Appendix L
Build Out Analysis

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June 29, 2016

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Prepared for Washington State Department of Ecology

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ACRONYMS AND ABBREVIATIONS LIST

BFE	Base Flood Elevation
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Agency
I-5	Interstate 5
OFM	Office of Financial Management
SEPA	State Environmental Policy Act
UGA	Urban Growth Area

1 INTRODUCTION

This report evaluates potential development, or build out, in the modeled Chehalis River 100-year floodplain (hereafter referred to as the modeled 100-year floodplain) to inform the land use analysis in the Chehalis Basin Strategy State Environmental Policy Act (SEPA) Programmatic Environmental Impact Statement (EIS). This report presents potential future development patterns in the floodplain that could occur during the 100-year planning horizon for action elements in the EIS. Reduced flooding extents may increase the development pressure in localized areas where the reduction is large enough to substantially reduce the risk of being flooded. This effect has been seen in other river basins in Washington, such as the Green River valley after installation of the Howard Hanson Dam. However, the circumstances surrounding that facility are such that they cannot be compared to the Chehalis Basin Strategy (see Appendix A for more details).

The analysis compares combinations of EIS action elements that correspond with the following EIS alternatives:

- No Action Alternative
- Alternative 1: 2014 Governor's Work Group Recommendation (which includes Flood Retention Facility and Airport Levee Improvements)
- Alternative 2: Structural Flood Protection Without Flood Retention Facility (which includes Airport Levee Improvements and Interstate 5 [I-5] Projects)

The Land Use Management action element from the EIS is part of Alternatives 1 and 2, but was evaluated separately in this report as a means to understand its effect when implemented. Alternative 3: Nonstructural Flood Protection does not include Large-scale Flood Damage Reduction Projects that broadly affect the extent of floodplain flooding, and therefore was not evaluated. Information for Alternative 4: Restorative Flood Protection is not available at this time; an evaluation of the build out potential associated with that alternative may be included in the future when data are available, as an addendum to this report.

Modeled Chehalis River 100-year Floodplain

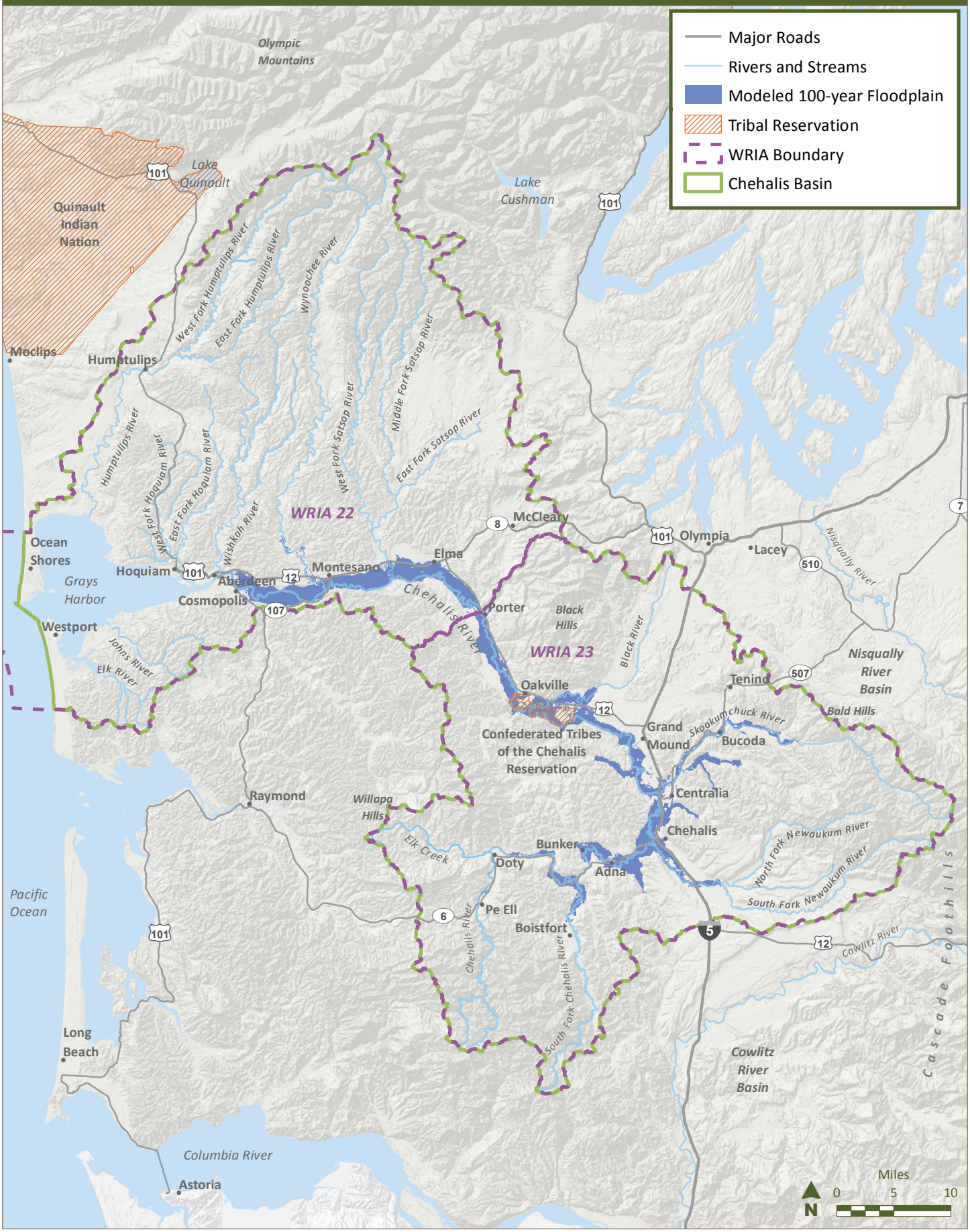
There are many different floodplain maps that illustrate the extent of flooding in the Chehalis Basin, the most common being the Federal Emergency Management Agency (FEMA) floodplain maps. **This report uses the Chehalis River's 100-year floodplain, as modeled by Watershed Science and Engineering (2015).** The modeled 100-year floodplain differs from the FEMA flood maps in that the floodplain extent has been refined based on observed and modeled floods in the Chehalis Basin. This modeled floodplain continues upstream on some tributaries. The floodplain associated with these tributaries represents modeled surface water elevations in these tributaries during a 100-year event on the Chehalis River. The modeled 100-year floodplain was chosen because it allows a comparison between changes in flood extents as a result of different combinations of EIS actions. For more information on the modeled 100-year floodplain, see Appendix B.

This report analyzes areas in the modeled 100-year floodplain, which lies within portions of Lewis, Thurston, and Grays Harbor counties along the Chehalis River. Due to strict floodplain regulations in Thurston County, floodplain development is expected to be low and occur as reasonable use exceptions. The portion of the Chehalis Basin evaluated in this analysis begins south of Pe Ell and extends north and west to the mouth of the Chehalis River near Cosmopolis (see Figure 1). This report is focused on the modeled 100-year floodplain, as delineated by Watershed Science and Engineering (2015), and does not include tributary floodplains except as affected by mainstem Chehalis River modeled flooding.

This report includes a description of potentially developable parcels in the modeled 100-year floodplain and the potential for future development on those parcels. Population growth projections were used to estimate the development that may occur in the modeled 100-year floodplain, which are primarily focused on residential development because it is the most closely tied to population growth. Commercial and industrial development was assumed to correlate with residential growth at ratios similar to current trends. Development potential on agricultural properties is briefly discussed.

Figure 1

Chehalis Basin and the Modeled 100-year Floodplain



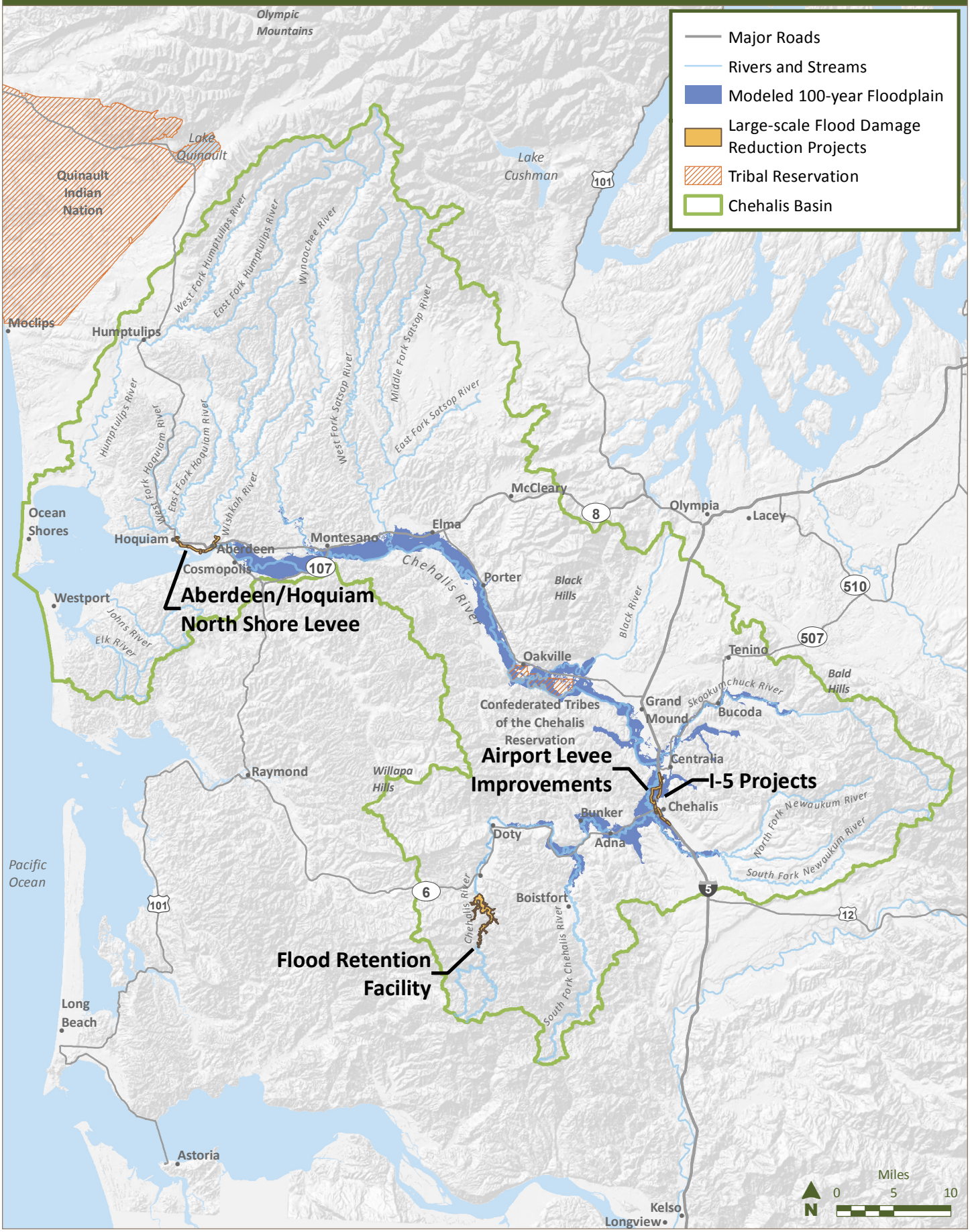
2 EIS ACTION ELEMENTS EVALUATED

The EIS evaluates alternatives designed to reduce flood damage and restore aquatic species habitat. These alternatives, described in Section 1, comprise different combinations of action elements. Only some of these action elements are likely to affect the level of future development in the modeled 100-year floodplain. The EIS action elements that are relevant to this report include several of the Large-scale Flood Damage Reduction Projects (see Figure 2) and Land Use Management actions. At this time, the Large-scale Flood Damage Reduction Projects applicable to this analysis include the Flood Retention Facility (e.g., dam), Airport Levee Improvements, and I-5 Projects (levees and walls).

The Aberdeen/Hoquiam North Shore Levee was not evaluated because it is primarily intended to provide 100-year coastal flood protection to the majority of the lowlands in Aberdeen and Hoquiam. Additionally, a description of the Restorative Flood Protection action element is not currently available; its relationship to potential future floodplain development may be evaluated in the future.

Figure 2

Large-scale Flood Damage Reduction Projects



2.1 No Action Alternative

The No Action Alternative represents the most likely future in the absence of implementing any of the EIS action elements. The No Action Alternative and this report assume floodplain growth in the next 100 years would occur consistent with past trends and current regulations, such as existing floodplain regulations and protections. Under current floodplain regulations, where allowed, development must meet specific building requirements in the floodplain that are not required outside of the floodplain.

2.2 Land Use Management

The Land Use Management action element is included in all of the EIS alternatives, and involves local governments revising and improving land use regulations and practices in the floodplain. The two main types of Land Use Management recommendations evaluated in this analysis would: minimize development in the floodplain and require higher levels of or more effective protection for buildings constructed or substantially improved in the floodplain.

The following three Land Use Management recommendations minimize development in the floodplain by limiting the creation of future new developable parcels, and were evaluated for their effect on total development potential in the floodplain:

- **Open space preservation**: This standard would minimize construction of new buildings, filling, and destruction of natural floodplain functions. Publicly owned areas that are currently open space in the floodplain would be required to remain open space (i.e., no buildings, filling, or storage).
- **Subdivision set asides**: This standard would require new subdivisions or other large developments to set aside all or part of their flood-prone area as open space. This would mainly affect parcels that have area both inside and outside of the floodplain.
- **Low-density zoning**: This standard would ensure zoning designations that have large minimum lot sizes are preserved and encouraged in the floodplain. This recommendation does not involve local governments downzoning properties currently in the floodplain; rather, it states that existing zoning districts or ordinances that require large minimum lot sizes (for example, 10 acres) would not be amended to allow more dense development in the floodplain.

The second set of recommendations restrict development in the floodplain by requiring higher levels of or more effective protection for buildings constructed or substantially improved in the floodplain. The following recommendations would reduce the amount of growth in the floodplain instead of reducing the total development potential:

- **Filling restrictions**: Filling anywhere in the floodplain would either be prohibited or compensatory storage would be required.

- **Freeboard elevation**: Freeboard refers to the height above a given water level that the lowest floor of a structure is built. In this case, the water level is the Base Flood Elevation (BFE) defined by regulations. This standard requires the freeboard height of new buildings to be 3 feet above the BFE. This would also apply to substantial improvements of existing buildings.

2.3 Alternative 1

Alternative 1 includes the Flood Retention Facility (e.g., dam) and Airport Levee Improvements. This analysis focuses on the effect these action elements could have on future development in the modeled 100-year floodplain because the structures would decrease the extent of flooding. Although the Flood Retention Facility would be intended to substantially reduce damages during major (approximately 7-year) flood events, it would not protect communities from all flooding. A decrease in flood risk could result in increased confidence and an associated increase in development pressures in the floodplain.

2.4 Alternative 2

Alternative 2 includes the Airport Levee Improvements and I-5 Projects. The Airport Levee Improvements include elevating the height of the existing levee and raising a portion of Airport Road to provide 100-year flood protection for the Chehalis-Centralia Airport, local businesses, and a portion of I-5 near Chehalis and Centralia. The I-5 Projects include a series of earthen levees and structural floodwalls along I-5. These action elements would protect a portion of I-5, as well as provide protection to nearby developed areas. Flood protection could increase development pressure in these areas.

3 EXISTING CONDITIONS AND POTENTIAL FUTURE FLOODPLAIN DEVELOPMENT

3.1 Existing Conditions

In recent years, most Chehalis Basin communities have experienced limited population growth and development in the modeled 100-year floodplain. In Centralia, the little growth that has occurred in residential and industrial development (Pierson 2016). Lewis County has also experienced limited growth in the floodplain in recent years (Napier 2016). Much of the modeled 100-year floodplain in Grays Harbor County is currently low-density zoning, such as agriculture, with very little development occurring in recent years (Hewitt 2016). Thurston County has not seen recent growth in the floodplain, primarily due to development restrictions put in place in recent years.

Many of the Chehalis Basin communities considered in this report do not currently have regulations that prohibit development in the floodplain (French & Associates 2014a). Current regulations in both Lewis and Grays Harbor counties allow for continued subdivision and development in the floodplain; however, additional development standards apply in the floodplain (Lewis County Code 15.35.230 and Grays Harbor County Code 18.06.120).

Zoning Categories

For this report, land use was split into three different categories based on zoning designations. These categories are residential, agricultural, and commercial/industrial. The types of development that generally characterize each category are described as follows:

Residential: This category represents both rural and city residential areas. Most rural residential zoning districts have 5- to 20-acre minimum lot sizes, while city residential minimum lot sizes are as small as 5,000 square feet. Most of these zones allow for one residential structure per parcel.

Agricultural: This category is mainly characterized by zones with large minimum lot sizes (mostly greater than 10 acres) with allowed uses such as agriculture or forest practices. This zoning typically allows for one dwelling unit per parcel and other farming buildings, such as barns.

Commercial/industrial: This category captures zoning designations ranging from industrial and commercial uses to less dense rural centers. Minimum lot sizes in these zones are typically smaller than residential or agricultural zones, mostly ranging from 5,000 to 20,000 square feet. However, because many commercial and industrial land uses utilize larger lots, the minimum lot size was assumed to be 1 acre in this analysis.

See Appendix C for a full list of zoning designations in each category.

Current floodplain regulations in Thurston County are highly restrictive and do not allow for development in the floodplain except under certain limited exceptions (Thurston County Code 24.20.070 and 24.55.020). In addition, 43% of the Thurston County special flood hazard area is currently preserved as open space and cannot be developed (French & Associates 2014b).

3.1.1 Existing Structures

The number of existing structures in the modeled 100-year floodplain helps to provide an understanding of the current floodplain development (see Table 1). Currently, there are approximately 3,014 structures in the modeled 100-year floodplain, but not all of these structures would be flooded above their finished floor in a 100-year flood event (WSE 2014).

Table 1
Existing Structures in the Modeled 100-year Floodplain

STRUCTURE TYPE	COUNTY			TOTAL
	LEWIS	GRAYS HARBOR	THURSTON	
Residential	1,427	242	274	**1,943**
Agricultural	148	162	133	**443**
Commercial	477	150	1	**628**
Total	**2,052**	**554**	**408**	**3,014**

Note: Residential structure type includes mobile homes

Most of the existing structures in the modeled 100-year floodplain are located in Lewis County. Approximately 70% of those structures are residential. Of the remaining structures in Lewis County, 23% are commercial and 7% are agricultural. In Grays Harbor County, 44% of the structures in the modeled 100-year floodplain are residential, 29% are agricultural, and 27% are commercial. In Thurston County, 67% of structures in the modeled 100-year floodplain are residential, 33% are agricultural, and less than 1% (one structure) is commercial. Overall, in the modeled 100-year floodplain, approximately 65% of the existing structures are residential, 20% are commercial, and 15% are agricultural.

3.1.2 Parcels

The distribution and number of existing parcels in the floodplain and the number of new parcels that could be created through subdivisions helps provide an understanding of the potential for development that could occur in the modeled 100-year floodplain. Parcels currently in the floodplain can be categorized as either developed or undeveloped, and as either non-subdividable or subdividable. Accordingly, all of the parcels currently in the floodplain can be placed into one of four categories: developed, non-subdividable; 2) developed, subdividable; 3) undeveloped, non-subdividable; or 4) undeveloped, subdividable. No additional development can occur on developed, non-subdividable parcels; therefore, these parcels were not included in this report. The remaining three categories contribute to the total development potential in the floodplain. Total development potential is used to

describe the total number of parcels and, therefore, capacity for future development in the modeled 100-year floodplain. Limited capacity would result in limited growth regardless of population growth projections. Existing and potential new parcels are also categorized by their location: in an incorporated city or town, in an Urban Growth Area (UGA), or in an unincorporated, non-UGA area.

Types of Parcels

Developed parcels have a structure value of greater than $10,000.

Undeveloped parcels have a structure value of less than $10,000.

Subdividable parcels have a buildable area of greater than two times the minimum lot size required by zoning.

Non-subdividable parcels have a buildable area of less than two times the minimum lot size required by zoning.

Types of Developable Parcels

Undeveloped, non-subdividable parcels include parcels that currently have no development and are not large enough to be split into two or more parcels.

Undeveloped, subdividable parcels are parcels that currently have no development, but could be subdivided.

Developed, subdividable parcels currently have some level of development, but are large enough to be subdivided into two or more parcels.

For a more detailed explanation of methods, see Appendix D.

As shown in Table 2, there are currently 3,059 developed parcels in the modeled 100-year floodplain, 2,582 of which could not be further subdivided and 477 that could be further subdivided. There are 2,073 undeveloped parcels, of which 1,841 could not be further subdivided and 232 could be further subdivided. The undeveloped parcels represent the development capacity that currently exists in the floodplain, and are referred to as existing developable parcels.

The parcels that could be further subdivided include existing developed and undeveloped parcels that could be subdivided into two or more parcels. If the existing parcels were subdivided to the maximum extent, up to 3,519 new parcels could potentially be created in the modeled 100-year floodplain (see Table 2). Those parcels are referred to as new developable parcels.

The distribution of existing developable parcels in the modeled 100-year floodplain is important for understanding where development could occur in the future. Undeveloped, non-subdividable parcels are mostly located in unincorporated areas in the modeled 100-year floodplain, with a majority located in agricultural and residential areas of Lewis and Grays Harbor counties. Overall, the most undeveloped parcels are located in Lewis County and the greatest subdivision potential exists on residential developed and undeveloped parcels in incorporated and UGA areas in Lewis County (see Table 2).

Table 2

Parcels in the Modeled 100-year Floodplain

	DEVELOPED[1]						UNDEVELOPED[2]						POTENTIAL NEW PARCELS THROUGH SUBDIVISION[3]					
	NON-SUBDIVIDABLE[4]			SUBDIVIDABLE[5]			NON-SUBDIVIDABLE[4]			SUBDIVIDABLE[5]			FROM DEVELOPED PARCELS			FROM UNDEVELOPED PARCELS		
COUNTY	RES	C/I	AG	RES	C/I	AG	RES	C/I	AG	RES	C/I	AG	RES	C/I	AG	RES	C/I	AG
LEWIS																		
Incorporated	501	247	0	154	32	0	72	136	0	49	24	0	900	185	0	487	135	0
UGA	184	11	0	97	1	0	44	22	0	26	2	0	409	3	0	161	5	0
Unincorporated	349	17	320	9	5	13	314	17	410	16	3	10	36	31	28	33	10	18
County Total	*1,034*	*275*	*320*	*260*	*38*	*13*	*430*	*175*	*410*	*91*	*29*	*10*	*1,345*	*219*	*28*	*681*	*150*	*18*
GRAYS HARBOR																		
Incorporated	51	32	2	29	4	1	11	24	1	8	3	1	114	6	8	38	8	4
UGA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unincorporated	114	7	312	22	4	44	114	6	338	24	2	36	164	12	93	78	5	73
County Total	*165*	*39*	*314*	*51*	*8*	*45*	*125*	*30*	*339*	*32*	*5*	*37*	*278*	*18*	*101*	*116*	*13*	*77*
THURSTON																		
Incorporated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UGA	94	0	0	31	0	0	29	0	0	14	0	0	171	0	0	203	0	0
Unincorporated	220	1	120	23	2	6	193	0	110	10	0	4	59	4	9	21	0	8
County Total	*314*	*1*	*120*	*54*	*2*	*6*	*222*	*0*	*110*	*24*	*0*	*4*	*230*	*4*	*9*	*224*	*0*	*8*
Zone Total	**1,513**	**315**	**754**	**365**	**48**	**64**	**777**	**205**	**859**	**147**	**34**	**51**	**1,853**	**241**	**138**	**1,021**	**163**	**103**
Grand Total	**2,582**			**477**			**1,841**			**232**			**2,232**			**1,287**		

Notes:

1. Number of developed parcels, structure value greater than $10,000, in the modeled 100-year floodplain.
2. Number of undeveloped parcels, structure value less than $10,000, in the modeled 100-year floodplain.
3. Number of additional parcels that could be created by subdividing parcels that are greater than twice the minimum lot size.
4. Number of parcels that cannot be subdivided under current zoning (smaller than twice the minimum lot size).
5. Number of parcels that are greater than twice the minimum lot size and therefore could be subdivided.

AG = Agricultural C/I = Commercial/industrial RES = Residential

3.1.3 Total Development Potential

The total development potential in the modeled 100-year floodplain includes all existing and created developable parcels, as described in Section 3.1.2. In the modeled 100-year floodplain, the total development potential equates to a maximum of 5,592 parcels (see Table 3), which are distributed throughout the floodplain (see Figures 3, 4, and 5). The abundance and distribution of these parcels differs between general zoning categories.

The greatest development potential exists on residential parcels, which is approximately 68% of the total development potential (see Table 3). Most of these residential parcels are located in incorporated and UGA areas (2,736 parcels), many of which are in Chehalis and Centralia. The remaining residential parcels are located in unincorporated areas distributed throughout all three counties. Agricultural parcels are the second most common in the modeled 100-year floodplain, with approximately 21% of the total development potential. These parcels are mostly located in unincorporated areas throughout all three counties (see Table 3). Commercial/industrial parcels represent the fewest developable parcels in the modeled 100-year floodplain, making up approximately 11% of the total development potential (see Table 3). These commercial/industrial parcels are highly concentrated in incorporated areas in Lewis County, mostly associated with Chehalis and Centralia.

Although residential parcels are the most abundant type of developable parcel in the modeled 100-year floodplain, they do not cover the largest area. In fact, residential parcels constitute only 22% of the buildable area in the modeled 100-year floodplain, at approximately 4,231 acres (see Table 4). If developed to the maximum, residential development would be concentrated in a small portion of the modeled 100-year floodplain mostly in incorporated and UGA areas in Lewis County (Chehalis and Centralia). Agricultural parcels represent 74% of the buildable area in the modeled 100-year floodplain, at approximately 14,386 acres (see Table 4). Agricultural parcels show moderate development potential but comparatively cover a larger portion of the land; therefore, parcels created and developed in agricultural areas would be more widely dispersed. Commercial/industrial parcels are the smallest in both abundance and size, covering only 4% of the buildable area and approximately 731 acres (see Table 4). Commercial/industrial development pressure in the modeled 100-year floodplain is relatively low and concentrated almost entirely in Chehalis and Centralia.

Table 3

Total Development Potential in the Modeled 100-year Floodplain

COUNTY	DEVELOPABLE PARCELS		
	RES	C/I	AG
LEWIS			
Incorporated	1,508	480	0
UGA	640	32	0
Unincorporated	399	61	466
County Total	*2,547*	*573*	*466*
GRAYS HARBOR			
Incorporated	171	41	14
UGA	0	0	0
Unincorporated	380	25	540
County Total	*551*	*66*	*554*
THURSTON			
Incorporated	0	0	0
UGA	417	0	0
Unincorporated	283	4	131
County Total	*700*	*4*	*131*
Zone Total	**3,798**	**643**	**1,151**
Grand Total	**5,592**		

Notes:
AG = Agricultural
C/I = Commercial/industrial
RES = Residential

Table 4

Acres of Buildable Land on Developable Parcels in the Modeled 100-year Floodplain

ZONING DESIGNATION	COUNTY			TOTAL
	LEWIS	GRAYS HARBOR	THURSTON	
Residential	2,479	602	1,150	**4,231**
Agricultural	4,336	8,366	1,684	**14,386**
Commercial/industrial	663	62	6	**731**
Total	**7,478**	**9,030**	**2,840**	**19,348**

Note: See Appendix D for a description of how buildable land is calculated.

Figure 3

Developed and Potentially Developable Parcels – Upper Chehalis Basin

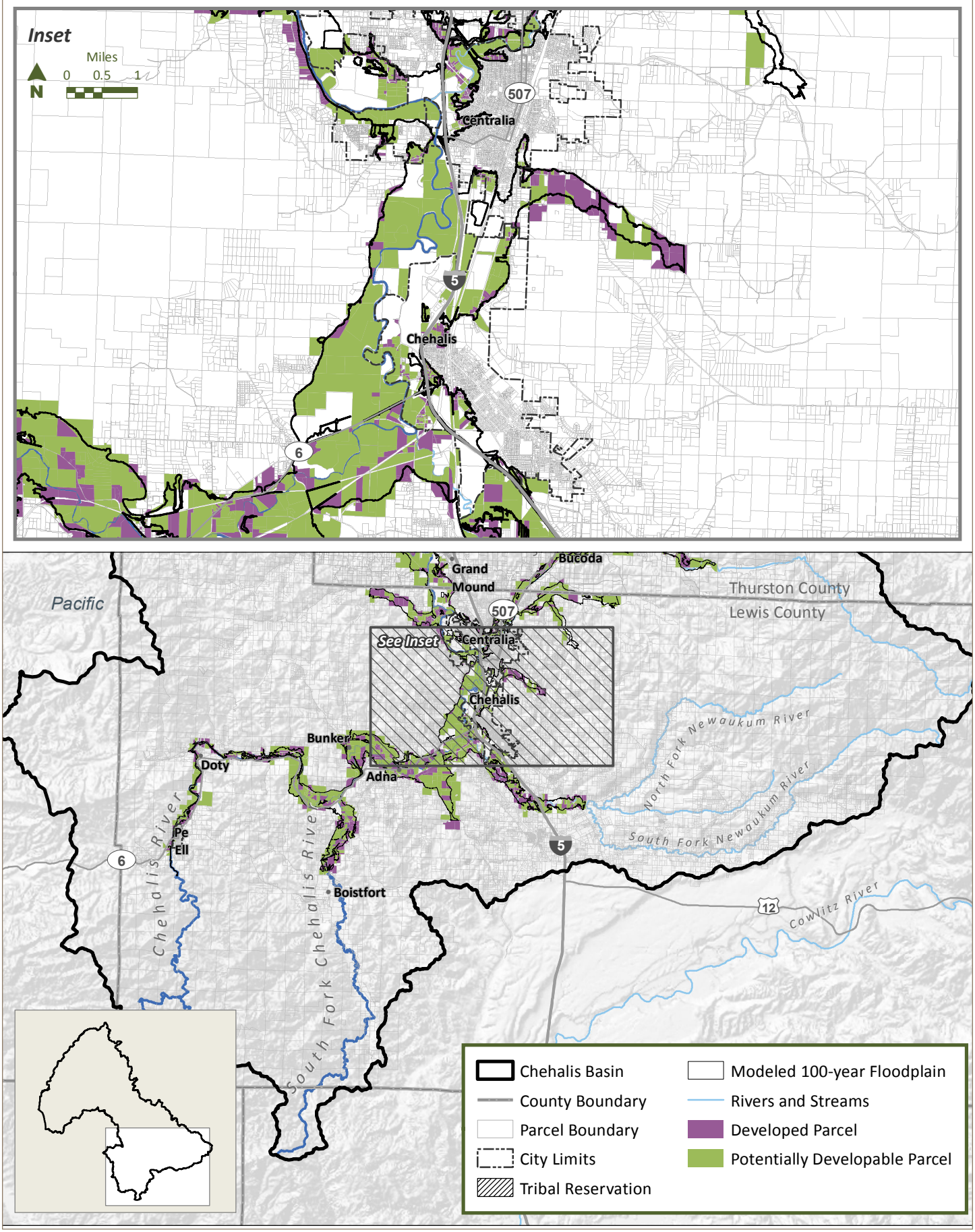


Figure 4

Developed and Potentially Developable Parcels – Middle Chehalis Basin

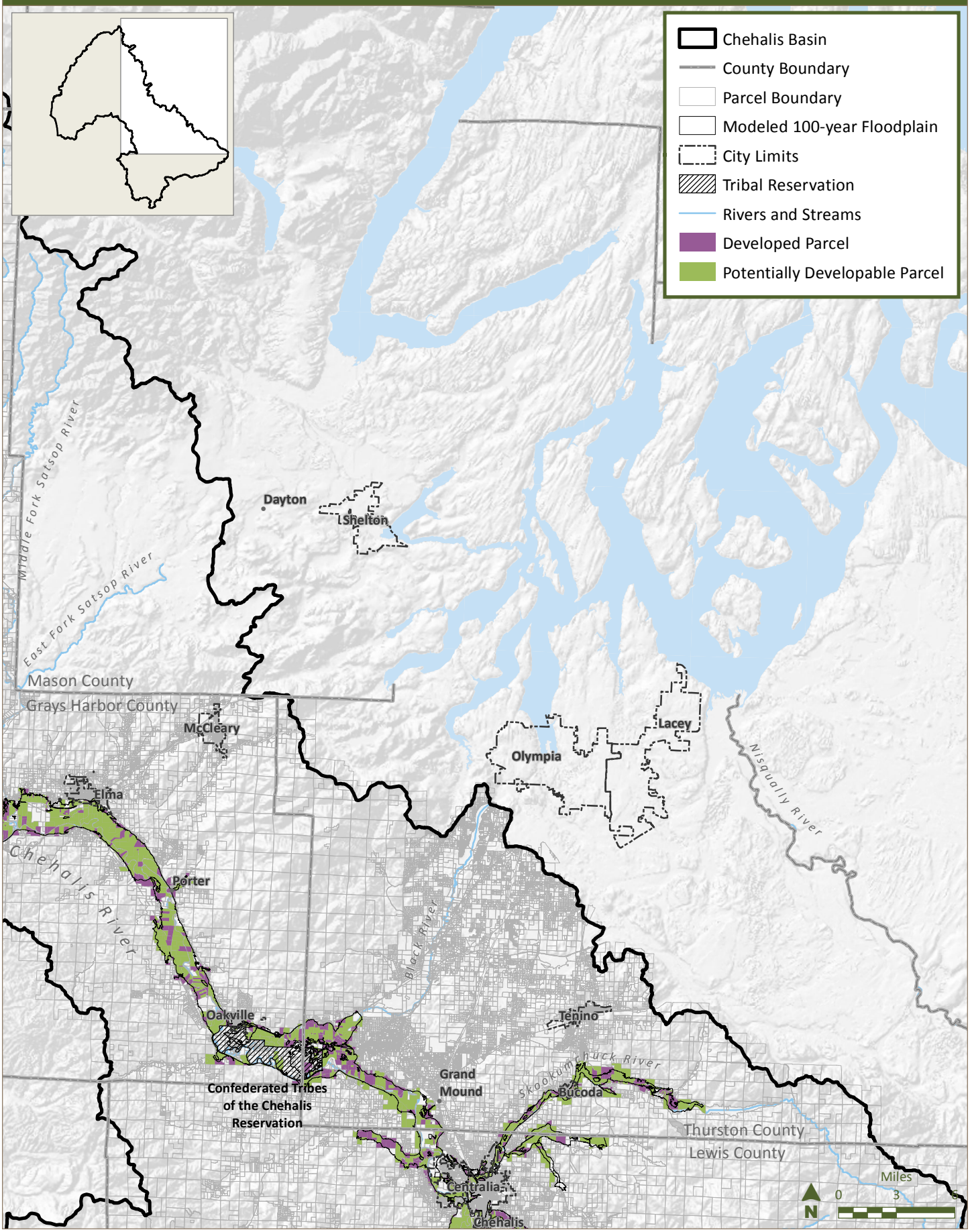
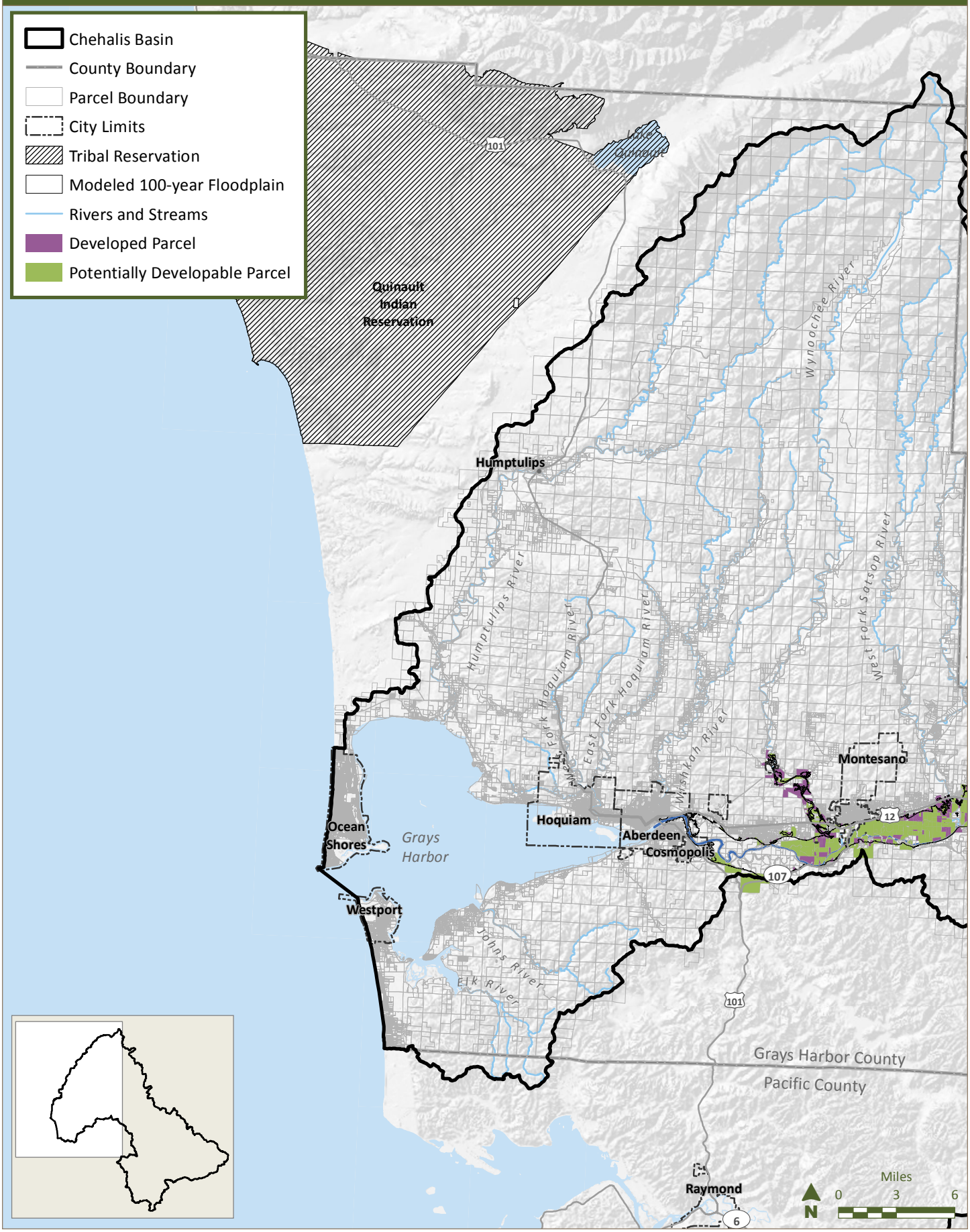


Figure 5

Developed and Potentially Developable Parcels – Lower Chehalis Basin



3.2 Future Floodplain Growth

This section includes estimates of the possible levels and patterns of development in the modeled 100-year floodplain up to the year 2120. The total development potential represents the sum of current and future created parcels that could be developed in the modeled 100-year floodplain. It is unlikely that the total development potential would be realized in the 100-year planning horizon for this analysis.

3.2.1 Population

Population growth estimates in the modeled 100-year floodplain are based on a continuation of the current floodplain population growth rate (approximately 38% of county-wide growth). For Lewis and Grays Harbor counties, the combined county-wide growth rate is 0.3% to 1% per year, while the floodplain growth rate is 0.17% to 0.38%. Due to very low growth rates in the Thurston County floodplain, population growth rates in that area were calculated separately and based on the expected number of new residential structures in the next 100 years (Rubert 2016). Based on discussions with city and county planners, it is likely that these population growth estimates overestimate actual population growth, and can be considered conservative estimates. Office of Financial Management (OFM) projections were used to estimate county population growth (OFM 2012), and floodplain growth estimates are a portion of this estimated growth projection. For more information on population estimate methods, see Appendix D.

Total population in the modeled 100-year floodplain is expected to increase by 16% to 35% in the next 100 years. Most of this population growth is expected to occur in Lewis County, with little growth in Grays Harbor and Thurston counties. The portion of the modeled 100-year floodplain in Lewis County is estimated to house 714 to 1,541 additional residents by 2120. The Grays Harbor County floodplain is likely to experience less population growth than Lewis County, with an estimated 19 to 124 new residents by 2120. Thurston County has the lowest estimated floodplain population growth of all three counties, with 28 to 55 new residents. Overall, the highest estimate of population growth would result in 1,720 additional residents in the floodplain by 2120. This would equate to a total floodplain population of 6,577 in 2120 (see Table 5).

Table 5
Population Projections in the Modeled 100-year Floodplain

COUNTY	TOTAL FLOODPLAIN POPULATION 2015[1]	TOTAL FLOODPLAIN POPULATION 2120[2,3]	CHANGE IN POPULATION
Lewis	3,567	4,281 – 5,108	714 – 1,541
Grays Harbor	605	624 – 729	19 – 124
Thurston[4]	685	713 – 740	28 – 55
Total	**4,857**	**5,618 – 6,577**	**761 – 1,720**

Notes:
1. The 2015 population estimated from the number of residential structures in the floodplain is based on the 2014 WSE Structure Survey Data; these are assumed to represent the 2015 population to align with the 5-year population projections from OFM.
2. This represents population in the modeled 100-year floodplain if current floodplain growth trends (approximately 38% of county-wide growth rate) were to continue. For more information on projection methods, see Appendix D.
3. The low end of the range is equal to the medium OFM population projection, and the high end of the range is equal to the high OFM population projection. This was selected as a conservative estimate. For more information on projection methods, see Appendix D.
4. This is based on an estimated one additional residential structure per decade for the medium estimate and two residential structures per decade for the high estimate, calculated as 2.5 people per household (Rubert 2016).

3.2.2 Future Structure Development

The population estimates described in Section 3.2.1 were used as the basis to determine the number of structures that could potentially be built in the modeled 100-year floodplain in the next 100 years. Residential structures are assumed to house 2.5 people per household, while the estimates for new commercial/industrial structures are based on the current ratio of commercial/industrial to residential structures in the modeled 100-year floodplain. Current ratios of commercial/industrial to residential are 1:2.99 in Lewis County, 1:1.61 in Grays Harbor County, and 1:274 in Thurston County. Development of new agricultural structures is influenced more by market factors than by population growth, and is not quantitatively estimated in this analysis. Between 2007 and 2012, both Lewis and Grays Harbor counties had no, or very little, change in farm acreage (Census of Agriculture 2012a, 2012b). Therefore, the number of agricultural structures in the modeled 100-year floodplain is assumed not to change for purposes of this analysis.

Based on the estimated range of total floodplain population in 2120 (see Table 5), the largest increase in the number of structures in the modeled 100-year floodplain would occur as a result of residential development in Lewis County, with between 286 and 617 new residential structures (see Table 6). The next highest increase in the number of structures in the modeled 100-year floodplain would also occur in Lewis County, but as result of commercial/industrial development (between 96 and 207 new

structures). New structures in the modeled 100-year floodplain in both Grays Harbor and Thurston counties would be relatively few and associated mainly with residential development.

Overall, the total number of new structures needed to support the highest estimated 2120 floodplain population would be less than the current inventory of existing developable parcels (924 residential parcels and 239 commercial/industrial parcels; see sum of total undeveloped parcels in Table 2). However, the estimated distribution of future structures based on population growth does not align with the location of existing developable parcels. There would be a slight parcel deficit in Lewis County at the upper limit of the estimated development range based on population growth (521 existing residential parcels and 204 existing commercial/industrial parcels; see sum of Lewis County undeveloped parcels in Table 2). However, the residential parcel deficit would be decreased or potentially disappear if some residential development occurs on agricultural parcels. For the entire modeled 100-year floodplain, the total development potential—5,592 parcels—far exceeds the highest estimated number of new structures that would be needed in the 100-year floodplain to accommodate potential population growth (914 structures; see Tables 3 and 6, respectively).

Table 6
Potential Number of New Structures Constructed
in the Modeled 100-year Floodplain by 2120

STRUCTURE TYPE	NUMBER OF NEW STRUCTURES[1,2,3]
LEWIS COUNTY	
Residential[4]	286 – 617
Commercial/industrial[5]	96 – 207
Agricultural[6]	0
Total	**382 – 824**
GRAYS HARBOR COUNTY	
Residential[4]	8 – 50
Commercial/industrial[5]	5 – 17
Agricultural[6]	0
Total	**13 – 67**
THURSTON COUNTY	
Residential[7]	11 – 22
Commercial/industrial	1
Agricultural[6]	0
Total	**12 – 23**
Grand Total	**407 – 914**

Notes:
1. Based on population estimates
2. Potential number of new structures in the modeled 100-year floodplain if current floodplain growth trends (approximately 38% of county-wide growth rate) were to continue
3. The low end of the range is equal to the medium OFM population projection, and the high end of the range is equal to the high OFM population projection. This was selected as a conservative estimate.
4. Calculated as floodplain population growth divided by 2.5 (people per household [U.S. Census Bureau 2016])
5. Calculated as the number of residential structures divided by the number of commercial/industrial structures currently in the modeled 100-year floodplain by county (i.e., commercial/industrial to residential); ratios equal: Lewis County 1:2.99, Grays Harbor County 1:1.61, and Thurston County 1:274
6. The number of agricultural structures in the modeled 100-year floodplain is not expected to increase during this period; the number is expected to remain constant.
7. Estimated at one additional residential structure per decade for the medium estimate and two residential structures per decade for high estimate (Rubert 2016).

4 BUILD OUT ANALYSIS

4.1 No Action Alternative

Under the No Action Alternative, development in the floodplain would occur consistent with past trends. Development pressure in the modeled 100-year floodplain would not increase as a result of construction of any Large-scale Flood Damage Reduction Projects, and Land Use Management recommendations would not be implemented.

As discussed in Section 3.2.2, during the next 100 years, population growth in the floodplain could result in development of 407 to 914 new residential and commercial/industrial structures. These structures would be distributed throughout all three counties in the modeled 100-year floodplain, with the highest portion of this development expected in Lewis County. Because of the sustained risk of flood damage associated with developing in the floodplain without additional flood damage reduction actions being taken, it is anticipated that development would tend toward the low end of the range. In that case, future development could be accommodated by existing developable parcels. Most of the potential development associated with the No Action Alternative would occur as residential structures in Lewis County, likely in incorporated and UGA areas in Chehalis and Centralia.

4.2 Land Use Management

The Land Use Management recommendations described in Section 2.2 consist of regulatory standards designed to protect remaining floodplain functions and prevent flood damage by minimizing future floodplain development. Some of the recommendations restrict the creation of developable parcels in the floodplain through open space preservation, subdivision set asides, and low-density zoning. Other recommendations increase the cost of future development in the floodplain, and include filling restrictions and freeboard elevation requirements. However, the extent to which these Land Use Management recommendations would prevent flood damage by constraining floodplain population growth and development is uncertain. This analysis looks at the potential effects that these types of Land Use Management recommendations could have on development in the modeled 100-year floodplain.

Recommendations that restrict the number of potential developable parcels in the floodplain would likely not restrict future development due to the abundance of developable parcels that currently exist in the modeled 100-year floodplain. New structures that would be necessary for the estimated population growth during the next 100 years could be accommodated by the number of developable parcels that currently exist in the modeled 100-year floodplain, with minimal further subdivision in Lewis County to accommodate the highest level of potential population growth. Therefore, any restriction on subdivision would not effectively curtail floodplain development, except at the upper range of the estimate. Most of the subdivision potential in the modeled 100-year floodplain currently

occurs in incorporated and UGA areas (see Table 2). In Lewis County, up to 1,707 new parcels could potentially be created in incorporated areas and 578 in UGA areas, with only 156 parcels created in unincorporated areas. These additional parcels would only be needed if the higher range of growth in the floodplain were to occur.

Due to the abundance of existing developable parcels in the modeled 100-year floodplain, restricting subdivisions and requiring large lots in future subdivisions may not further limit development. Regulations that more directly restrict floodplain development may be more effective at preventing potential future flood damage. These regulations could include restricting certain types of development or applying additional development standards in the floodplain.

Examples of restrictions and standards applied in Thurston County in recent years that have been effective in reducing floodplain development include prohibiting construction of single-family residences and on-site sewage systems in the floodplain, except through a reasonable use exemption (Thurston County Code 24.20.070), and requiring new wells to be constructed outside of the 100-year floodplain (Thurston County Code 24.20.180). Thurston County has seen a reduction in the number of structures built in the floodplain from approximately 121 building permits issued in the 1990s to only 8 building permits issued between 2010 and 2016 (Rubert 2016; Ambrogi 2016). Although these types of restrictions may not be feasible in every Chehalis Basin community, they may be examples of how specific Land Use Management regulations in the floodplain could effectively reduce future potential flood damage through limiting development, even when there is an abundance of available parcels.

4.3 Alternative 1

Operation of the Flood Retention Facility and Airport Levee Improvements would result in a reduction in the extent of flooding in the modeled 100-year floodplain (see Figures 6, 7, and 8). For the purposes of this analysis, the reduction of 5,000 square feet or more of inundated, buildable area as a result of operation of the Flood Retention Facility and the Airport Levee Improvements was considered a substantial reduction (see Appendix D for more information on methods).

The largest reduction in flood extents as a result of constructing the Flood Retention Facility and the Airport Levee Improvements would be seen in the upper Chehalis Basin, close to the facility and near Chehalis and Centralia (see Figures 6, 7, and 8). Though this alternative would result in minor marginal reductions in flood elevation and extent in Thurston and Grays Harbor counties (occurring mainly as strips or small patches near the floodplain edge), the effect is likely not great enough to increase future development pressure. Therefore, no effect from this alternative is noted in Thurston and Grays Harbor counties.

After installation of the Flood Retention Facility and Airport Levee Improvements, up to 649 of the total potential development parcels in Lewis County would contain 5,000 square feet or more of area no longer inundated. The parcels that could potentially see the increased development pressure are mostly

residential areas located in incorporated and UGA areas of Lewis County (345 parcels; see Table 7), with 81 residential parcels located in unincorporated Lewis County. Commercial/industrial parcels that experience substantial flood reduction and, therefore, may be subject to greater development pressure are mainly located in incorporated areas of Lewis County (75 parcels). The agricultural parcels that contain area no longer inundated are located in unincorporated Lewis County (see Table 7).

As a result of decreased flooding extents and the corresponding increase in development pressure on those parcels, future floodplain development rates under this alternative may tend toward the high end of the range discussed in Section 3.2. As stated previously, this effect is only likely to occur in Lewis County where flood extents are substantially reduced. Given these assumptions, operation of these action elements could result in up to 824 new structures in the portions of the modeled 100-year floodplain in Lewis County in the next 100 years (see Table 6).

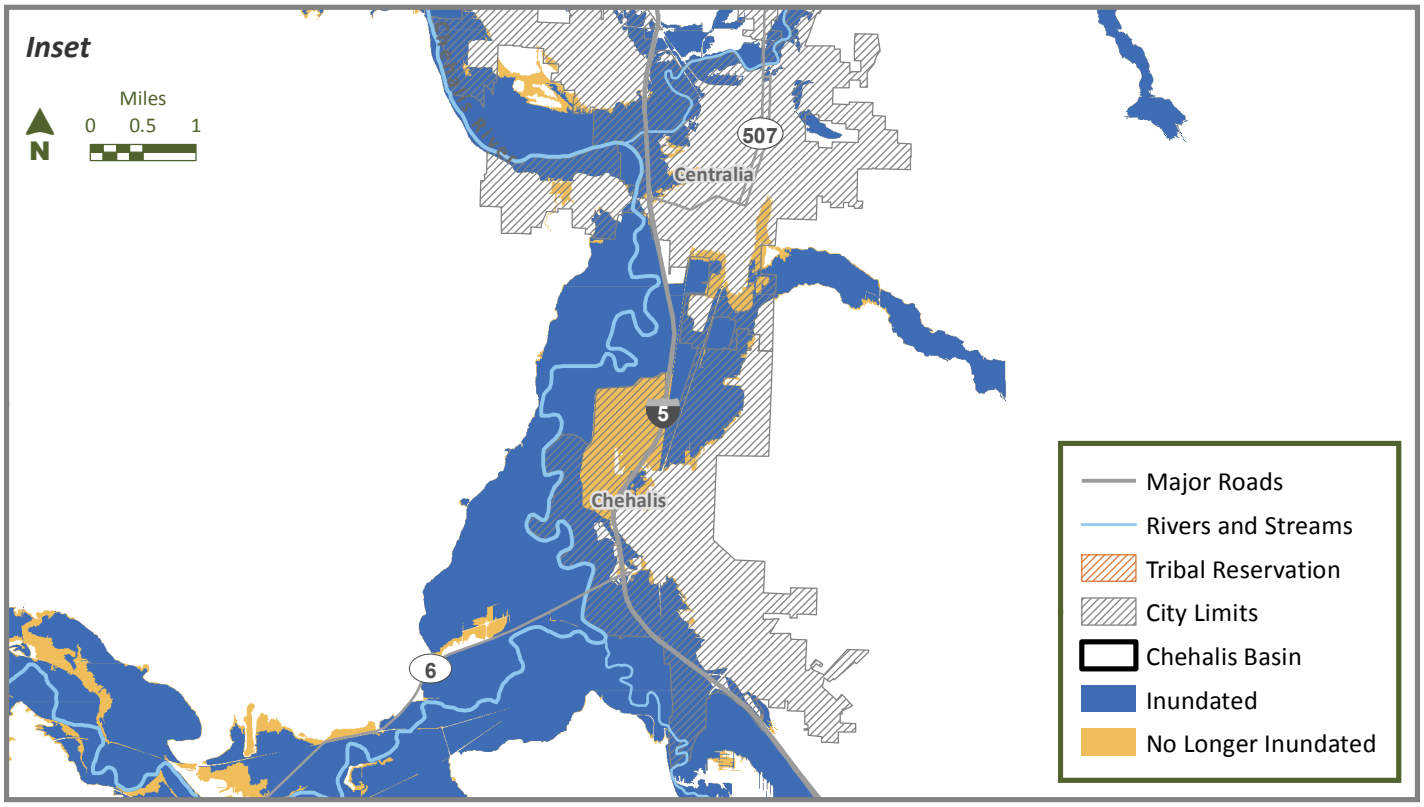
Table 7
Developable Parcels with Higher Development Potential Due to
Flood Retention Facility Operation and Airport Levee Improvements

	NO LONGER INUNDATED PARCELS			
GENERAL ZONE	**INCORPORATED**	**UGA**	**UNINCORPORATED**	**TOTAL**
LEWIS COUNTY				
Residential	263	82	81	**426**
Commercial/industrial	75	1	37	**113**
Agricultural	0	0	110	**110**
Total	*338*	*83*	*228*	***649***
GRAYS HARBOR COUNTY				
Residential	0	0	0	**0**
Commercial/industrial	0	0	0	**0**
Agricultural	0	0	0	**0**
Total	*0*	*0*	*0*	***0***
THURSTON COUNTY				
Residential	0	0	0	**0**
Commercial/industrial	0	0	0	**0**
Agricultural	0	0	0	**0**
Total	*0*	*0*	*0*	***0***
Grand Total	**338**	**83**	**228**	**649**

Note: The numbers shown indicate those parcels with buildable areas of greater than 5,000 square feet that would no longer be inundated after installation of the Flood Retention Facility and Airport Levee Improvements. Parcels are displayed by location in incorporated, UGA, or unincorporated areas of each county.

Figure 6

Flood Retention Facility and Airport Levee Improvements Inundation – Upper Chehalis Basin



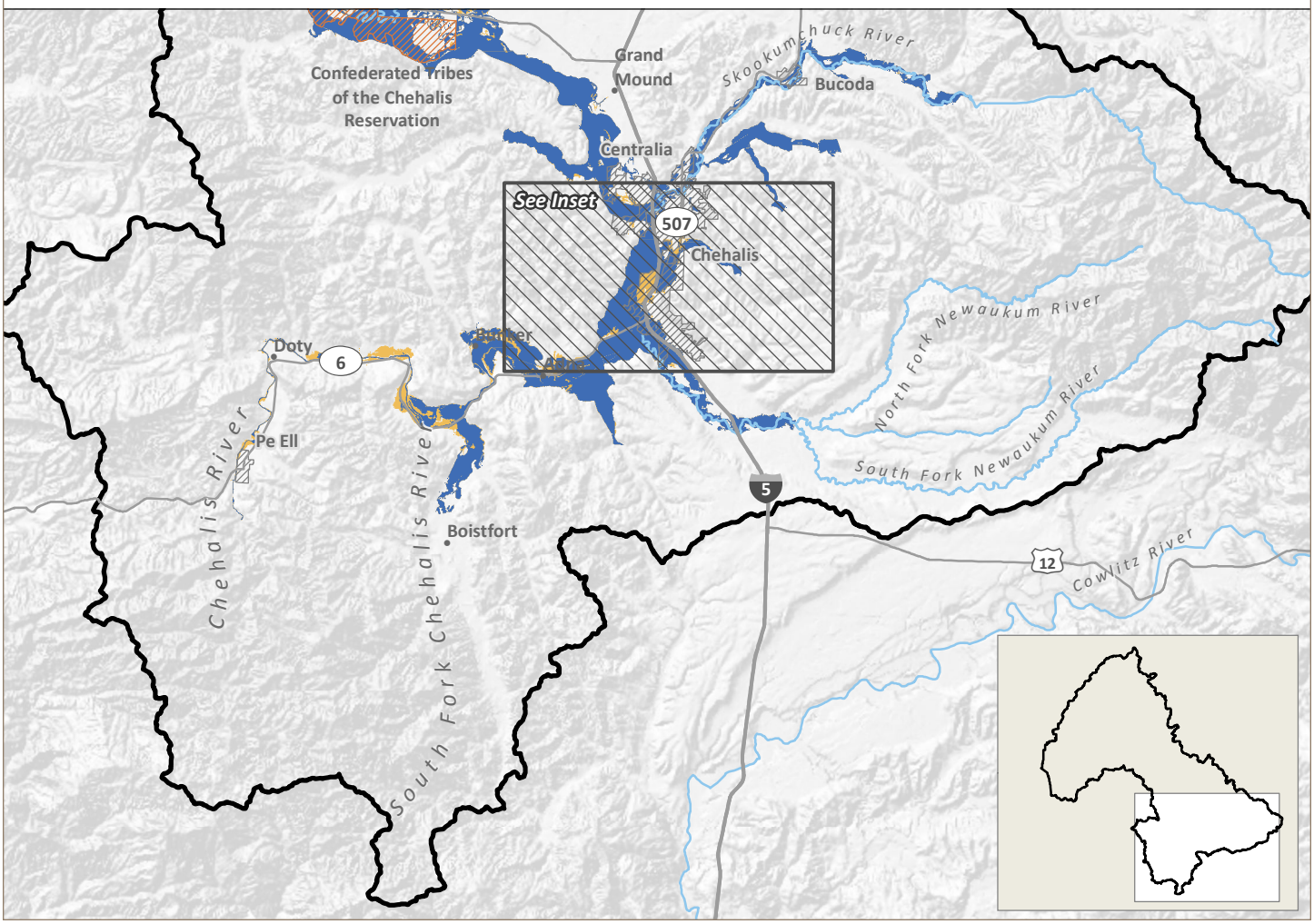


Figure 7

Flood Retention Facility and Airport Levee Improvements Inundation – Middle Chehalis Basin

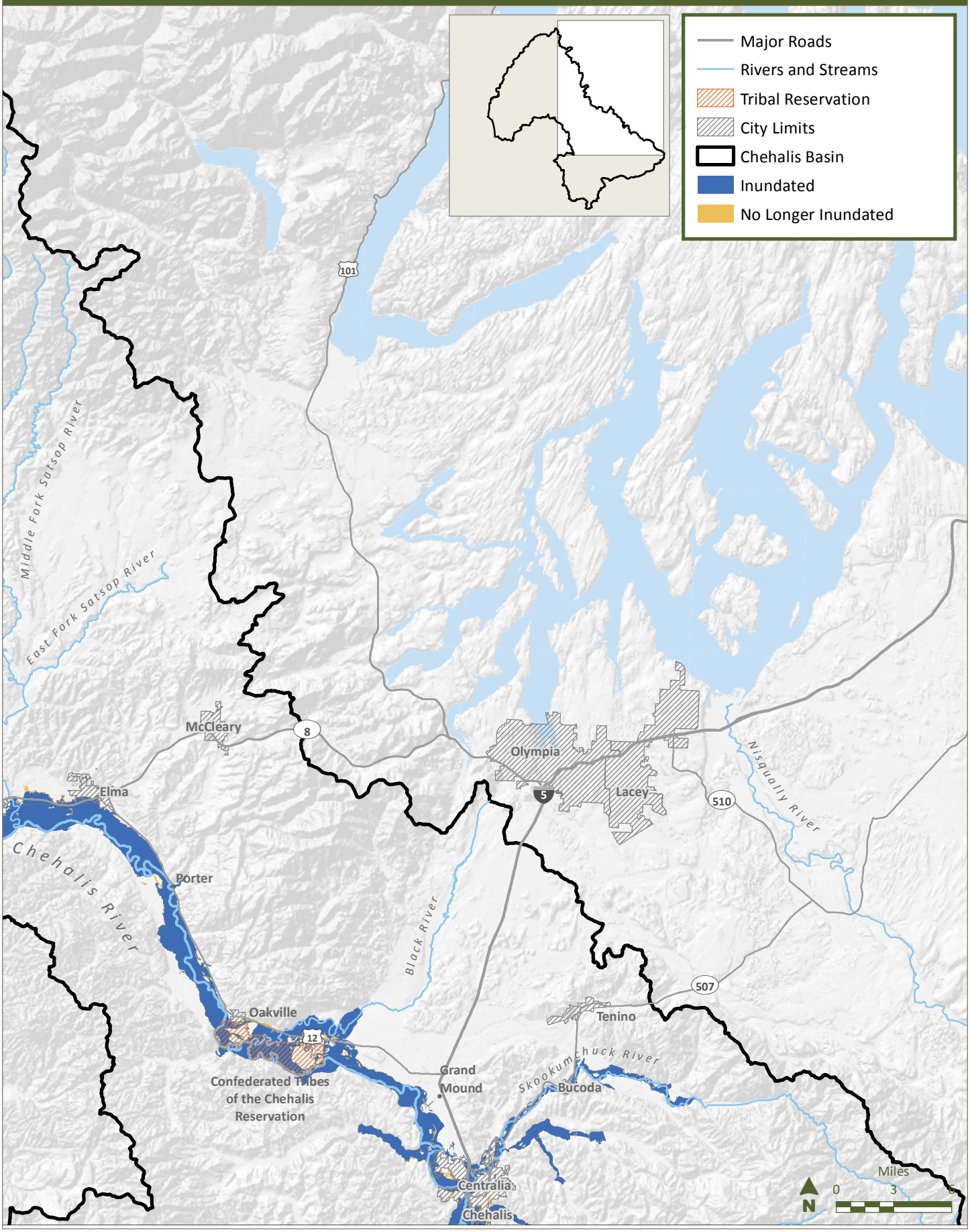
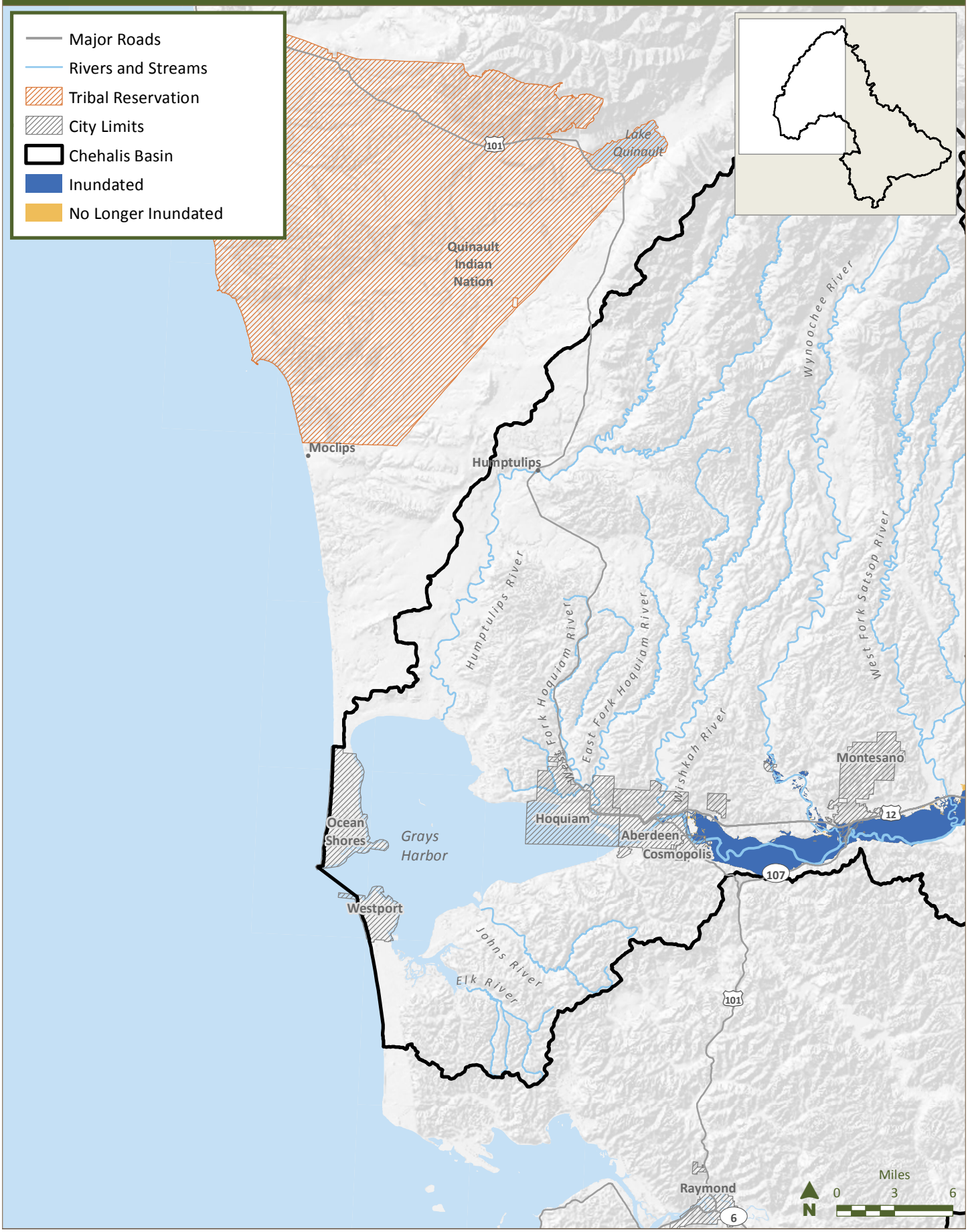


Figure 8

Flood Retention Facility and Airport Levee Improvements Inundation – Lower Chehalis Basin



4.4 Alternative 2

Implementation of the Airport Levee Improvements and I-5 Projects would result in a reduction in flooding extent in portions of the modeled 100-year floodplain (see Figures 9, 10, and 11). The reduced flooding extents may increase the development pressure in localized areas where the reduction in area is large enough to allow for development. For purposes of this analysis, reductions of 5,000 square feet or more of inundated, buildable area as a result of operation of Airport Levee Improvements and I-5 Projects was considered a substantial reduction (see Appendix D for more information on methods).

Implementing the Airport Levee Improvements and I-5 Projects would only affect residential and commercial/industrial parcels in the incorporated areas of Chehalis and Centralia, with only one parcel affected in Lewis County (in the UGA; see Figure 9 and Table 8). This alternative could increase development pressure on up to 173 parcels of the total development potential in the portion of the modeled 100-year floodplain located in Lewis County. Most of these parcels are residential (104 parcels), while the remaining parcels are commercial/industrial (68 parcels; see Table 8). No agricultural parcels would be affected.

As a result of decreased flooding extents and the corresponding increase in development pressure on those parcels, future floodplain development rates under this alternative may tend toward the middle of the range as discussed in Section 3.2. As stated previously, this effect would only occur in Lewis County where flood extents are substantially reduced. This development would likely concentrate in incorporated and UGA areas in Chehalis and Centralia associated with decreased flooding extent. Development in Thurston and Grays Harbor counties would not be influenced by this alternative.

Table 8

Developable Parcels with Higher Development Potential Due to Airport Levee Improvements and I-5 Projects

GENERAL ZONE	NO LONGER INUNDATED PARCELS			
	INCORPORATED	UGA	UNINCORPORATED	TOTAL
LEWIS COUNTY				
Residential	104	1	0	**105**
Commercial/industrial	68	0	0	**68**
Agricultural	0	0	0	**0**
Total	*172*	*1*	*0*	***173***
GRAYS HARBOR COUNTY				
Residential	0	0	0	**0**
Commercial/industrial	0	0	0	**0**
Agricultural	0	0	0	**0**
Total	*0*	*0*	*0*	***0***
THURSTON COUNTY				
Residential	0	0	0	**0**
Commercial/industrial	0	0	0	**0**
Agricultural	0	0	0	**0**
Total	*0*	*0*	*0*	***0***
Grand Total	**172**	**1**	**0**	**173**

Note: The numbers shown indicate those parcels with buildable area of greater than 5,000 square feet that would no longer be inundated after installation of Airport Levee Improvements and I-5 Projects. Parcels are displayed by location in incorporated, UGA, or unincorporated areas for each county.

Figure 9

Airport Levee Improvements and I-5 Projects Inundation – Upper Chehalis Basin

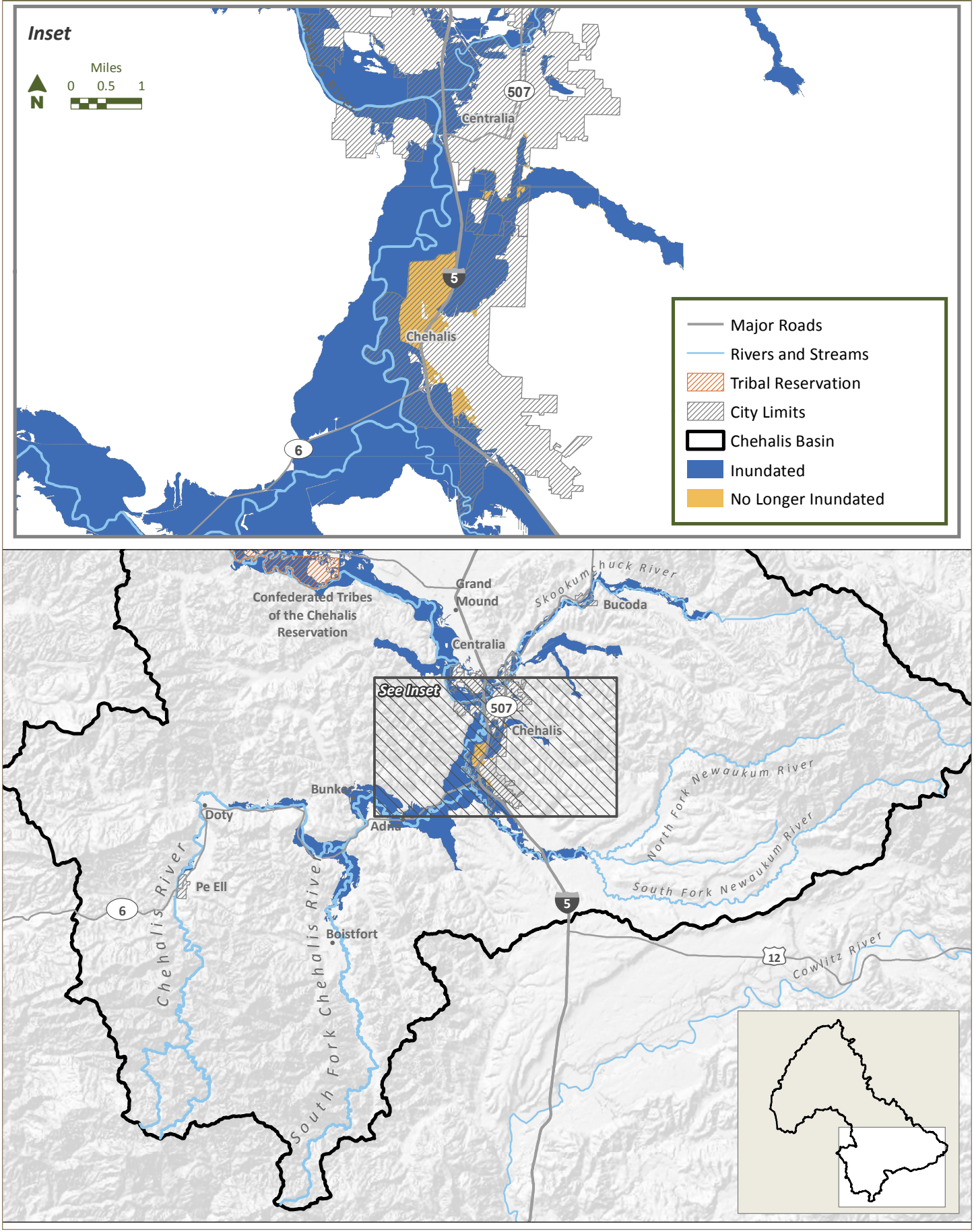


Figure 10

Airport Levee Improvements and I-5 Projects Inundation – Middle Chehalis Basin

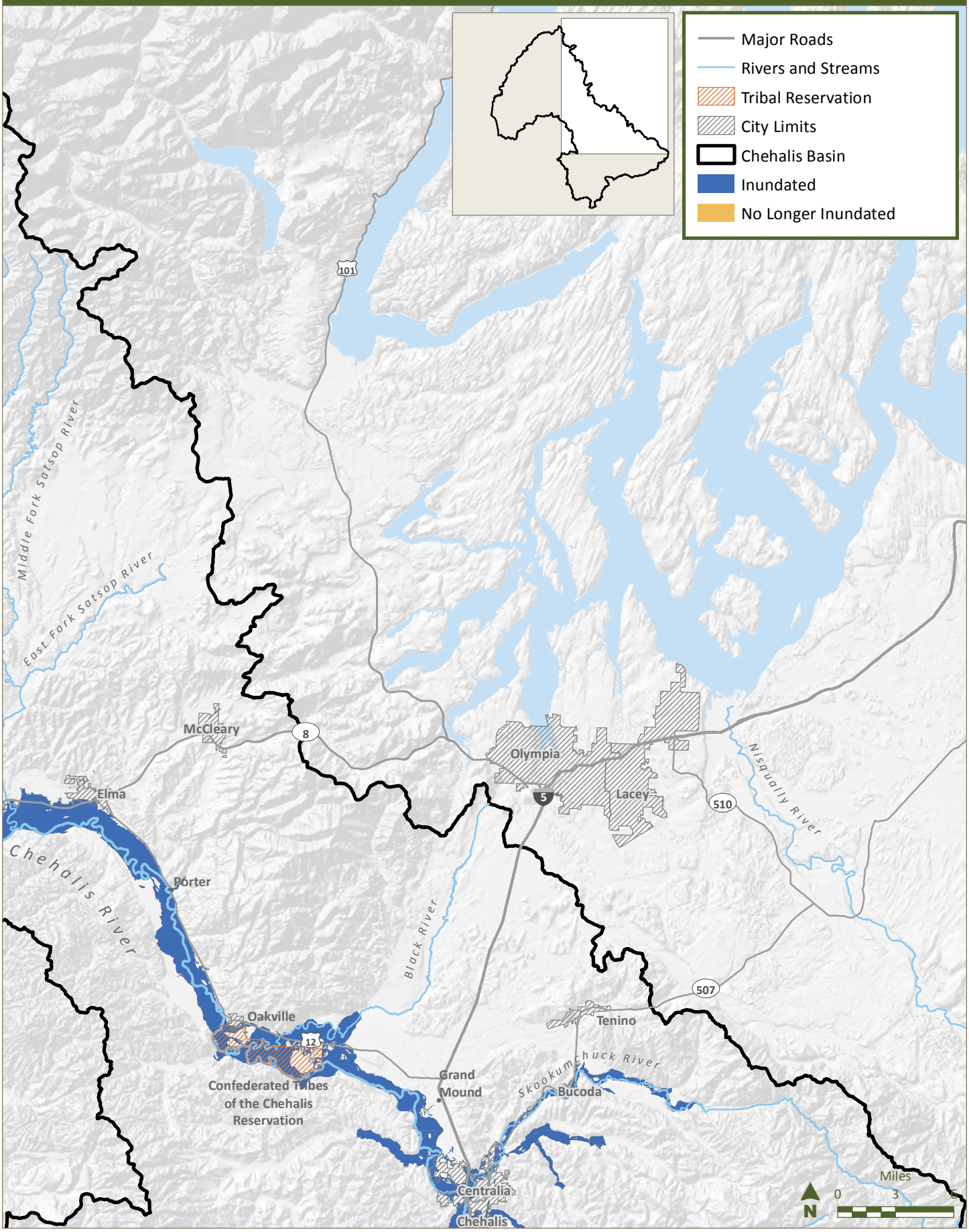
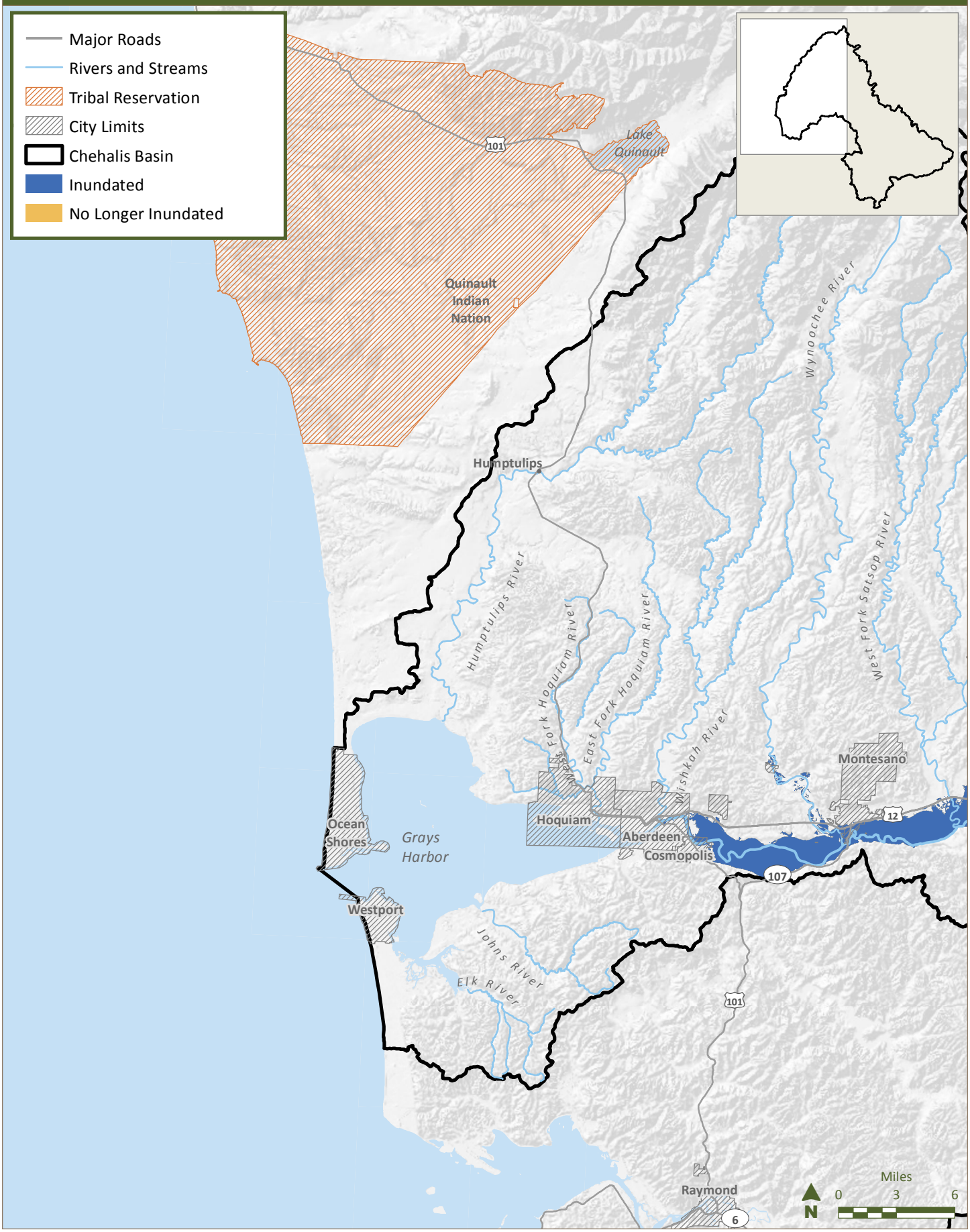


Figure 11

Airport Levee Improvements and I-5 Projects Inundation – Lower Chehalis Basin



5 CONCLUSIONS

This report estimates the potential future levels of development in the modeled 100-year floodplain during the 100-year planning horizon. Additionally, it explores the effect different EIS alternatives could have on development in the floodplain. Although growth has been slow in recent years, many of the Chehalis Basin communities do not currently have regulations that prohibit development in the floodplain.

Currently, development in the modeled 100-year floodplain could occur on an existing 3,059 parcels, most of which are residential and agricultural parcels in Lewis County. Additionally, a majority of the development occurs as residential structures. The capacity for future development in the modeled 100-year floodplain is determined by the number of existing undeveloped parcels (2,073 parcels) and the number of new parcels that are created through subdivision (3,519 parcels). This combined 5,592 parcels equals the total development potential in the modeled 100-year floodplain. Of the total development potential, the most abundant parcel type is residential and is concentrated in Lewis County.

Although residential parcels are the most abundant type of parcel available for potential future development, they do not cover the largest area. If developed to full potential, residential development would be concentrated on parcels in a small portion of the modeled 100-year floodplain area, mostly in incorporated and UGA areas in Lewis County. Agricultural parcels have moderate development potential, but comparatively cover a larger portion of the land area; therefore, parcels developed in agricultural areas would occur on larger parcels and be more broadly dispersed. Commercial/industrial development pressure in the Chehalis Basin is relatively low and concentrated almost entirely in Chehalis and Centralia.

Future floodplain development would occur in the total development potential outlined previously. However, the total development inventory of parcels exceeds the amount of development expected in the modeled 100-year floodplain in the 100-year planning horizon. Based on population estimates in the next 100 years, 407 to 914 structures could be constructed on parcels in the modeled 100-year floodplain. Other than the highest population projection for Lewis County, forecasted growth can be contained within existing residential parcels. Agriculturally zoned lands in Lewis County could accommodate this upper growth range. The total development potential of 5,592 available parcels far exceeds the highest estimated number of new structures (914) that could be located in the modeled 100-year floodplain per the projections.

The evaluated alternatives have the potential to affect development in the modeled 100-year floodplain. Most of the potential development anticipated under the No Action Alternative could be contained within existing parcels (without subdivision), with the exception of residential and

commercial/industrial development, which may require a small amount of subdivision. Because the No Action Alternative does not include large-scale flood damage reduction measures that affect the extent of flooding in the modeled 100-year floodplain, development under the No Action Alternative may trend more toward the lower end of the potential development range. Most of this development would occur as residential structures in Lewis County, likely in incorporated and UGA areas in Chehalis and Centralia.

Land Use Management recommendations designed to minimize creating future parcels in the modeled 100-year floodplain may not be effective at limiting development due to the abundance of developable parcels that currently exist. Other Land Use Management regulations that prohibit or restrict specific uses, such as restricting new on-site sewage systems, may be more effective at minimizing future development and associated flood damage risk even with the abundance of existing developable parcels.

The reduction in the extent of flooding associated with Alternative 1 (Flood Retention Facility and Airport Levee Improvements) affects areas near Chehalis and Centralia and in the upper Chehalis Basin. This alternative would increase development pressure on up to 649 parcels in the modeled 100-year floodplain. Increased development pressure on the parcels with sufficient area no longer inundated could result in floodplain development at levels toward the high end of the development range in Lewis County. No change in the rate of floodplain growth is anticipated to occur in Thurston or Grays Harbor counties as a result of these actions, because flood reduction benefits are expected to be minimal.

Alternative 2 (Airport Levee Improvements and I-5 Projects) would reduce the extent of flooding in localized areas near Chehalis and Centralia. The extent of flooding is not reduced as substantially as under Alternative 1. This combination of actions would increase development pressure on 173 additional parcels in the modeled 100-year floodplain. Increased development pressure on the parcels with additional buildable land no longer inundated could cause the floodplain development to tend toward the middle of the growth projection range for Lewis County. No change in the rate of floodplain growth is anticipated to occur in Thurston or Grays Harbor counties as a result of these actions, because no flood reduction benefits would occur.

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Appendix A
Howard Hanson Dam Case Study

HOWARD HANSON DAM CASE STUDY

Could urban development and population increase in the floodplain after a flood retention facility is constructed? This question has been asked by interested citizens in the Chehalis Basin who point to changes in communities in the Green River valley following construction of the Howard Hanson Dam in 1961. After installation of the dam, flooding impacts were reduced and the Green River valley became an attractive location for industry, resulting in increased development in the shoreline areas of Tukwila (USACE 2016; ESA Adolfson 2007) and Kent (Kent Historical Society 2016). However, the specific causes of increased growth in the Green River Valley cannot be singularly attributed to the installation of the dam, and other factors should be considered when comparing the potential land use impacts of the proposed dam in the Chehalis Basin to the circumstances of Howard Hanson Dam in the Green River valley.

Location

The Green River valley is located between Seattle and Tacoma, two of the largest city centers in Western Washington. Both cities have seen large and rapid growth between 1960 and 2010, which has resulted in increases in population and density within surrounding areas, including Kent (925% growth) and Tukwila (1004% growth; U.S. Census Bureau 1961, 2016). In contrast, the Chehalis Basin is removed from major metropolitan areas, and the largest city in proximity to Centralia and Chehalis is Olympia, approximately 30 miles to the north. The combined population growth in Lewis, Grays Harbor, and Thurston counties during the next 70 years is projected to be up to 136%, which includes growth outside of the floodplain, including Olympia; see Appendix D for population projection methods.

Floodplain Regulations

The regulatory environment today is significantly different from 1961 when the Howard Hanson Dam was constructed. It was not until 1968 that the federal government created the National Flood Insurance Program, and 1969 when the State Legislature prohibited building within floodways. It was another 20 years (1989) before the State Legislature established minimum floodplain management requirements (Ecology 2016).

Flooding Extents

Federal Emergency Management Agency flood insurance rate maps for the Green River Valley reflect the hydrology of the river with the dam and various levees in place that act to confine floods. Hydrologic modeling results for a permanent reservoir in the upper Chehalis Basin indicate that the floodplain would not change significantly; the dam would reduce flood extents in some areas but primarily serve to reduce flood elevations.

Given the disparate circumstances between the Howard Hanson Dam and the facilities proposed in the Chehalis Basin, the pattern of growth and development in the Green River valley during the last 55 years is not anticipated to be replicated in the Chehalis Basin if a flood retention facility were constructed.

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Appendix B
Modeled 100-year Floodplain

MODELED 100-YEAR FLOODPLAIN

In 2014, Watershed Science and Engineering (WSE) developed and calibrated a hydraulic model of the Chehalis River, which extends from the mouth of Grays Harbor near Aberdeen to upstream of Pe Ell. The updated model helped to improve the understanding of flooding on the mainstem Chehalis River and to evaluate the performance of flood reduction alternatives. Updates to the model included new topographic and channel survey data. For this reason, the 2014 WSE hydraulic model modeled 100-year floodplain was chosen as the basis for the *Build Out Analysis*.

The technical memorandum explaining the development of the hydraulic model can be found on the Chehalis Basin Strategy website (WSE 2014; http://chehalisbasinstrategy.com/publications/). Some frequently asked questions related to the modeled 100-year floodplain are addressed below.

Why does the floodplain extend so far up certain tributaries, like the Skookumchuck River, Hanaford Creek, Lincoln Creek, and the Newaukum River, but not others?

In addition to the mainstem Chehalis River, the model includes portions of the Wynoochee River, Satsop River, Black River, Independence Creek, Lincoln Creek, Skookumchuck River, Hanaford Creek, Salzer Creek, Dillenbaugh Creek, Newaukum River, Stearns Creek, South Fork Chehalis River, and Crim Creek. These tributaries were included in the model because detailed models or modeling data were already available. The 100-year floodplain on these tributaries is representative of flood conditions in the tributaries when the Chehalis River mainstem is experiencing a 100-year flood over its entire length. In many cases these flows approach but do not equal the 100-year flood on that tributary. For example, the inflows from the South Fork Chehalis River in the modeled 100-year floodplain do not necessarily equal a 100-year flow on the South Fork, rather they represent the inflow to the mainstem Chehalis River from the South Fork during a 100-year mainstem flood event.

The modeled 100-year floodplain used in this analysis includes the floodplains associated with the tributaries in the model, which differs from other mapped Chehalis River 100-year floodplain extents.

What inputs went into the model (measured gage data versus observed flood elevations/locations, Federal Emergency Management Agency data, etc.)?

The model of the 100-year flow (or the 2-, 10-, 20-, or 500-year events) used hypothetical flood events (design flow) (see WSE 2014). The inflows in the model were based on U.S. Geological Survey (USGS) gage data to the extent it was available, but the design flows are statistically generated. The model was calibrated to the February 1996, December 2007, and January 2009 events. Please see WSE 2014 for more detailed information.

Were groundwater inputs included?

Groundwater inputs are included to the extent that they are captured by the USGS streamflow gages, and used in the calibration or statistical analysis described above and in the technical memorandum. Groundwater inputs were not explicitly included as separate from the inflow data. Modeling has focused on extreme flood events, in which the magnitude of groundwater inputs is likely very limited as a percentage of the total flow.

Reference

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Appendix C
Land Use Categories List

General Zone List

GENERAL ZONE	ZONES INCLUDED
Residential	• General Residential (GR) – Elma • Multi-Family Residential (MF) – Bucoda • Rural (R 1/20) – Thurston • Low-Density Residential (R1) – Montesano • Restricted Residential District (R1) – Grays Harbor • General Residential District (R2) – Grays Harbor • Single-Family, Low Density (R1) – Chehalis • Single-Family, Medium Density (R2) –Chehalis • Moderate-Density Residential (R2) – Montesano • Very Low Density Residential District (R2) – Centralia • Low-Density Residential District (R4) – Centralia • Moderate-Density Residential District (R8) – Centralia • Medium-High Density Residential District (R15) – Centralia • High-Density Residential District (R20) – Centralia • Rural Development District 10 (RDD-10) – Lewis • Rural Development District 20 (RDD-20) – Lewis • Rural Development District 5 (RDD-5) – Lewis • Residential – Pe El, Oakville, Bucoda • Residential LAMRID (RL 1/1) – Thurston • Rural Residential (RR) – Grays Harbor, Elma • Rural Residential/Resource (RRR 1/5) – Thurston • Urban Growth Area Residential (RUGA) – Chehalis • General Development District Five (G5) – Grays Harbor
Commercial/industrial	• Commercial – Napavine, Oakville • Commercial/Industrial (C/I) – Napavine • General Commercial District (C1) – Centralia • Community Business (C1) – Elma • Highway Commercial District (C2) – Centralia • Heavy Commercial/Light Industrial (C2) – Montesano • Freeway Commercial (CF) – Chehalis • General Commercial (CG) – Chehalis • General Development District One (G1) – Grays Harbor • Industrial (I) – Elma • Industrial District (I2) – Grays Harbor • Heavy Industrial (IH) – Chehalis • Light Industrial (IL) – Chehalis • Limited Business District (LBD) – Centralia • Rural Area Industrial (RAI) – Lewis • Rural Commercial Center (RCC) – Thurston • Small Towns – Mixed Use (STMU) – Lewis

GENERAL ZONE	ZONES INCLUDED
Agricultural	• Agricultural Use District (A1) – Grays Harbor • Long Term Agricultural District (A2) – Grays Harbor • Agricultural Resource Land (ARL) – Lewis • Long Term Agriculture (LTA) – Thurston • Mining Resource Land (Mine) – Lewis • Agriculture/Forestry – Oakville

Appendix D
Build Out Methods

BUILD OUT METHODS

Population Estimates

Population estimates were reviewed and extended to 2120 as a first step in estimating the amount of total county population growth that could occur in the modeled 100-year floodplain for single-family residential development potential under low, medium, and high population growth rates for all three scenarios analyzed. The population growth rates used were based on the Office of Financial Management (OFM) Growth Management Act county projections for 2015 through 2040 (OFM 2012). Growth projections were extended to 2120 consistent with the period of evaluation in the Programmatic Environmental Impact Statement (EIS) using the projected 5-year incremental growth rate (2035 to 2040).

The next step was to determine what percent of total projected county growth might occur in the modeled 100-year floodplain. Projections for this information were not available, so this growth was approximated using census data from Lewis and Grays Harbor counties for the years 2000 and 2010 (U.S. Census Bureau 2000, 2010), which was the most recent information available. During this period, the combined population increased in Grays Harbor and Lewis counties by a combined growth rate of approximately 9.2%, while growth in the floodplain for the same period only increased by 3.5%. Put another way, the Chehalis River floodplain growth occurred at approximately one-third the rate of growth in the surrounding counties.

A 2014 structures survey (WSE 2014) was used to estimate a starting population for 2015 in the modeled floodplains of Lewis and Grays Harbor counties. The 2014 structures survey included a count of all valuable structures in the modeled 100-year floodplain reported by type: agriculture, commercial, and residential. The number of residential structures, which included mobile homes, was multiplied by 2.5 (the number of people per household). This same calculation for floodplain population was used in both Lewis and Grays Harbor counties (U.S. Census Bureau 2016).

Two floodplain population estimates were then calculated. The estimate of population consistent with current trends was created by applying the estimated floodplain growth rate, as described previously, to the floodplain population estimate to calculate population growth in the floodplain. This was done in 5-year increments through 2120. The upper floodplain population estimate was calculated by applying the county growth rate directly to the floodplain population, which was calculated in 5-year increments through 2120. Population estimates for Thurston County were based on the amount of residential structures anticipated in the floodplain based on conversations with Thurston County planners (Rubert 2016).

Population Estimate Assumptions

The following assumptions were used in the population projection estimates:

- The OFM population projections were extended beyond 2040 by applying the 5-year growth rate (from 2035 to 2040) through 2120
- The ratio of growth in the floodplain compared to the combined counties' growth rate (for Lewis and Grays Harbor counties 2000 to 2010) was applied from 2015 through 2120
- The 2014 population estimate, based on the structure survey (WSE 2014), is assumed to be equal to the 2015 population in the floodplain
- There are 2.5 people per residence in both Lewis and Grays Harbor counties in 2014 (U.S. Census Bureau 2016)

Build Out Analysis Approach

The *Build Out Analysis* identifies potential developable parcels in portions of the modeled 100-year floodplain of Lewis and Grays Harbor counties under three scenarios: No Action; Alternative 1; and Alternative 2. Thurston County was excluded from the analysis due to highly restrictive floodplain regulations that do not allow subdivision or development in the floodplain. The *Build Out Analysis* identifies the modeled changes to the modeled 100-year floodplain under each scenario. Using a Geographic Information Systems (GIS) model, analysts intersected parcel areas with key features that regulate development in the floodplain: 100-year floodplain, floodway, applicable zoning, and wetlands (Ecology 2011). The results were stored in a spatial database that can be queried and analyzed to identify potential levels of development.

The initial step for the *Build Out Analysis* was to identify the available developable areas of a parcel. The analysis area contains many parcels that are located in inventoried wetlands, are public parcels that were assumed could not be developed for other uses, or are designated land uses that would likely remain unchanged. To accurately estimate the amount of parcel area that is available to be developed, these areas were filtered out of the analysis by using queries developed in GIS that selected only portions of parcels that met the following criteria:

- More than 2,500 square feet of parcel in the modeled 100-year floodplain
- Not in an inventoried wetland area (Ecology 2011)
- Not including the following land uses: transportation, communication, utilities, railroad, transit, recreational, or water areas
- Not publicly owned

Following the selection of each parcel's developable area, each parcel was placed into one of four categories: 1) developed, non-subdividable; 2) developed, subdividable; 3) undeveloped, non-subdividable; 4) and undeveloped, subdividable. The categorization of each parcel was established

by identifying each parcel's zone using zoning data from the county, city, or town in which it resides. Zoning ordinances were reviewed to select a minimum lot size for each zone. The number of lots each parcel could potentially support was calculated by dividing each parcel's available developable area by its minimum lot size. An additional filter was applied based on its improved or building values. Parcels categorized as undeveloped must also have an improved or building value of less than $10,000. It was assumed that parcels exceeding this threshold were already developed. If a subdividable parcel has an improvement value of greater than $10,000, then one parcel was subtracted from the total number of subdivided lots because it was assumed that one of those parcels was developed. The parcels were divided as follows:

- **Developed, non-subdividable**: structure value greater than $10,000 and the parcel is less than twice the minimum lot size
- **Developed, subdividable**: structure value greater than $10,000 and the parcel is greater than twice the minimum lot size
- **Undeveloped, non-subdividable**: structure value less than $10,000 and the parcel is less than twice the minimum lot size
- **Undeveloped, subdividable**: structure value less than $10,000 and the parcel is greater than twice the minimum lot size

Additional analysis was conducted to determine the percent of each parcel that would no longer be inundated based on different combined action. Spatial data for the modeled inundation extents of the scenarios were provided by Watershed Science and Engineering for two combinations of actions: I-5 Projects and Airport Levee Improvements; and Flood Retention Facility and Airport Levee Improvements. Using the inundation extents of each scenario, locations were identified that were inundated under the modeled 100-year floodplain as well as a reduction or elimination of flood inundation depending on which scenario was implemented. These locations were filtered to include contiguous, no-longer-inundated regions with areas greater than 5,000 square feet (the area assumed buildable for this analysis). The percent of each developable parcel area no longer inundated was then calculated for each combinations of actions.

The results of this analysis were then compared to the actual reduction of inundation for each individual parcel. In Lewis County, both structural combinations reduce the inundation extent. Areas that had only long thin strips on the outer reaches of the modeled 100-year floodplain were then eliminated from the analysis because it was determined that no increase in development pressure would result from that type of reduction in inundation.

In Thurston and Grays Harbor counties, no reduction in inundation extent is anticipated from the Airport Levee Improvements and I-5 Projects combination. The Flood Retention Facility and Airport Levee Improvements combination does show some minor marginal reductions in flood elevation and extent in

Thurston and Grays Harbor counties. However, the effect is not great enough to affect future development pressures and, therefore, these areas were eliminated from analysis.

This resulted in two subsets of parcels drawn from the maximum build out potential, identifying areas where higher development pressures may exist in future development associated with each scenario.

Build Out Analysis Assumptions

The following assumptions were used in development of the GIS model:

- Parcel potential development is based on 2015 zoning
- Residential parcel development would be single family
- Wetland areas are not developable (no wetland buffer applied)
- Parcel must have at least 2,500 square feet of area within the modeled 100-year floodplain
- Floodways are not developable
- Parcels with assessor improvement or building values more than $10,000 are considered developed
- Port-owned properties are excluded from parcel subdivision
- Publicly owned parcels are excluded and further development on these parcels would not occur
- Parcels within the territories of the Confederated Tribes of the Chehalis Reservation are excluded, as information on development potential for this area was not available
- Locations no longer inundated must have a contiguous area of 5,000 square feet or more

GIS Data for the *Build Out Analysis*

Several GIS data sources were used in the *Build Out Analysis*. These include the following:

- Watershed Science and Engineering model data (WSE 2015a, 2015b, and 2015c)
  - Modeled 100-year floodplain, updated to reflect the most current hydrologic information and topographic data
  - Alternative element inundation extents (primarily associated with Large-scale Flood Damage Reduction Projects)
- Federal Emergency Management Agency Floodways (FEMA 2012)
- Washington State Department of Ecology Wetland Inventory (Ecology 2011)
- County zoning and parcels
  - Lewis County
  - Grays Harbor County
  - Thurston County
- Where applicable, city and town zoning:
  - Pe Ell
  - Chehalis

- Centralia
- Napavine
- Oakville
- Bucoda
- Elma
- Montesano
- Cosmopolis

Number of Lots No Longer Inundated

A final step in the analysis was the consideration of specific areas in the modeled 100-year floodplain that might no longer be inundated, per Watershed Science and Engineering modeling data, if several Large-scale Flood Damage Reduction Projects are implemented. Over time, these areas that are no longer inundated could receive the highest development pressures in the modeled 100-year floodplain.

The flood inundation layer included a variety of different-sized areas. Many areas that would no longer be inundated were small, fragmented, and of such a size and configuration that they would not support future development. Therefore, a GIS method was used to screen these fragments out, leaving only larger areas (5,000 square feet or more) identified for potential to support future development. Where these non-inundated areas existed on a single parcel that could not be subdivided, the parcel was counted as a single parcel with a higher potential development. Where these non-inundated areas existed on a subdividable parcel, one or more of the resulting subdivided parcels may have a higher development potential.

To calculate the estimated number of subdivided parcels that would have non-inundated area, the total number of potential parcels was multiplied by the percent of the original parcel that would be no longer inundated. For example, if there was a 10-acre parcel zoned as a 1-acre minimum lot size that contained 50% area no longer inundated, then 50% of the resulting subdivided parcels would also contain area no longer inundated and 50% would not. Therefore, the resulting parcels would be five parcels with area no longer inundated and five parcels completely inundated. The single and subdivided parcels were then summed to identify the total number of parcels with a higher development pressure potential.

Assumptions for Number of Lots No Longer Inundated

The following assumptions were used in the new structure estimates:

- The number of dividable lots, with area no longer inundated and large enough for development, is proportionate to the percent of total original parcels that are no longer inundated. For example, if a parcel could be split into ten smaller parcels and 50% of the original parcel contained area no longer inundated and large enough for development, then it is assumed that 50% of the subdivided parcel would contain area sufficient for development that is no longer

inundated. The resulting subdivided parcels would be composed of five inundated parcels and five parcels containing area that is no longer inundated.

- If a parcel contains an area of more than 5,000 square feet that is contiguous and no longer inundated (after implementation of the structural combinations), then that area would be available for development.
- If the amount of non-inundated area on a parcel is greater than 1%, then at least one of the resulting subdivided lots would have a non-inundated area large enough for development. For example, if a lot is 20 acres but only has 5,000 square feet of land no longer inundated, then the percentage of the total parcel that is no longer inundated would be less than 1% of the total parcel area. However, 5,000 square feet is sufficient area for building a structure such as a single-family residence. Therefore, one parcel would be counted as containing area no longer inundated.

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