MEMORANDUM

Date: October 30, 2020
To: Andrea McNamara-Doyle, Office of Chehalis Basin
From: Larry Karpack, PE, and Bob Elliot, PE, Watershed Science and Engineering; Mike Gieschen, Anchor QEA, LLC
Cc: Chrissy Bailey, Office of Chehalis Basin; Jim Kramer and Ken Ghalambor, Office of Chehalis Basin consultant staff; Robert Montgomery, Heather Page, and Merri Martz, Anchor QEA, LLC
Re: Local Actions Program Near-term Technical Analyses for Office of Chehalis Basin: Summary and Evaluation of Options for Increasing Floodplain Storage

Overview

The purpose of this memorandum is to provide a summary and evaluation of actions to increase floodplain storage in the Chehalis River Basin for potential inclusion in the Local Actions Program. Recommendations made herein may be modified based on input from the Technical Advisory Group at the direction of the Office of Chehalis Basin (OCB) prior to consideration by the Chehalis Basin Board.

The Chehalis Basin Board has provided guidance for how they will evaluate a Local Actions Program. The Board directed that a Local Actions Program should plan for the 100-year flood conditions that are predicted for 2080 when considering outcomes and actions. This planning assumption provides the foundation for all of the outcome measures agreed to by the Chehalis Basin Board. The Chehalis Basin Board has agreed upon the following relevant outcome measures related to this memorandum: increasing floodplain storage could result in flood damage reduction to valuable structures (Outcome 1), farmland and rural structures (Outcome 4), critical facilities (Outcome 5), and transportation routes (Outcome 6) while advancing equity for communities with environmental justice concerns (Outcome 7).

This memorandum summarizes existing studies that sought to identify potential areas for improving floodplain storage, as well as proposed projects that include new floodplain storage. Areas in the basin with low floodplain slopes (0.3% or less) are identified. Finally, additional locations where existing levees, roads, railroads, or natural features restrict floodplain inundation and storage during extreme flood events are identified and evaluated for their potential to increase floodplain storage. These potential floodplain storage areas were chosen based on their potential to provide additional storage for flood waters during the late-century 100-year flood.

As described herein, this new analysis identifies 1,550 acre-feet of potential additional flood storage within the modeled Chehalis River floodplain.[1] Approximately 300 acre-feet of this potential storage is

[1] The term "modeled Chehalis floodplain" refers to the area covered by the Chehalis Basin Strategy RiverFlow2D model (WSE 2019). This includes the entire mainstem Chehalis River from Grays Harbor to the proposed dam site (river mile 108) plus significant portions of many tributaries including 5 miles of the South Fork Chehalis River, all of the mainstem Newaukum River, all of the Skookumchuck River to the dam and included significant portions of the Black River, Stearns Creek, Salzer Creek, Dillenbaugh Creek, Lincoln Creek, Satsop River, and Wynoochee River.

located upstream of Centralia and approximately 1,250 acre-feet is downstream, with most of that (1,100 acre-feet) in one location upstream of State Route (SR) 12 on the Black River. Based on past hydraulic modeling and analysis, it is estimated that the amount of additional storage identified upstream of Centralia could provide a reduction in flood levels near Centralia on the order of 0.012 foot (0.1 inch) during the late-century 100-year flood. Evaluations for the State Environmental Policy Act (SEPA) Draft Environmental Impact Statement (EIS) showed that the 65,000 acre-feet of flood storage provided by the Flood Retention Expandable (FRE) facility would result in a 2.7-foot reduction in floodwater levels near Mellen Street in Centralia during the late-century 100-year flood.

Summary of Options

Near-term Option

In the near term, the large storage area upstream of the railroad embankment upstream of SR 12 on the Black River could be further investigated to determine: 1) the actual volume of storage available during the late-century 100-year flood; 2) the potential water level reduction and area of benefit if this potential storage area is opened up to additional floodwater storage; and 3) structures, agricultural properties, critical facilities, and transportation routes potentially benefited by the additional storage.

Long-term Options

No long-term options were identified for using floodplain storage to benefit structures, agricultural land, transportation routes, critical facilities, or communities with environmental justice concerns.

Questions for Technical Advisory Group

1. Are there other locations for potential floodplain storage that should be included in Table 2 as YES or MAYBE options?
2. Are there other technical considerations for any of the potential floodplain storage locations listed in Table 2 that would change their viability between the YES, MAYBE, NO classifications?
3. What other near-term or long-term options are available for evaluating the potential for additional floodplain storage to benefit structures, agricultural land, transportation routes, critical facilities, or communities with environmental justice concerns?

Summary of Previous Studies on Floodplain Storage

Several studies have been conducted in the Chehalis Basin to evaluate the effects of improved floodplain connection on floodplain storage. The following summaries have been separated into studies where increasing floodplain storage is the primary objective, and proposed or implemented projects that could have an effect on floodplain storage.

Studies on Floodplain Storage

The following studies were identified as either focusing on floodplain storage or having components that address these goals. A brief summary of these studies is provided below.

- U.S. Army Corps of Engineers (Corps) Final General Reevaluation Report for the Centralia Flood Damage Reduction Project, Chehalis River, Washington (Corps 2003)
- Preliminary Scientific Assessment of a Restorative Flood Protection Alternative for the Upper Chehalis River Watershed (Abbe et al. 2016)
- Chehalis Basin Strategy Restorative Flood Protection Advanced Feasibility Evaluation for the North and South Forks for the Newaukum River, Washington (Abbe et al. 2020)
- City of Chehalis Flood Storage and Habitat Enhancement Master Plan (CRBFA 2018a)

Corps Final General Reevaluation Report: Centralia Flood Damage Reduction Project

The Corps General Revaluation Report identifies and evaluates several alternatives to increase flood storage and reduce flood damages in the Chehalis Basin (Corps 2003). Seven total alternatives are considered, but only Alternatives 5, 6, and 7 include measures for increasing floodplain storage. Alternative 5 explores flow restriction structures and distributed upstream storage options. Alternative 6 includes non-structural actions, some of which target improving floodplain connectivity and increasing storage. Table 1 summarizes the floodplain connectivity improvement projects evaluated as part of non-structural Alternative 6. Alternative 7 is an interagency alternative that identifies multiple measures for addressing flood damage in the Chehalis Basin. Measure 7 of Alternative 7 (preserve/enhance floodplain storage) and Measure 13 of Alternative 7 (use of upstream flow restriction structures) both have the potential to increase flood storage on the floodplain. Measure 7, in particular, identifies specific locations where floodplain connectivity could be restored with possible increases in floodplain storage.

The Corps report determined that Alternatives 5 and 6 would not adequately reduce flood hazards or decrease transportation closures during the 100-year flood event.[2] Therefore, these alternatives were not considered for further analysis. Alternative 7 was determined to be viable to meet the flood reduction criteria, but only if it were paired with other structural flood reduction measures including modification to the Skookumchuck Dam to add flood storage and construction of levees at various locations.

[2] This is the 100-year flood event determined by the Corps at the time of their 2003 study. The Corps reported that this was essentially the same as the February 1996 flood.

Table 1
Summary of Potential Floodplain Connectivity Projects Identified in the Corps Study (Alternative 6)

LOCATION	RIVER	PROJECT TYPE
Scheuber Ditch	• Mainstem Chehalis	• Side Channel Connection
SR 6 Oxbow Reconnection	• Mainstem Chehalis	• Oxbow Reconnection
Chehalis River Mainstem White Road/ Ceres Hill Road	• Mainstem Chehalis	• Floodplain Connection
South Fork Chehalis, Chehalis Confluence	• South Fork Chehalis	• Wetland Creation
Newaukum, Chehalis Confluence	• Newaukum River	• Wetland Creation • Revegetation
Newaukum, Stan Hedwall Park	• Newaukum River	• Side Channel Connection
North Fork/South Fork Newaukum Confluence	• Newaukum River	• Wetland Creation
Salzer Creek, Chehalis Confluence	• Salzer Creek	• Wetland Creation
Salzer Creek Frozen Foods Site	• Salzer Creek	• Wetland Creation
Salzer Creek, RM 3.1	• Salzer Creek	• Floodplain Connection
Salzer Creek, RM 4.5	• Salzer Creek	• Floodplain Connection

RM: river mile

Restorative Flood Protection Alternative for Upper Chehalis Basin and Newaukum River

The Restorative Flood Protection Alternative (RFPA) reports for the Upper Chehalis Basin and North and South Forks of the Newaukum River were intended to provide a scientific basis for using areas of improved floodplain connectivity to increase flood storage throughout the basin, as well as provide multi-ecosystem and geomorphic process benefits to the fluvial system. Both reports note that areas in the basin where channel slopes are less than 0.003 foot per foot (ft/ft) are the most viable for increasing flood storage through floodplain restoration. The Newaukum River RFPA examined flood attenuation due to improved floodplain connectivity for five flood events: 2-year, 10-year, 100-year, 100-year with climate change, and a replication of the January 2009 event (Abbe et al. 2020). For the Upper Chehalis RFPA, the following five events were evaluated: 2-year, 10-year, 20-year, 100-year, and 500-year events.

The RFPA analysis found that flood attenuation was greatest in restored channels with shallow slopes (less than 0.003 ft/ft). The analysis further found that the RFPA provided limited peak flow reductions (approximately 3%) during large flood events like the 2009 flood. Within the RFPA study area, there were approximately 87 miles of channel with slopes less than 0.003 ft/ft. Because the RFPA found limited flow reduction during large floods, and approximately two-thirds of the upper Chehalis Basin was too steep to significantly attenuate peak flows, it was determined that the RFPA would not provide meaningful downstream reductions in peak flood flows during major or catastrophic floods on a river the scale of the Chehalis mainstem. The analysis described that localized flood water level reductions could be achieved during smaller floods.

City of Chehalis Wastewater Treatment Plant Restoration and Flood Storage Master Plan

This project, which includes two phases, is being designed to enhance habitat and increase flood storage at the City of Chehalis Wastewater Treatment Plant (WWTP) property in Chehalis. The WWTP property covers approximately 156 acres along the east bank of the Chehalis River between the Chehalis Airport and SR 6. Phase 1 of the project was completed in June 2017 and included data gathering and preliminary design and evaluation. Phase 2, currently underway, includes more detailed hydraulic evaluations. Watershed Science and Engineering (WSE) updated the RiverFlow2D hydraulic model developed for the Chehalis Basin Strategy and is using this model to evaluate hydraulic impacts and potential flood damage reduction benefits of the WWTP project. The current design proposal would remove existing buildings and excavate approximately 1.5 million cubic yards (930 acre-feet) of floodplain material to increase available on-site flood storage.

WSE's analysis indicates that the project design currently being evaluated would reduce flood levels upstream from the project site during the 100-year (historical condition) flood, while downstream water levels would see increases in some locations and modest reductions in other locations. Overall, downstream flood level changes are expected to range from increases of 0.3 foot near the project downstream boundary and up to 0.05 foot through the Chehalis airport area and across Interstate 5 (I-5), and decreases of up to 0.05 foot on the mainstem Chehalis River along the airport levee. Upstream flood reductions range from 0.6 foot at the upstream project boundary to 0.4 foot at the SR 6 Bridge and 0.15 foot at the Newaukum River confluence. Flood reductions of up to 0.01 foot extend approximately 2 miles upstream of the project site. It is important to note that the WWTP project is still in design, and that ongoing refinements seek to eliminate water surface increases associated with the project. Results reported here may change as alternative designs are considered.

Additional Past Projects with Floodplain Storage Components

In addition to the studies noted previously, several projects with flood storage components have been implemented or are currently in planning. The following projects all include improving floodplain connectivity and have the potential for adding flood storage.

Porter Oxbow Flood Storage Project

This project, sponsored by the Chehalis Tribe, provides 100 acre-feet of new flood storage near a remnant oxbow on the left bank of the Chehalis River upstream of Porter. The benefits in terms of flood hazard reduction have not been specifically evaluated. Based upon other investigations of flood volumes, it is estimated that 100 acre-feet of storage would provide less than 0.01 foot of flood reduction during the late-century 100-year flood.

China Creek Flood and Habitat Mitigation (CRBFA 2016, 2018b)

This project, sponsored by the City of Centralia, intends to improve floodplain connection and increase floodplain storage on China Creek through excavation of naturally shaped landforms, and installation of fish habitat features. Phase 2 of the project is ongoing and includes raising the storage level of the Agnew

mill ponds to further enhance storage. The project is expected to delay the timing of peak flows from the upper China Creek basin and allow the lower China Creek basin to more efficiently transport stormwater from urban areas in the middle China Creek basin to the Chehalis River. The project's focus is on flooding in China Creek and it is not expected to have a significant impact on Chehalis River flood flows.

Lower Satsop Floodplain Restoration Projects (WDFW 2017; Grays Harbor County 2019)
The Lower Satsop Floodplain Restoration Phase 2 study was completed in 2017 and identified five alternatives for addressing channel migration, adding floodplain connectivity, and enhancing habitat in the lower 2 miles of the Satsop River (WDFW 2017). The selected alternative implemented in 2019 and 2020 includes filling of quarry ponds on the floodplain ponds and creation of floodplain wetlands, removal of multiple earthen dikes, and in-channel restoration. Phase 1 of this project was completed in 2017 and Phase 2 in 2019. This project was not designed to increase floodplain storage, but rather to address bank erosion.

Additional avulsions occurred in 2018 on the Lower Satsop River near river mile (RM) 0.4, prompting additional studies that led to the current project sponsored by Grays Harbor County. The current project design focuses on restoration of geomorphic processes, installation of engineered log jams, minimization of erosion hazards, and improved floodplain connectivity. This project is not intended to increase floodplain storage (Grays Harbor County 2019).

South Fork Newaukum River Early Action Reach (Chehalis Basin Strategy 2019)
This project is located between RM 11 and RM 13 on the South Fork Newaukum River. The goal is to restore instream and riparian habitat by installing large wood along the channel and floodplain and riparian plantings. The project will also remove riprap from the banks and reconnect the floodplain, to help restore floodplain connectivity. These actions may provide localized flood storage benefits during small or moderate floods but the effect on water levels during the late-century 100-year event would likely be negligible.

Stillman Creek Early Action Reach (Chehalis Basin Strategy 2019)
The Stillman Creek project targets restoring instream and riparian habitat near the mouth of the creek by installing large wood along the channel and floodplain. Lewis County Conservation District will also plant and restore riparian vegetation in this area. The project objectives are to remove riprap from the banks, reconnect the floodplain, and create off-channel habitat. These actions are not expected to significantly increase flood storage at the late-century 100-year event but may provide localized flood storage benefits during small or moderate floods.

Skookumchuck River (Chehalis Basin Strategy 2019)
This project is located between RM 19 and RM 22 on the Skookumchuck River. Project objectives include restoring instream, riparian, and adjacent habitats by removing invasive species, adding riparian plantings, and installing engineered log jams. Additionally, the project plans to create off-channel habitat, and promote

more frequent floodplain connectivity. This project was not designed to increase flood storage. A no-rise evaluation was performed showing no increase in flood inundation during the 100-year flood event.

Evaluation of Locations in the Basin with Low Slopes

The RFPA analysis suggests that areas with slopes less than 0.003 ft/ft have the greatest potential for improving floodplain connectivity and increasing floodplain storage. The RFPA categorized these areas based on the slope of the channel bottom (Abbe et al. 2016, 2020). For the evaluation performed for this memorandum, the slope of the water surface from the late-century 100-year flood, as modeled for the Chehalis Basin Strategy, was used instead of channel slope. Using the slope of the water surface eliminates slope anomalies due to irregularities in the channel bed and more effectively highlights areas of shallow slope (<0.003 ft/ft) that could be looked at to store or slow water.

Analysis of the slope of the water surface shows similar results to the analysis done for the RFPA (Abbe et al. 2016, 2020). The majority of the Lower Chehalis River (including downstream of Grand Mound) has water surface slopes less than 0.003 ft/ft, and these areas would therefore provide potential opportunities for restoring floodplain connectivity and increasing floodplain storage. On the Skookumchuck River, much of the area downstream of Bucoda has water surface slopes below 0.003 ft/ft and could provide an opportunity for flood storage upstream of the City of Centralia. However, some of the low water surface slopes in this area can be attributed to backwater from the mainstem Chehalis River, indicating these areas are already flooded significantly during the late-century 100-year flood and, as such, would not be viable candidates for RFPA treatment. Upstream of Bucoda, some areas of low-slope exist but the floodplain becomes more dominated by slopes greater than 0.003 ft/ft.

Much of the mainstem Chehalis River through Centralia and Chehalis is within the target low-gradient range, as well as the downstream-most portions of some of the smaller tributaries in this area including Salzer Creek, Coal Creek, Dillenbaugh Creek, and Bunker Creek. Most of these areas already flood to significant depth during extreme flood events. As a result, the potential for further increasing floodplain storage in these areas to reduce downstream flows diminishes. Model results are not available farther upstream on the smaller tributaries but most of them appear to have slopes significantly greater than 0.003 ft/ft.

Water surface slopes on the lower portion of the mainstem Newaukum River are consistently below 0.003 ft/ft. Farther upstream, near the confluence of the North and South Forks, there are many areas with slopes greater than 0.003 ft/ft, and it is expected that this is generally the case upstream of the confluence. Water surface slopes on the South Fork Chehalis River appear to be mostly below 0.003 ft/ft, although these begin to transition to steeper slopes near the upper reach of the model. Finally, the water surface slope on the mainstem Chehalis River transitions to more consistently above 0.003 ft/ft near the Ceres Hill bend, and by Pe Ell the water surface slope is almost entirely above 0.003 ft/ft. Many of these lower slope reaches—including the mainstem Chehalis River upstream of Centralia, the mainstem Newaukum River, and the South Fork Chehalis River—were included in the RFPA analysis, which found that RFPA treatment in these areas achieved limited reductions in downstream flood levels.

Identification of Opportunities for Floodplain Storage

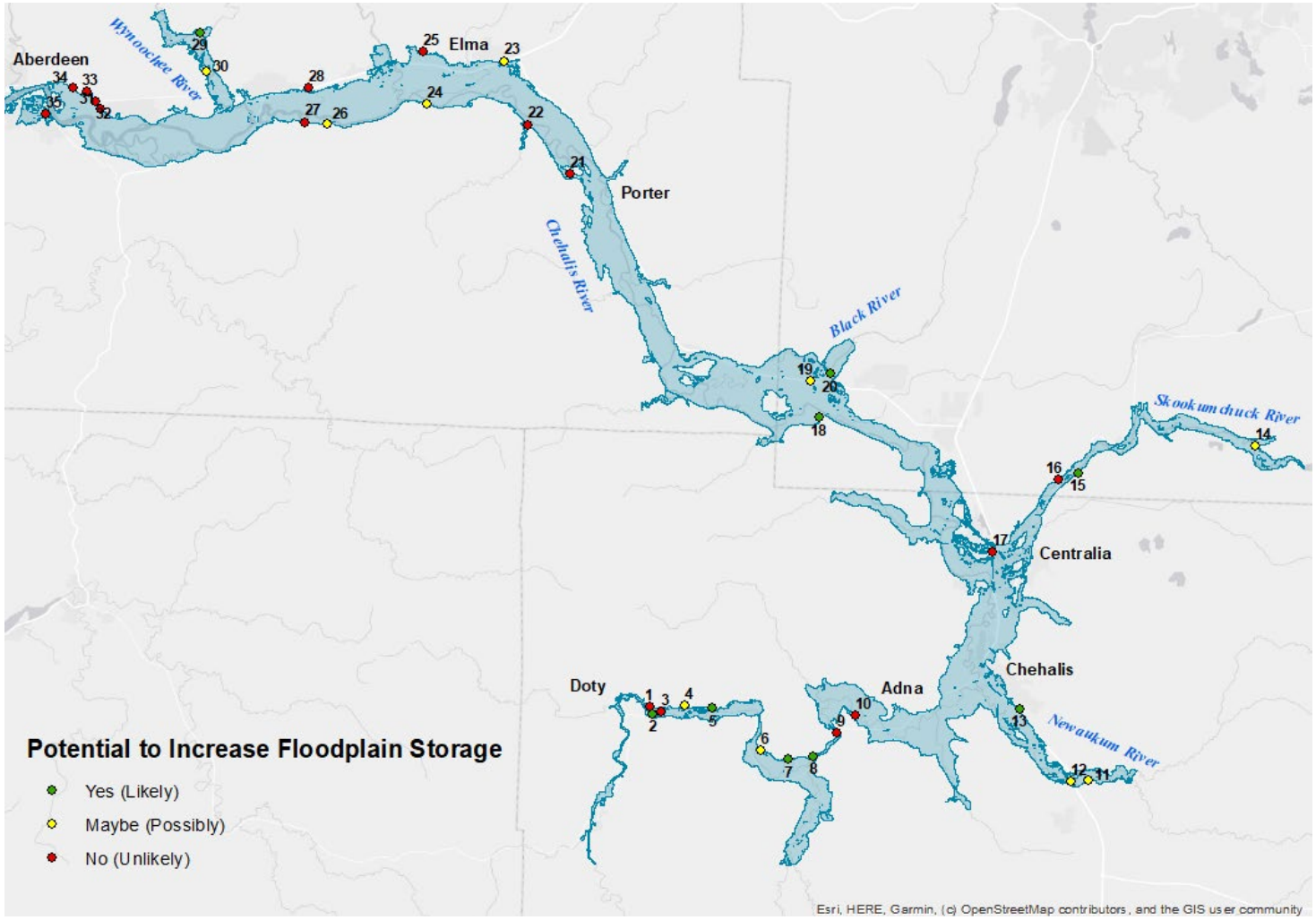
WSE completed a high-level evaluation of additional areas that could provide opportunity for increased floodplain storage. This evaluation identifies the potential use of non- or minimally flooded areas in the floodplain to store floodwaters during the late-century 100-year flood as part of a Local Actions Program. Specifically, WSE identified areas where existing levees, embankments (including roadway, railroad, and trail embankments), bridge constrictions, or other human-made or natural features may currently prevent or restrict floodwaters from filling the floodplain during the late-century 100-year flood event. The amount of potential additional storage in each location was estimated, along with an estimate of the potential flood water level reductions that could be achieved.

Evaluation

The computed maximum water surface elevations and inundation limits from the late-century 100-year hydraulic model were thoroughly examined and compared to the topography and aerial imagery. This allowed identification of topographic features that appeared to be holding back or otherwise preventing access of floodwaters into areas of the floodplain that might provide additional storage volume. No significant natural features were identified, because a flood of this magnitude essentially inundates the full extent of natural floodplain from valley wall to valley wall and already overtops these features. However, a number of human-made features were identified that appeared to inhibit maximum flood storage. Removal of these features, or the addition of openings therein, would allow floodwaters to more freely access these areas. In some cases, the areas are completely protected by the structure or embankment. In other cases, the areas may already be inundated by downstream backwater or through a constricted opening, but not to its fullest capacity. A number of these areas were identified along channels that are blocked off in the model by roadways. However, closer examination of many of these indicates a culvert likely exists, although not represented in the model, and thus these areas would already be filled with water during an actual flood event.

An initial 35 total locations were identified where increased floodplain storage may be possible. Each location was examined more carefully to consider its potential to provide flood storage without impacting developed property or exacerbating flood conditions in other areas. From the initial list of 35 locations, 16 were removed from the list as being either too insignificant to provide meaningful benefit or likely causing impacts that exceed any potential benefits. Such impacts are typically either to existing development, or an expected downstream increase in flows resulting from either an overall net reduction in storage or short-circuiting of flow. Nine remained as likely viable candidates that could provide some benefit. Another 10 were identified as possibly providing benefit but with some anticipated constraints or limitations. The subdivided set of 9, 10, and 16 locations were classified as YES, MAYBE, and NO, accordingly. Figure 1 shows each location identified by color, with YES, MAYBE, and NO represented by green, yellow, and red dots, respectively. Table 2 summarizes each location and explains its assigned category.

Figure 1
Locations with Potential for Increased Floodplain Storage



RiverFlow2D late-century 100-year event mapped floodplain (no action), identifying locations to potentially increase floodplain storage. Locations are color coded to indicate likelihood of project benefits exceeding impacts.

Table 2

Summary of Identified Locations for Possibly Increasing Floodplain Storage

POTENTIALLY VIABLE LOCATION FOR FLOODPLAIN STORAGE (YES)	POSSIBLE BUT WITH LIMITED VIABILITY FOR FLOODPLAIN STORAGE (MAYBE)	UNLIKELY TO PROVIDE FLOODPLAIN STORAGE WITHOUT IMPACTS (NO)
2 Doty-Dryad Road along right bank slightly elevated, limiting overflows to farmland with storage potential.	**4** Floodplain area cut off by Willapa RR trail, likely too small to be significant.	**1** Backwater from Willapa RR trail already provides upstream storage, downstream properties would be impacted.
5 Old road grade blocks flood access to north floodplain.	**6** Willapa RR trail does not overtop. Landward floodplain backwaters but does not completely fill.	**3** Chandler Road already stores water upstream but would exacerbate flooding downstream for at least one structure.
7 Willapa RR trail prevents complete filling of area north. Would flood several feet deeper.	**11** Kirkland Road blocking access to south floodplain, but if opened would likely short-circuit flow exacerbating downstream flooding.	**9** Willapa RR trail blocks left overbank flow, but currently adds some upstream storage and prevents short-circuiting.
8 Willapa RR trail blocks access to modest landward floodplain area.	**12** Levee and I-5 fill flock overflow. Would lose storage upstream and flood development downstream.	**10** Willapa RR trail partially blocks area south. Would only add minimal depth and volume, and may short-circuit natural flow path.
13 I-5 grade blocks access to northeast floodplain margin and ponds.	**14** Skookumchuck Road may block some floodplain access to north, but homes could be impacted.	**16** Highway cuts off some floodplain area to the west, but too small to have significant benefit.
15 BNSF RR cuts off landward floodplain and remnant channel.	**19** Head difference across SR 12 suggests it is limiting flood volume to the north. Could impact farms.	**17** I-5 at Centralia cuts off access to downstream floodplain, but this is too highly developed.
18 Old RR grade does not overtop. Landward floodplain backwaters but does not completely fill.	**23** SR 12 blocking full access to north floodplain. Already floods but could be slightly deeper.	**21** Nursery perimeter berm may inhibit floodplain storage function, but flooding nursery not an option.
20 Head difference across RR grade southwest to northeast indicates flood access is constricted into Black River floodplain.	**24** Old RR grade blocks access to tributary backwater storage, but a culvert likely already exists.	**22** Old RR grade blocking access to small part of floodplain to southwest, but too small to be significant.
29 Wynoochee Valley Road only barely overtops, not completely filling landward floodplain.	**26** Old RR grade blocks access to backwater storage. Small area but reasonably deep.	**25** RR grade may block access to some north floodplain, but small area at very shallow flood depths.
	30 Full access to ponds limited by perimeter berm, would increase pond volume only marginally.	**27** Minkler Road appears to cut off a tributary, but likely small and may flood a homestead.
		28 SR 12 freeway appears to cut off small tributary backwater storage. Likely culvert not in model.

POTENTIALLY VIABLE LOCATION FOR FLOODPLAIN STORAGE (YES)	POSSIBLE BUT WITH LIMITED VIABILITY FOR FLOODPLAIN STORAGE (MAYBE)	UNLIKELY TO PROVIDE FLOODPLAIN STORAGE WITHOUT IMPACTS (NO)
		31-34 Roadways cut off series of small backwater floodplains, but culvert(s) likely exist. Possible private property impacts. Minimal benefit this far downstream.
		35 Levee blocks floodplain access on edge of Cosmopolis, but too urbanized and too far downstream for any downstream benefit.

RR: railroad

Summary of Additional Floodplain Storage Opportunities

Numerous locations throughout the Chehalis River floodplain were identified that could provide additional flood storage to reduce downstream flows and resultant flood damages. A total of 19 locations were found where additional flood storage might have the potential to reduce flood damages (this includes all locations classified as YES or MAYBE in Figure 1 and Table 2). Cumulatively these locations could provide approximately 1,550 acre-feet of additional flood storage, although only 300 acre-feet of this is upstream of Centralia (11 locations). Past investigations of the Airport Levee area showed that filling the 3,000 acre-feet airport area east of the levee would result in a 0.12-foot rise in downstream water levels. Thus, it is assumed that increasing floodplain storage by 3,000 acre-feet near Centralia would result in a 0.12-foot reduction in downstream flood water levels. Based on this previous analysis, it can be reasonably estimated that 300 acre-feet of flood storage upstream of Centralia could lower water levels near Centralia by approximately 0.012 foot (0.1 inch) during the late-century 100-year flood.

The Chehalis Basin Partnership is currently preparing a Streamflow Restoration Plan for the basin that will include several projects to add floodplain storage. In particular, the managed aquifer recharge projects may add storage. However, because these projects are generally only conceptual in nature at this time, and locations for several of these projects have not yet been identified, the effects on flooding cannot be evaluated herein. As the Local Actions Program progresses, coordination with the Chehalis Basin Partnership's Streamflow Restoration Plan and the Washington Department of Fish and Wildlife's Aquatic Species Restoration Plan will occur to identify additional future floodplain storage opportunities.

Options

Near-term Options

The current investigation identified 1,550 acre-feet of potential additional flood storage within the Chehalis River floodplain, 300 acre-feet of which is upstream of Centralia, and 1,250 acre-feet of which is downstream of Centralia. Based on past hydraulic modeling and analysis, it is estimated that implementing projects at every one of the identified locations upstream of Centralia could result in a reduction in flood levels near Centralia on the order of 0.012 foot (0.1 inch) during the late-century 100-year flood. Although localized flood reductions or reductions during smaller floods may be possible, no near-term Local Actions Program option was identified for these potential storage areas upstream of Centralia.

Of the 1,250 acre-feet of potential flood storage downstream of Centralia, 1,100 acre-feet are contained in one location, Location 20 upstream of the railroad embankment upstream of SR 12 on the Black River. Hydrologic and hydraulic conditions at this site are not well understood at present. Extreme flood hydrology of the Black River is uncertain because the Washington Department of Ecology gage on the Black River near SR 12 becomes backwatered during extreme flood events and thus does not provide useful flow data. In addition, hydraulic connections at this site have not been field verified so it is

unclear if there are culverts or other penetrations through the railroad embankment, not included in the current model, which would allow this area to flood in the current condition. This obviates its potential as a future flood storage site. Additional analysis using a refined version of the existing RiverFlow2D model could address these uncertainties and provide an evaluation of the potential flood reduction benefits of this storage area.

This option would determine: 1) the actual volume of storage available during the late-century 100-year flood; 2) the potential water level reduction and area of benefit if this potential storage area is opened up to additional floodwater storage; and 3) structures, agricultural properties, critical facilities, and transportation corridors potentially benefited by the additional storage.

Long-term Options

With the possible exception of Location 20 (described under the near-term option) there were no opportunities for significant additional floodplain storage identified in either the review of previous studies or the new evaluation of floodplain storage opportunities. Therefore, no long-term options for using floodplain storage to reduce flooding of structures, agricultural land, transportation routes, critical facilities, or communities with environmental justice concerns were identified.

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