However, the hydraulic conditions in this reach are fairly complex with shallow overbank flow in many locations. Without additional high water mark data or detailed field investigations to verify existing

conditions we did not feel it was appropriate to make adjustments to the existing model at this time.

RE: Casey Kramer comment letter of 4/2/2012:

Mr. Kramer's comments were discussed between Mr. Kramer, WSE, WEST, and NHC staff in a meeting at WSE's office on March 27, 2012. As a group we agreed upon a plan of action for updating the model to address the comments. It is noted that Mr. Kramer's model comments focused on the Twin Cities portion of the model constructed by others and not actually part of the current model development effort. However, in an effort to ensure that all future analyses conducted with the model are as useful as possible the following modifications were made:

1) USGS Chehalis River Near Grand Mound, WA Gage 12027500

No model modifications were necessary to address questions with the USGS gage. WSE confirmed with the USGS that the Grand Mound gage rating curve was extrapolated from the available discharge measurements, none of which were made at a time when there was any overbank flow or flow over Prather Road. An excel plot of the available USGS discharge measurements was prepared by WSE and discussed at the meeting on March 27th. As concurred by the group, the lack of high flow discharge measurements from which to develop the high flow rating means that the upper end of the current rating curve is subject to greater uncertainty than if actual discharge measurements were available. In our opinion, discharges at higher stages (e.g. near the 100-year event) should only be considered accurate to within plus or minus 15% or so. Thus, the "observed" flow in the December 2007 flood event (79,100 cfs) could actually range between about 67,000 and 91,000 cfs.

2) Chehalis River along I-5 Upstream of Mellen Street

As discussed during the March 27th meeting, several changes were made to the model geometry near the Mellen Street Bridge. The small section of Long Road Dike immediately adjacent to I-5 was lowered and a connection was added between SA501 and SA5. Ineffective limits were added in the left overbank upstream of Mellen Street, at RS 67.86 through 67.59. Ineffective limits through the bridge itself were also modified to further constrict the upstream and downstream cross sections.

These changes had only limited effect on simulated water surface elevations upstream of Mellen Street Bridge. When constrictions were added to the Chehalis River, in the form of ineffective limits (changes to Manning's n and contraction/expansion coefficients were also briefly tested), water surface elevations in the vicinity of Mellen Street increased only about one tenth of a foot. However, more flow did overtop the lateral structures in the right overbank, which resulted in less flow in the Chehalis River.

WSDOT also provided new topographic survey data for I-5 and the airport levee. The lateral structure elevations in the model were revised to reflect the new survey data. The revision to the lateral structures resulted in minor changes to the simulated water levels in the main stem of the Chehalis River.

Considering the results of the model investigations in this area it appears that we would either need to make atypical changes to the modeling of the Mellen Street Bridge (such as arbitrary additional head losses) or increase the flows reaching the bridge in order to "hit" the higher of the high water marks upstream of the bridge. Increasing the flows would lead to problems with matching high water marks at other locations in the model so we do not feel that is a reasonable alternative. Similarly, we don't feel it is wise to insert arbitrary losses into the model simply to meet a few high water marks (bearing in mind that there are other, lower high water marks in the same area that we are already overshooting). Thus, we feel that the modeling in this area has been improved as much as possible and do not propose to make any additional changes.

3) Dillenbaugh Creek and Chehalis River Connections near Main Street and I-5

To better approximate December 2007 flood conditions near the Dillenbaugh Creek/Chehalis Junction, two lateral weirs (0.120 and 0.092) were added along Dillenbaugh to model flow entering the north- and southbound lanes of I-5 and flowing under the Highway 6 overpass. Weir elevations were based on 2012 survey completed by WSDOT. Additionally, the weir coefficient (C_d) for Main Street was reduced from 2.0 to 1.5 to approximate losses as water exiting Dillenbaugh flows through vegetation and around buildings on its path to Storage Area #303.

With these changes the model showed peak flow values of:

- 1870 cfs flowing over the Main Street weir (LS 0.187) between Dillenbaugh Creek and Storage Area #303
- 1710 cfs overtopping of the I-5 weir returning to the Chehalis River (LS 74.41, Chehalis Reach 9) and 30 cfs flowing through the culvert under I-5
- 165 cfs flowing from SA #303 to Dillenbaugh Creek via the northbound lanes of I-5
- 145 cfs flowing from Dillenbaugh Creek to the Chehalis River via the southbound lanes of I-5

A section of the I-5 weir (LS 74.41) was then lowered (as discussed during the March 27th meeting) to simulate the portion of I-5 that does not have a jersey barrier along its east side, and the failure of the centerline jersey barrier that occurred during the Dec 2007 flood event. This resulted in peak flow values of:

- 2378 cfs flowing over the Main Street weir
- 2552 cfs flowing over the I-5 weir or through the culvert back into the Chehalis River
- 176 cfs flowing from Dillenbaugh to SA #303 via the northbound lanes of I-5
- 87 cfs flowing from Dillenbaugh to the Chehalis via the southbound lanes of I-5

The maximum simulated depth of flow over I-5 in between SR-6 and NW West Street was about 2.0 ft, which may be somewhat high based on photographs we have seen from the 2007 flood. Additional model refinement might reduce the peak stages over the freeway in this area but it is not clear that there is enough information to definitively state how high the flow may have gotten and/or the direction and magnitude of breakout flows from Dillenbaugh Creek during the event. As such, no additional refinement to the model calibration was attempted.

Appendix K: Bibliography

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