

**To:** Bruce Mackey, ESA Associates  
**From:** Todd Chase and John Ghilarducci, FCS GROUP  
**CC:** Pam Bissonnette, FCS GROUP  
**RE:** Chehalis River Flood Funding Study, Task 3 – Economic Benefit Analysis (draft findings)

## SUMMARY

This memorandum summarizes the results from the economic benefits analysis (Task 3). The work undertaken by FCS GROUP to complete the economic benefits analysis included:

- Compiling and reviewing relevant available background materials, reports, studies, data, land use plans, and related information;
- Evaluating property damage estimates from prior flood events;
- Evaluating overall economic impacts from local community perspectives using the IMPLAN model;
- Conducting interviews with federal, state and local agency representatives to ascertain quantitative measures of economic damages from prior flood events;
- Evaluating the short-term (construction benefits) of flood mitigation projects;
- Evaluating the long-term permanent economic benefits of flood mitigation;
- Summarizing results and identifying potential funding allocation methods.

It should be noted that the results included in this document are intended to help inform the Chehalis River Basin Flood Authority and interested local stakeholders about the relative economic benefits that would be expected from flood mitigation projects and activities. The findings could also serve as a potential basis for allocating local funding responsibilities or revenue requirements should the Authority decide to formalize local funding agreements to assist with constructing flood projects or flood mitigation activities.

It is not the intent of the consultant to present these findings in accordance with standard Army Corps of Engineers methods and procedures, which tend to limit the economic benefit analysis to an assessment of avoided costs from future flood events, such as: clean up costs, damage to property, damage to agricultural crops, and transportation costs. Instead our approach to analyzing economic benefits focuses on the actual experience that has been documented by local and state agencies from prior flood events, and a supplemental analysis of business losses that could be avoided and property values that could be gained from flood mitigation.

The results of the Economic Benefits Analysis are organized into the following sections:

1. Summary – includes a summary of key findings and preliminary recommendations
2. Overview – provides an overview of the Chehalis River Basin and the 100-year floodplain area in terms of acres, land use, population, employment, and socio-economic patterns.

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3. Economic Benefit Analysis – describes the long-term (permanent) economic benefits from Chehalis River flood mitigation.
4. Construction Benefit Analysis – describes the potential short-term construction-related benefits attributed to flood project construction activities.
5. Potential Funding Allocation Methods – includes a preliminary list of methods that can serve as a basis for allocated local funding responsibilities (cost sharing) for capital and/or operations expenditures associated with flood project mitigation projects or activities.

## SUMMARY OF PRELIMINARY FINDINGS

Public investment in Chehalis River flood mitigation projects and activities will have measurable short-term and long-term economic benefits to the state and region. The recent 2007 flood event cost the state and region an estimated \$938 million in total economic losses (2010 dollar estimates). Based on supporting facts provided by the local and state government agencies, the majority (64%) of these losses were incurred by local businesses and residents in the form of property damage, business disruption and infrastructure damage. Nearly 36% of the total economic losses were statewide—in the form of transportation disruption and state highway and railway damage).

Local economic benefits from reduced future flooding can be consistently measured in terms of:

- ◆ Residential benefits (population and households);
- ◆ Business benefits (economic valued added that is “at risk” in the floodplain); and
- ◆ Property valuation benefits (measures of assessed values);

Other types of economic benefits, including potential reductions in property damage or loss avoidance, reduced flood insurance premium payments, and ecosystem benefits are difficult to apply across the region in a consistent and accurate manner given the limited nature of existing data.

A preliminary allocation of economic benefits within the Chehalis River Basin among local counties (Lewis County, Grays Harbor and Thurston County) and the Chehalis Indian Reservation can be derived using measures of economic benefits, which is quantified using the IMPLAN model along with local U.S. Census estimates of employment. For comparative purposes the potential economic impact from one-day of business disruption within the floodplain is expected to impact approximately 15,018 workers and cause approximately \$4.26 million in lost “direct economic value.”

The direct impact from \$4.26 million in lost economic value per day (associated with business closures within the floodplain) would result in additional indirect and induced regional economic losses of approximately \$1.72 million. Hence, the total amount of economic value that is at risk due to one day of major flooding is an estimated \$5.98 million, of which 71 percent is within the floodplain area, and 29 percent is within the larger regional area.

The relative measures of economic activity could serve as a basis for potential allocation of future flood mitigation project costs or funding commitments.

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## BACKGROUND AND OVERVIEW

This section provides an overview of the Chehalis River Basin and the 100-year floodplain area in terms of acres, land use, population, employment, and socio-economic patterns.

### A. CHEHALIS RIVER BASIN AND FLOODPLAIN AREAS

The Chehalis River and its tributaries form the Chehalis River basin, which is bounded by the Pacific Ocean to the west, the Deschutes River basin to the east, the Olympic Mountains to the north, and the Willapa Hills and Cowlitz River basin to the south. According to the *Chehalis River Basin Hazard Mitigation Plan* (2009), the Chehalis River basin is the second largest basin in Washington, next to the Columbia River basin.

The geographic extent of the Chehalis River Basin is located primarily within Lewis County, Thurston County, and Grays Harbor County (see **Figure 1**). The boundary for the Chehalis River Basin has been determined by the Washington Department of Ecology and the Washington Department of Natural Resources (2008). The Chehalis River Floodplain area is also noted on **Figure 1**, and reflects the area determined to be within the designated 100-year floodplain (2008).

### B. EXISTING CONDITIONS

Within the Chehalis River Basin area, FCS GROUP has evaluated existing conditions using available data sources, such as the local county planning and county assessor departments, local/state Geographic Information System (GIS) data bases, U.S. Census, and other state or federal agencies. An overview of population, households and employment for the floodplain and the area that contributes to the flooding (outside the floodplain but inside the Basin) is provided in **Table 1**.

An analysis of general land use classifications (by *Real Urban Geographics*) in the Chehalis River Basin reflects a slightly different land use mix, including forest/farming (84% of land area); residential (10% of land area); industrial (3% of land area); commercial (retail/office/services/recreation with about 2% of the land area); and 1% of the land area is vacant.

There are four major urban areas located within the basin—Chehalis, Centralia, Aberdeen, and Hoquiam. The Confederated Tribes of the Chehalis Reservation are also located within the basin. In 2000, total population in the Chehalis River basin was approximately 111,000 (U.S. Census, 2000). There were an estimated 31,446 people residing in 12,239 households (dwelling units) within the floodplain area. It should be noted that more current population estimates for the floodplain area will not be available until detailed population census estimates are released later in 2011.

Population centers within the basin are primarily located in the lower Chehalis Basin area within cities, including Aberdeen (pop. 16,450) and Hoquiam (pop. 8,770). The most populated centers in the upper basin area include Chehalis (pop. 7,185) and Centralia (pop. 15,570).<sup>1</sup>

Employment levels within the floodplain for year 2008 include an estimated 14,090 workers working in over 1,000 business establishments, according to U.S. Census estimates for the local area.

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<sup>1</sup> Source: Washington Office of Financial Management, April 1, 2010 population estimate.

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**Table 1 - Chehalis River Floodplain and Basin Characteristics**

<b>Floodplain Area</b>	<b>Grays Harbor County</b>	<b>Thurston County</b>	<b>Lewis County</b>	<b>Chehalis Tribe</b>	<b>Total</b>
Population <sup>1</sup>	22,209	2,400	6,837	691	32,137
Households <sup>1</sup>	8,787	982	2,470	214	12,453
Employment (at place of work) <sup>2</sup>	8,205	542	5,343	928	15,018
Land Area (acres)	236,486	50,439	93,778	n/a	380,703
Taxable Assessed Value - Total <sup>3</sup>	\$1,958,064,000	\$588,825,000	\$677,313,000	\$5,400,000	\$3,229,602,000
Taxable Assessed Value - Improvements <sup>3</sup>	\$1,214,534,000	\$316,494,000	\$344,845,000	\$3,309,000	\$1,879,182,000
<b>Contributing Area (outside Floodplain in Basin)</b>	<b>Grays Harbor County</b>	<b>Thurston County</b>	<b>Lewis County</b>	<b>Chehalis Tribe</b>	<b>Total</b>
Population <sup>1</sup>	17,318	29,564	32,404	n/a	79,286
Households <sup>1</sup>	6,933	10,621	12,643	n/a	30,197
Employment (at place of work) <sup>2</sup>	10,813	11,360	13,001	n/a	35,174
Land Area (acres)	527,912	451,932	108,943	n/a	1,088,787
Taxable Assessed Value <sup>3</sup>	\$3,501,736,000	\$3,535,775,000	\$2,694,075,293	\$8,762,000	\$9,740,348,293
Taxable Assessed Value - Improvements <sup>3</sup>	\$2,314,466,000	\$1,854,506,000	n/a	\$5,856,000	n/a
<b>Basin Area</b>	<b>Grays Harbor County</b>	<b>Thurston County</b>	<b>Lewis County</b>	<b>Chehalis Tribe</b>	<b>Total</b>
Population <sup>1</sup>	39,527	31,964	39,241	n/a	110,732
Households <sup>1</sup>	15,720	11,603	15,113	n/a	42,436
Employment (at place of work) <sup>2</sup>	19,018	11,902	18,344	n/a	49,264
Land Area (acres)	764,398	502,371	202,721	n/a	1,469,490
Taxable Assessed Value <sup>3</sup>	\$5,459,800,000	\$4,124,600,000	\$3,371,388,293	\$14,162,000	\$12,969,950,293
Taxable Assessed Value - Improvements <sup>3</sup>	\$3,529,000,000	\$2,171,000,000	n/a	\$9,165,000	n/a

Notes:

<sup>1</sup> derived from U.S. Census, Census Tract Block Groups, 2000.

<sup>2</sup> derived from Census, On-The-Map, 2008 estimates.

<sup>3</sup> derived from local county assessor data, 1st quarter, 2010. Lewis County data reflects preliminary estimates by FCS GROUP based on ratios of taxable AV to total AV evidenced by Grays Harbor and Thurston County.

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## **C. PRIOR STUDIES**

The Chehalis Basin experienced catastrophic flooding in 2007 and 2009. Investigative hydrological studies have been conducted by the U.S. Army Corps of Engineers, along with flood damage assessments and economic impact assessments by consultants working on behalf of state and local governmental agencies.

The Chehalis River Basin Flood Authority was created in 2009 to proactively coordinate local actions regarding public safety and flood mitigation projects/activities that help prevent flood damage and reduce flood hazards.

The results of prior background studies on economic impacts of Chehalis River flooding events, and related hazard mitigation plans indicate that there has already been hundreds of millions in lost economic activity and property damage due to flood events within the Chehalis Basin over the past decade (not to mention preceding decades) and that there are still significant risks from future flooding events. Selected background reports and related findings are discussed below.

***Chehalis River Flood Water Retention Project, Phase IIB Feasibility Study, Draft, November 10, 2010 (prepared by EES Consulting)*** – This feasibility study was conducted for the Chehalis River Basin Flood Authority as part of a multi-phased evaluation of the economic costs and benefits of flood reduction structures on the Chehalis River. The study considered flood mitigation facility construction costs regarding flood reduction and multi-purpose project solutions for the Upper-Chehalis and South Fork areas. Economic benefits were compiled and analyzed based on the level of benefit that was expected over a 50-year period, using current Corps of Engineers National Economic Development (NED) methods, a Regional Economic Development (NED) method, and an Alternative Economic Development (AED) method.

National economic benefits are typically considered by the Corps of Engineers, and include the potential for:

- Reduced estimated annual damages to building structures and contents, agriculture crops and equipment;
- Avoided clean up costs;
- Avoided transportation delays or detours;
- Avoided infrastructure improvement cost or added operating and maintenance cost;
- Increased availability of water for irrigation or other use;
- Value of hydropower and related renewable qualities; and
- Increased recreational visits and related economic benefits.

Regional economic benefits are generally more localized than the NED benefits, and include the potential for:

- Changes in property values;
- Changes in local employment and business income; and
- Avoided lost business income.

Alternative economic benefits also considered the quantification of environmental benefits and costs, by taking into account:

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- The value of changes in acreage of ecosystems (such as riparian and wildlife habitats);
- Effects on fish and wildlife and water quality;
- Reduction in carbon dioxide or other air pollutants;
- Positive effects on historical or cultural properties;
- Positive impacts on quality of life and population distribution; and
- Beneficial effects on public safety, health and life.

***Flood Protection and Ecosystem Services in the Chehalis River Basin, May 2010 (by Earth Economics) –***

This study was conducted for the Chehalis River Basin Flood Authority as input into the above-mentioned alternative economic analysis, and incorporated into the EES Consulting study. The analysis considered the regional benefits from flood protection on ecosystems, watersheds, land coverage, water, food, soils, biodiversity, plant and wildlife habitat, cultural, aesthetic, recreational, educational and related values. The study findings were based on a GIS analysis and application of the ARIES Mapping (Artificial Intelligence for Ecosystem Services) model.

***December 3, 2007 Chehalis River Flooding Event Description (aka. One Year Later report), prepared November 20, 2008; and revised August 1, 2009 (by Lewis County) –*** document compiled all known costs or damages associated with the flood damage caused in West Lewis County after the December 3, 2007 flood event. The assessment of damages included:

- Residential losses;
- Business losses;
- Public infrastructure (roads, parks, sewer plants, etc.) damages;
- Agriculture/Farm losses;
- Lewis County government revenue losses;
- Local agency (special district) losses;
- State agencies and parks losses; and
- Federal agency costs (railroads, levees, federal highways)

***Storm-related Closures of I-5 and I-90: Freight Transportation Economic Impact Assessment Report, Winter 2007-2008, Final Research Report, September 2008 (prepared by the Washington Department of Transportation and Washington State University) –*** This report documented the economic impact of storm-related closures of I-5 and I-90 that occurred in the winter of 2007-2008 when flooding of the Chehalis River and other water bodies resulted in a four day closure of I-5. The analysis included a survey and economic research using the IMPLAN model to evaluate direct, indirect and induced impacts on the state economy.

In addition to these reports and studies, FCS GROUP relied on available data provided by local county governments, the Chehalis Tribe, and the Federal Emergency Management Agency, through a combination of interviews and research.

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## ECONOMIC BENEFIT ANALYSIS

This section provides a summary of the economic benefits analysis, including an analysis of documented damages and losses from prior flood events, and an assessment of business disruption attributed to lost business activity.

### A. METHODOLOGY

The results included in this section are intended to incorporate prior related study findings regarding various measures of economic losses that were attributed to major Chehalis River Basin flood events. Recent economic studies by EES Consulting and Earth Economics evaluated overall economic benefits for the entire Chehalis River Basin but did not provide a sub-regional economic benefit assessment. Hence, this work is intended to focus on sub-regional economic benefits that could potentially be considered as a basis for allocating local costs or funding shares for flood mitigation projects or activities.

To undertake this economic benefit analysis, FCS GROUP relied primarily on background studies by local county governments, WSDOT, and FEMA flood insurance data. We also supplemented these local studies with additional economic analysis using the IMPLAN model.

The IMPLAN model is an economic analysis model developed by MIG, Inc. (formerly known as Minnesota IMPLAN Group) to quantify the direct and secondary (indirect and induced) economic effects of changes in investment on local and regional economies. IMPLAN divides economies into 506 industry sectors. The IMPLAN model was originally developed by the United States Department of Agriculture (USDA) Forest Service, in cooperation with the United States Department of the Interior, Bureau of Land Management, to assist in land and resource management planning. The IMPLAN model has been in use since 1979 and has evolved into an interactive microcomputer program that has become the national standard for performing economic impact analysis. For more detailed information about the IMPLAN model, please visit [www.IMPLAN.com](http://www.IMPLAN.com).

For analysis purposes, FCS GROUP utilized the IMPLAN models for each of the three counties included in the study basin (Lewis, Thurston, and Grays Harbor counties) for the most recent year available 2009. Estimates of local employment by specific business sector were derived from the U.S. Census of employment (2007 data) using the U.S. Census *LED On-The-Map* program for the floodplain area and the basin area. Only “Primary Jobs,” jobs counted as one job per person, are considered in this analysis, not “All Jobs.”

The results depict the economic impacts of business disruption within the floodplain attributed to one-full day of business closure. All results have been converted to 2010 dollars using the U.S. Bureau of Labor Statistic Consumer Price Index.

The advantage of the IMPLAN model is that it serves as a consistent means of comparing economic benefits from reductions in business disruption among multiple jurisdictions. The model can be used to quantify the local (direct) impacts as well as the regional (indirect and induced impacts). For example, a large flood event will prevent the businesses within the floodplain from operating. Economic output will not be generated by these businesses, workers will not be paid, goods will not be sold, and business income will not be generated. Lost business income will generate indirect and induced impacts that extend beyond the floodplain into the larger regional market area, which in turn affects other businesses

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in the form of lower sales and less economic output. In light of the direct and indirect impacts, protecting the floodplain area has measurable regional economic importance.

In addition to measuring the value of business disruption, IMPLAN is also used in this analysis to quantify the short-term economic benefit of constructing flood mitigation projects. The economic benefit from construction spending will vary by project type and location, but will have local as well as regional benefits given the direct and indirect wage and income benefits described above.

#### **Abridged Definitions of IMPLAN Economic Analysis Terms**

**Direct Impacts:** *The direct economic activity (employment, income, etc.) expected from business facilities and operations located in the floodplain.*

**Indirect Impacts:** *The regional economic activity (employment, income, etc.) that results from the direct economic activity.*

**Induced Impacts:** *The regional economic activity that results from the indirect impacts of business spending and indirect household spending. This includes the interaction of all businesses (such as business to business supply chain purchases) within the local area and the larger market region.*

**Economic Output:** *The value of economic activity of goods and services produced. It reflects estimated annual gross sales minus the value of inventory.*

**Employment:** *People working at business enterprises including full and part time workers.*

**Labor Income:** *A subcomponent of “value added”: the value of employment payroll during the calendar year.*

**Sector:** *The units that make up the total economy: business, households and institutions, and general government.*

**Value Added:** *The difference between an industry’s total economic output and the cost of its intermediate input (consumption of goods and services purchased from other industries). The direct annual value added is sometimes referred to as gross domestic product.*

## **B. ECONOMIC IMPACTS OF BUSINESS DISRUPTION**

Economic disruption from lost business income during a flood event was calculated using the IMPLAN model for each of the affected counties. The per day economic disruption is represented by jobs in the floodplain and related lost labor income, value added and economic output at risk due to one day of closure. The potential amount of economic loss attributed to one full day of business disruption in the floodplain is estimated to result in the direct loss of approximately \$2.5 million in labor income, \$4.1 million in value added, and \$8.1 million in lost output for the local economy. These direct impacts would create additional indirect and induced regional economic impacts of approximately: \$948,000 in

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additional lost labor income; \$1.7 million in lost value added; and \$2.9 million in lost economic output for the larger region (see **Table 3**).

As indicated in **Table 3**, the total (direct, indirect and induced) amount of business disruption from one day of lost business activity in the floodplain is estimated at approximately: \$3.5 million in lost labor income; \$5.8 million in lost value added; and \$11.1 million in lost economic output.

**Table 3 – Per Day Business Activity At-Risk, Chehalis River  
Floodplain (2009 dollars)**

Impact Type	Labor Income	Value Added	Output
Direct Effect	\$2,610,272	\$4,262,644	\$8,364,296
Indirect Effect	\$493,219	\$869,682	\$1,603,423
Induced Effect	\$481,138	\$849,918	\$1,384,212
Total	\$3,584,629	\$5,982,243	\$11,351,931

*Source: 2009 IMPLAN models for Grays Harbor, Lewis and Thurston Counties, US Census LED On The Map (employment estimates). Analysis based on 260 working days per year.*

In light of the fact that the December 2007 flood event closed Interstate 5 for four days, the cumulative amount of lost business activity during a four-day event would be approximately four times the amounts shown in **Table 3**, or: \$10.4 million in lost labor income; \$23.2 million in lost value added; and \$44.2 million in lost economic output (direct, indirect and induced local and regional impacts).

The estimated allocation of business impacts during a one-day closure of businesses within the Chehalis River floodplain by county is provided in **Table 4**.

According to the report prepared by Lewis County titled: *December 3, 2007 Chehalis River Flooding Event Description* (“one year later report” prepared November 20, 2008; and revised financial figures as of August 1, 2009), “many small, independent businesses failed to reopen after the (2007) flood.” In addition to lost economic activity, labor income and output during the flood event, businesses and residents experienced significant loss of property, inventories, and land values.

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**Table 4 – Daily Estimated Business Disruption At-Risk in Chehalis Floodplain (2009 dollars)**

Grays Harbor County Floodplain Per Day			
Impact Type	Labor Income	Value Added	Output
Direct Effect	\$1,227,243	\$1,950,898	\$4,593,204
Indirect Effect	\$295,707	\$507,679	\$977,262
Induced Effect	\$218,693	\$385,583	\$639,825
Total	\$1,741,643	\$2,844,161	\$6,210,290
Lewis County Floodplain Per Day			
Impact Type	Labor Income	Value Added	Output
Direct Effect	\$1,181,277	\$2,036,831	\$3,350,563
Indirect Effect	\$177,204	\$325,252	\$563,215
Induced Effect	\$226,568	\$399,856	\$642,975
Total	\$1,585,050	\$2,761,939	\$4,556,753
Thurston County Floodplain Per Day			
Impact Type	Labor Income	Value Added	Output
Direct Effect	\$115,221	\$146,446	\$202,766
Indirect Effect	\$8,299	\$14,901	\$24,115
Induced Effect	\$21,994	\$40,016	\$60,798
Total	\$145,514	\$201,362	\$287,679
Chehalis Tribe Floodplain Per Day			
Impact Type	Labor Income	Value Added	Output
Direct Effect	\$86,531	\$128,469	\$217,764
Indirect Effect	\$12,008	\$21,849	\$38,831
Induced Effect	\$13,882	\$24,462	\$40,613
Total	\$112,421	\$174,781	\$297,208
Total Floodplain Per Day			
Impact Type	Labor Income	Value Added	Output
Direct Effect	\$2,610,272	\$4,262,644	\$8,364,296
Indirect Effect	\$493,219	\$869,682	\$1,603,423
Induced Effect	\$481,138	\$849,918	\$1,384,212
Total	\$3,584,629	\$5,982,243	\$11,351,931

*IMPLAN model for Chehalis floodplain, analysis represents one day of business impacts based on 260 working days per year; analysis by FCS GROUP.*

According to the Lewis County “*One Year Later report*”, major shopping centers and businesses along the I-5 corridor and along the “Miracle Mile” between Centralia and Chehalis took on 5 to 8 feet of water and I-5 was inundated with 14 feet of water and remained closed for four days.

Within Lewis County, five businesses closed permanently as a result of the 2007 flood event and 15 additional businesses closed for between four and 11 months. There were 222 separate business loss reports tallied by Lewis County with an estimated aggregate economic loss of \$26.5 million. In addition to these business impacts, another 17 large corporate businesses within the floodplain reported “major business losses” totaling \$78.8 million (costs stated in 2009 dollars).<sup>2</sup>

The business loss data estimated tallied in the “*One Year Later report*” reflected 222 businesses

<sup>2</sup> Source: Lewis County, December 3, 2007 Chehalis River Flooding Event Description (“one year later report”) prepared November 20, 2008; and revised financial figures as of August 1, 2009.

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and 17 large corporations. This is considered be an under-estimate of actual business damages and losses, since it includes only what was reported by Lewis County by cooperating businesses and corporations. The data are neither a comprehensive sum of business losses and damages nor a complete list of businesses that experienced losses. As a result, business impacts costs estimates in Lewis County should be considered conservative.

This level of detail regarding business disruption from prior flood events was not available for Thurston or Grays Harbor counties nor the Chehalis Tribe. However, Thurston County did report a business damage estimate of \$2,027,904 from the 2007 December flood event, and a business damage estimate of \$58,926 from the 2009 flood event.<sup>3</sup>

In addition to estimated of business disruption and damages, Lewis County and the Washington Department of Transportation reported economic/business activity lost due to the I-5 closure during the four-day 2007 flood event. During this closure period both truck and rail commerce was halted in the I-5 corridor. Roadway detours entailed a re-route of freight vehicles between Portland and Seattle via I-84 (Portland to Biggs Junction, Oregon), I-82 (Kennewick), I-90 and I-405 (Ellensburg to Seattle).

According to the WSDOT report, the I-5 detour tripled the driving distance between Portland and Seattle from 200 miles to more than 600 miles. The amount of lost economic output associated with the closure of I-5 is estimated at approximately \$49 million, as indicated in **Table 5**. In addition to the lost economic output, WSDOT also estimated that there were 290 jobs lost one-year following the I-5 closure, \$2.5 million in lost state tax revenues, and \$15.2 million in lost personal payroll attributed to the four-day closure of I-5 during the 2007 flood event.<sup>4</sup>

**Table 5 –Estimated Freight Disruption Impacts of Chehalis River Flood Event (2010 dollars)**

Impact Type	Lost Economic Output
Direct Impact	\$25,932,000
Indirect Impact	\$12,752,000
Induced Impact	\$10,406,000
Total Economic Output Lost	\$49,090,000
State Tax Revenue Lost	\$2,502,000
Reduction in Personal Income	\$15,223,000
Employment Loss (jobs)	290

*Source: Washington Department of Transportation. Adjusted to 2010 dollars by FCS GROUP.*

<sup>3</sup> Source: presentation to Chehalis River Basin Flood Authority, Public Meeting, October 14, 2010.

<sup>4</sup> Source: Washington Department of Transportation and Washington State University, Storm-Related Closures of I-5 and I-90: Freight Transportation Economic Impact Assessment Report, Winter 2007-08; adjusted by FCS GROUP to 2010 dollars.

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## C. RESIDENTIAL IMPACTS OF FLOOD DAMAGE

The amount of residential losses that were attributed to recent flooding far exceeds the amount of business losses and freight disruption losses. According to the “*One Year Later*” report by Lewis County (analysis of the 2007 flood event), residential losses included structure damage, the destruction of personal property, insured losses, and elevation costs. The costs reported by Lewis County included 3,000 residential structures, with total reported economic losses of \$192.4 million in 2009 dollars.

Thurston County reported \$13.46 million in total damages to homeowners from the 2007 flood event, and \$1.6 million in homeowner damages from the 2009 flood event.

The Federal Emergency Management Agency (FEMA) conducted additional residential property analysis in the City of Centralia with respect to losses avoided through flood hazard mitigation. The report titled *Evaluating Losses Avoided Through Hazard Mitigation* (Feb. 2008) noted that over the past 15 years, public agencies and private homeowners have invested several million dollars to acquire and elevate flood prone residential structures in Lewis County. The economic assumptions used in the report include:

- ◆ Building replacement costs of \$99.46 per square foot (2008 estimates intended to be specific to the Centralia area);
- ◆ Content value equal to 40% of building replacement cost;
- ◆ Default depth-damage relationships for residential structures, content value and displacement costs were based on the *Riverine Full Data BCA Modules*;
- ◆ A building damage of 50% or more would result in demolition of entire structure.

After reviewing the actual cost for elevating 116 homes in Centralia, FEMA concluded the average cost of elevating a home to be \$29,069. FEMA evaluated how a flood event similar to that which occurred in 2007 would result in economic losses for the Centralia area, and concluded that the amount of avoided losses would be approximately \$1,905,760 (\$54,450 per residential structure), and the cost of mitigation associated with home elevation would be \$1,017,415. Hence, the benefit-cost ratio from this mitigation measure after just one major flood event was almost two to one.

No residential damage estimate data were provided for Grays Harbor County.

## D. FLOOD INSURANCE PREMIUM LOSSES

Flood insurance is almost always required by mortgage holders for properties located within the 100-year floodplain. According to the Federal Emergency Management Agency (FEMA), there are 1,881 flood insurance policies in Lewis County covering \$3.2 million in property, and in Thurston County there are 3,599 policies that cover over \$5.0 million in property.<sup>5</sup> These policies appear to reflect properties within the Chehalis River floodplain as well as other floodplain areas (e.g., along the Nisqually River). Hence, the use of FEMA data may not be an accurate indicator of flood insurance risks or losses associated with Chehalis River flooding events.

Similar findings were not available for Grays Harbor County or for the Chehalis Tribe.

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<sup>5</sup> Source: FEMA policy estimates reported in interview with Mike Howard, external affairs director for FEMA office covering Washington, Idaho, Alaska, and Oregon, by Seattle Times reporter Sara Jean Green, December 8, 2007.

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FEMA tracks the amount of National Flood Insurance Program payments by local jurisdiction over time. As indicated in **Table 6**, the amount of payments made by FEMA over the 1978 to 2009 time frame ranges from \$686,941 in the City of Aberdeen to \$28 million for premium holders in the City of Chehalis.

**Table 6 –National Flood Insurance Premium Loss Statistics,  
1978 to 2009**

Thurston County (unincorporated)	\$3,448,798
Lewis County (unincorporated)	\$22,542,192
Grays Harbor County (unincorporated)	\$4,364,470
City of Aberdeen	\$686,941
City of Chehalis	\$28,041,374
City of Centralia	\$25,339,954

*Source: Federal Emergency Management Agency, National Flood Insurance Program data (Sept. 30, 2010), compiled by FCS GROUP.*

## E. PROPERTY AND PUBLIC FACILITY DAMAGE

The background studies prepared by Lewis County and WSDOT, and to a lesser extent Thurston County, provide a quantitative assessment of property and infrastructure damages that resulted from the 2007 flood event. This event recorded the highest flood stage levels recorded along the Chehalis. In December 2007, the highest river crests were recorded at Mellen Street, at nearly 10 feet over the flood stage (74.78'). The previous record level was recorded in February 1996 at 74.30 feet. Many residents were evacuated from their homes. In addition to the loss of personal property and real property, thousands of farm animals, crops, and pets were lost to the river.<sup>6</sup>

The extent of property damage from the 2007 flood event included both private residential and business properties and public infrastructure. Over 3,000 homes received some level of water damage in Lewis County alone, and 1,000 of these homes were classified as “major to destroyed” in terms of losses.

As indicated in **Table 7**, the financial losses in Lewis County from the 2007 flood event included an estimated \$512.1 million in damages. Residential losses amounted to approximately \$192.4 million in estimated damages, or 36% of total losses. Business losses amounted to \$120.14 million, including \$26.5 million in losses at “local owned” establishments, and \$93.94 million at corporate-owned establishments. A large portion of the “corporate owned” business losses included \$48 million in transportation costs associated with the I-5 closure (which is also reflected in the WSDOT data reported in **Table 5**).

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<sup>6</sup> *Source: December 3, 2007 Chehalis River Flooding Event Description, prepared by Lewis County, November 30, 2008; revised August 1, 2009.*

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**Table 7 –Lewis County “One Year Later” Loss Statistics from 2007  
Flood Event (2009 \$)**

Loss Type	Description	Amount
Residential	3,000 structures, personal property, insured losses, elevation costs	\$192,402,000
Business (local-owned)	222 preliminary reports minus major stores	\$26,500,000
Business (major corporations)	Major (17 corporations)*	\$93,640,000
Agriculture/Farm	126 farms, animal replacement, feed	\$4,641,000
Aid & Grant Contributions	Non-profit, social services, faith-based	\$24,164,000
Public Infrastructure	Local Buildings, debris, roads bridges	\$58,613,000
Government Revenue	Permitting, taxes	\$68,963,100
Other Local Agencies	Fire Services, Port Districts	\$1,659,000
State Agencies & Parks	Includes clean up and infrastructure	\$19,241,000
Federal Agency Costs	Railroads, Levees, Federal Highways	\$22,245,000
<b>Total</b>		<b>\$512,068,100</b>

*\* includes approximately \$48 million in local and regional business losses.*

*Source: December 3, 2007 Flood – One Year Later report by Lewis County, prepared Nov. 2008, revised August 2009.*

The extent of “private losses” in Lewis County that are associated with the 2007 flood event include an estimated \$223.54 million in structure damage, lost business revenue, and agricultural damage. An additional \$26.16 million in tax payer money was allocated to local residents and businesses and non-profits working on flood cleanup and emergency assistance (see **Table 8**).

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**Table 8 –Lewis County “One Year Later”**  
**Private Loss Statistics from 2007 Flood Event (2009 \$)**

Loss Type	Description	Cost
Residential	Structure repairs, personal property losses, insured losses, homes destroyed, homes elevated/repared	\$192,402,000
Business (smaller est.)	Based on 222 reports	\$26,500,000
Business (corporate est.)	Based on 17 reports (\$45.64 M) plus transportation industry business losses (\$48 M)	\$93,640,000
Agriculture	Animal Indemnity Program, feed/hay supplement, equipment/structure losses	\$4,641,000
<b>Property &amp; Content Damage, Cleanup Subtotal</b>		<b>\$223,543,000</b>
Federal Aid & Grant Contributions (to private sector)	American Red Cross, United Way, donated animal medical, feed, hay, Small Business Administration Loans, FEMA ONA rental assistance	\$24,164,000
<b>Total</b>		<b>\$341,344,000</b>

\* includes approximately \$48 million in local and regional business losses.

Source: December 3, 2007 Flood – One Year Later report by Lewis County, prepared Nov. 2008, revised August 2009.

The extent of public losses (including Lewis County, City of Centralia, City of Chehalis, Town of PeEll and Washington state and federal agencies) associated with the 2007 flood event has been estimated by Lewis County in the “one year later” report. A total of \$170.7 million in public losses were recorded in the “one year later” report, as indicated in **Table 9**. The highest loss categories included declining government property and sales tax revenues (\$68.96 million); public buildings (\$45.05 million); and highway and railway damage (\$22.45 million).

A separate flood damage study by Thurston County reported \$4.56 million in local public agency flood damage from the 2007 flood event, and \$2.5 million in public damage from the 2009 flood event.

In addition to the business disruption, highway damage, railway damage and repair costs, WSDOT has estimated that the cost to raise the I-5 freeway to avoid future flood events similar to that which occurred December 2007 to be approximately \$100 million. Locations prone to flooding along I-5 include three areas: the Highway 6 overpass; airport area; and the Saltzer Creek to Mellen Street area.<sup>7</sup>

No additional data were provided by Grays Harbor County or the Chehalis Tribe.

<sup>7</sup> Source: EES Consulting, Chehalis River Flood Water Retention Project Phase IIB Feasibility Study, Draft report, November 10, 2010.

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**Table 9 –Lewis County “One Year Later”**  
**Public Loss Statistics from 2007 Flood Event (2009 \$)**

Loss Type	Description	Cost
Structures	County buildings	\$45,047,000
Centralia Debris	Cleanup, debris removal, equipment costs	\$876,000
Chehalis Debris	Cleanup, debris removal, equipment costs	\$700,000
Town of PeEll	Water & Wastewater Treatment Plant	\$7,000,000
Non-FEMA/Insured County Losses		\$3,916,000
Non-Reimbursed County Costs	Debris disposal, mobile home removal, water testing	\$1,074,000
Government Revenue Losses	Cities of Chehalis and Centralia, tax refunds, property tax assessment loss, sales tax revenue	\$68,963,100
Other Agencies and Ports	Fire Districts, Centralia Port District	\$1,659,000
State Agencies	WA State Patrol, Employment Security, State Lands Cleanup,	\$2,180,000
Parks	Rainbow Falls, Willipa Hills Trails, bridge replacement/removal	\$17,061,000
Federal Agencies	Highway damage, ecology, Curtis railroad, Levees	\$22,245,000
<b>Total</b>		<b>\$170,721,100</b>

*\* includes approximately \$48 million in local and regional business losses.*

*Source: December 3, 2007 Flood – One Year Later report by Lewis County, prepared Nov. 2008, revised August 2009.*

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## F. EMERGENCY MANAGEMENT AND CLEAN UP COSTS

The background studies prepared by Lewis County provide an estimate of emergency management, debris removal and clean up costs. The Lewis County Emergency Operations Center coordinated water, air and land rescue activities for 10 days during the 2007 flood event. The Sheriff's Office and County staff provided over 7,000 hours of response and recover time over the December 3 to December 13 ten-day period. These public agencies were assisted by over 24 other public and community groups in the recovery efforts.<sup>8</sup>

The costs of emergency management and cleanup are referenced in the public agency cost estimates listed in **Table 9**, and include nearly \$5 million in unreimbursed costs in Lewis County, \$7 million in water and wastewater treatment plant rehabilitation in the Town of PeEll, and \$1.58 million in clean up costs in the cities of Centralia and Chehalis combined.

No additional detailed data were provided by Grays Harbor County, Thurston County or the Chehalis Tribe.

## G. ENVIRONMENTAL BENEFITS

In addition to the avoided business and resident impacts, public tax revenue impacts, property damage costs, and clean-up costs that could be realized from flood mitigation, there are significant environmental benefits from reduced flooding within the Chehalis Basin. The Chehalis River Basin Flood Authority contracted with Earth Economics to evaluate the economic benefits related to ecosystem preservation that can be attributed to flood protection. The findings from the Earth Economics study estimated the economic value of natural systems in the Chehalis River Basin, including forests, rivers, lakes, wetlands, soils, agriculture, and recreational areas. Key findings from the study:

- ◆ Natural, man-made infrastructure, and social infrastructure provide flood protection in the Chehalis Basin;
- ◆ An analysis of 12 Chehalis River Basin ecosystem services is estimated to provide an economic benefit of \$1.3 to \$11.6 billion to citizens annually. The ecosystem services reflect items such as flood protection, recreational value, aesthetic value, water filtration, oxygen production, and plant and animal habitat quality;
- ◆ The present value of the annual flow of ecosystem benefits (at a 2.7% discount rate) ranges from \$43 to \$400 billion for the Chehalis Basin. These benefits are provided to people living inside and outside the Basin.

While the benefits from ecosystem preservation are extensive from an economic perspective, ecosystem benefits cannot be easily quantified for specific geographies (such as counties). Hence, the economic analysis of ecosystems cannot serve as a formal basis for local funding or revenue sharing methodology purposes.

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<sup>8</sup> Source: December 3, 2007 Chehalis River Flooding Event Description, prepared by Lewis County, November 30, 2008; revised August 1, 2009.

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## H. SUMMARY OF FLOOD DAMAGE AVOIDANCE BENEFITS

To estimate overall economic losses from the 2007 flood event, FCS GROUP tallied available information from Lewis County, Thurston County, FEMA, and WSDOT. Since detailed estimates of business revenue losses were not provided by Grays Harbor County or Thurston County, FCS GROUP utilized the IMPLAN model results described previously to estimate local and regional economic impacts associated with business disruption in those areas. The resulting summary of economic impacts associated with a four-day event, such as the 2007 flood event are provided in **Table 10**. Total economic losses from the 2007 flood event include an estimated \$937.7 million, including approximately \$603.4 million in local/regional impacts, and \$334.4 million in statewide impacts.

**Table 10 – Summary of Economic Impacts  
and Losses from 2007 Flood Event (2010 \$)**

Cost Type	Local/Regional Impact	Statewide Impact	Total
Local Business Disruption <sup>1</sup>	\$57,443,691	-	\$57,443,691
Property & Content Damage, Cleanup <sup>2</sup>	\$340,342,820	-	\$340,342,820
Transportation/Infrastructure Damage <sup>3</sup>	\$86,696,488	\$23,374,900	\$110,071,388
Government Revenue Loss (tax dollars)	\$70,087,199	-	\$70,087,199
Transportation Disruption <sup>4</sup>	\$48,782,400	\$310,997,963	\$359,780,363
<b>Total</b>	<b>\$603,352,597</b>	<b>\$334,372,863</b>	<b>\$937,725,460</b>

Notes:

<sup>1</sup> based on IMPLAN analysis for Lewis, Thurston, and Grays Harbor counties.

<sup>2</sup> reflects findings from Lewis County "One Year Later" report and Thurston County estimates.

<sup>3</sup> reflects findings from Lewis County "One Year Later" report.

<sup>4</sup> includes findings from Lewis County "One Year Later" report and WSDOT estimates.

Compiled and adjusted to 2010 dollars by FCS GROUP, Inc.

## I. POTENTIAL PROPERTY VALUE BENEFITS

In addition to the documented local benefits from reductions in business disruption, property and clean-up losses, transportation/infrastructure damage, government revenue losses, and transportation disruption, there is also potential for future public investment in flood mitigation projects to result in permanent increases in property values. This often occurs after flood mitigation projects result in flood plain boundary alterations by the Corps of Engineers and after FEMA lowers the level of flood risk for properties (reclassifies areas that were previously prone to flooding).

While the analysis of potential property value enhancement is speculative, it can provide a consistent comparison of potential property value enhancement that may be realized for each local jurisdiction. FCS GROUP worked with local county assessor database records to evaluate the existing value of land and improvements within the Chehalis River floodplain and basin areas. The analysis is intended to represent a conservative relative comparison of the value of land area for properties by their general land use classification. The results may be informative to help quantify the economic benefit to properties, which is measured in terms of expected increases in *land value* if properties are removed from the floodplain. While there may also be some benefit in form of higher levels of private investment and

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related assessed improvement values, the level of improvements would be more indicative of long-term market conditions and local zoning regulations, which are not as predictable and consistent as land value estimates.

A preliminary analysis of all 95,002 tax lots within the Chehalis River Basin indicates that the average assessed land value per square foot of land area is \$0.77/SF inside the Chehalis River floodplain and \$1.08/SF outside the floodplain (within the Basin area). While there is a significant difference in land values by land use zoning or classification, this analysis generally indicates that the land values (excluding improvements) are approximately 40% higher outside the floodplain than inside the floodplain. This finding implies that if all of the land area in the floodplain (380,000 acres) was protected from future flooding, the potential assessed value created could be about \$720 million (see Table 11).

**Table 11 – Summary of Land Values, Chehalis River Floodplain and Contributing Areas**

Chehalis River Floodplain Area						
General Land Use Classifications	Sum of Taxlots	Total Assessed Value, Properties Impacted by 100-Year Floodplain	Assessed Improvement Value	Assessed Land Value	Land Area in SF	Land Value Per SF
Agricultural	1,821	\$ 262,991,172	\$ 110,706,683	\$ 152,284,489	2,538,833,352	\$ 0.06
Commercial	2,929	\$ 730,698,599	\$ 416,116,250	\$ 314,582,349	203,110,774	\$ 1.55
Forest	2,692	\$ 364,463,139	\$ 188,606,534	\$ 175,856,605	9,082,568,448	\$ 0.02
Government	204	\$ 331,838,388	\$ 262,255,140	\$ 69,583,248	122,591,718	\$ 0.57
Industrial	1,090	\$ 872,015,044	\$ 566,707,084	\$ 305,307,960	359,733,541	\$ 0.85
Multifamily	142	\$ 117,840,873	\$ 100,294,400	\$ 17,546,473	5,440,093	\$ 3.23
Residential Other	3,968	\$ 279,970,177	\$ 61,364,461	\$ 218,605,716	682,649,475	\$ 0.32
Single Family	9,826	\$ 1,225,073,092	\$ 857,253,917	\$ 367,819,175	1,428,398,826	\$ 0.26
Vacant	2,271	\$ 149,669,742	\$ 1,403,240	\$ 148,266,502	2,301,882,845	\$ 0.06
<b>Total / Average</b>	<b>24,943</b>	<b>\$ 4,334,560,226</b>	<b>\$ 2,564,707,709</b>	<b>\$ 1,769,852,517</b>	<b>16,725,209,073</b>	<b>\$ 0.77</b>
Chehalis River Basin Contributing Area (outside floodplain area)						
General Land Use Classifications	Sum of Taxlots	Total Assessed Value, Properties Not Impacted by 100-Year Floodplain	Assessed Improvement Value	Assessed Land Value	Land Area in SF	Land Value Per SF
Agricultural	2,505	\$ 261,286,998.00	\$ 114,627,722.00	\$ 146,659,276.00	1,293,548,801	\$ 0.11
Commercial	3,823	\$ 1,277,635,004.00	\$ 760,059,040.00	\$ 517,575,964.00	242,570,745	\$ 2.13
Forest	6,032	\$ 376,819,370.00	\$ 85,168,298.00	\$ 273,587,578.00	29,826,648,748	\$ 0.01
Government	424	\$ 909,402,665.00	\$ 754,565,880.00	\$ 154,836,785.00	185,570,202	\$ 0.83
Industrial	1,058	\$ 1,151,349,545.00	\$ 662,099,958.00	\$ 489,249,587.00	183,263,110	\$ 2.67
Multifamily	391	\$ 187,004,741.00	\$ 144,105,783.00	\$ 42,898,958.00	15,553,505	\$ 2.76
Residential Other	15,960	\$ 1,174,456,192.00	\$ 345,722,807.00	\$ 828,733,385.00	2,479,712,193	\$ 0.33
Single Family	34,612	\$ 3,787,087,887.00	\$ 1,731,536,856.00	\$ 2,055,551,031.00	2,594,328,630	\$ 0.79
Vacant	5,254	\$ 464,186,104.00	\$ 5,412,785.00	\$ 458,773,319.00	6,020,391,091	\$ 0.08
<b>Total / Average</b>	<b>70,059</b>	<b>\$ 9,589,228,506.00</b>	<b>\$ 4,603,299,129.00</b>	<b>\$ 4,967,865,883.00</b>	<b>42,841,587,023</b>	<b>\$ 1.08</b>

Source: compiled by Real Urban Geographics and FCS GROUP based on local county assessor data, 2010.

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### 3. CONSTRUCTION BENEFITS

This section provides an assessment of the potential local and regional economic benefits from construction of flood mitigation projects, such as reservoirs, levees, and multipurpose flood control structures.

In light of the fact that specific flood control projects and related capital and operating cost estimates are still being formulated, the construction benefit methodology relies on the IMPLAN model (described previously) and assumes \$1.0 million in annual construction spending on flood-control facilities. As mentioned previously, the IMPLAN model utilizes county and regional economic input-output assumptions for 506 separate industry sectors.

For analysis purposes, FCS GROUP assumed that the \$1.0 million in construction spending is allocated in the following sector distribution (according to IMPLAN sector definitions): 80% to water, sewage and other treatment and delivery, 10% to architectural and engineering services, and 10% to environmental and other technical consulting. The benefits are reported in **Table 12**.

The results indicate that \$1.0 million in capital spending is expected to generate approximately:

- ◆ 11 total jobs, including 6.9 direct jobs and 4.1 indirect/induced jobs (person years of employment);
- ◆ \$544,689 in direct and indirect/induced annual labor income;
- ◆ \$901,676 in direct and indirect/induced value added;
- ◆ \$1.4 million in direct and indirect/induced annual economic output.

**Table 12 – Construction benefit per \$1,000,000 of Flood District Mitigation Improvements (2010 dollars)**

Impact Type	Employment	Labor Income	Value Added	Output
Direct Impact	6.9	\$394,890	\$660,167	\$1,000,000
Indirect Impact	1.7	\$69,849	\$97,310	\$170,260
Induced Impact	2.3	\$79,951	\$144,199	\$235,997
<b>Total</b>	<b>10.9</b>	<b>\$544,689</b>	<b>\$901,676</b>	<b>\$1,406,257</b>

*Source: IMPLAN model (2009) for Lewis County, adjusted to 2010 dollars by FCS GROUP.*

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## 4. POTENTIAL FUNDING ALLOCATION METHODS

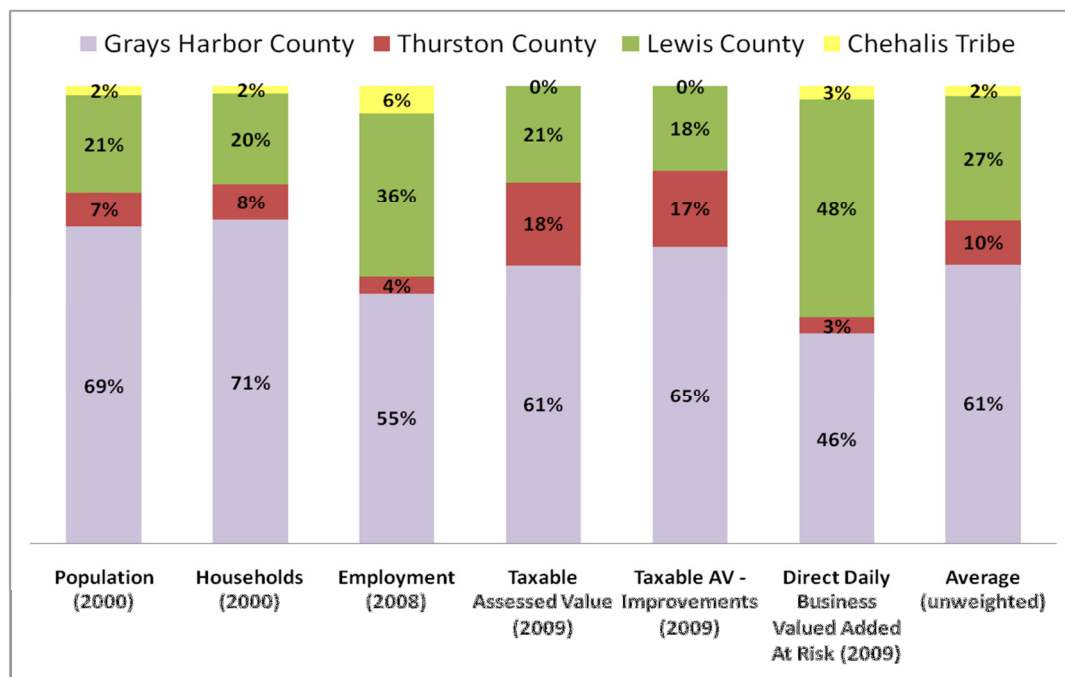
The results from the economic benefit analysis can serve as a basis for future inter-governmental funding agreements or local cost-sharing responsibilities. Local governments may consider a number of options as they formulate future revenue sharing allocations for projects that mitigate flooding within the Chehalis Basin. For analysis purposes, FCS GROUP has identified potential metrics that may serve as a basis for formulating a locally preferred funding allocation method. It is also possible to consider a weighted or unweighted average of these methods to derive additional allocation options.

### A. COMPARISON OF ALLOCATION METHODS

As indicated in **Tables 13** and **Table 14**, the metrics for allocating funding among local counties could include metrics such as population, households, employment, taxable assessed property value, National Flood Insurance Premium payments, and direct value added (a measure of economic activity). It is also possible to consider a weighted average of these metrics that could apply a larger share of weight to potential benefits in the floodplain relative to the remainder of the Chehalis River Basin.

**Figure 2** illustrates the relative comparison of how each allocation method varies by selected area for the Chehalis River Floodplain, and **Figure 3** reflects similar data for the entire Basin, and includes an un-weighted average of six metrics.

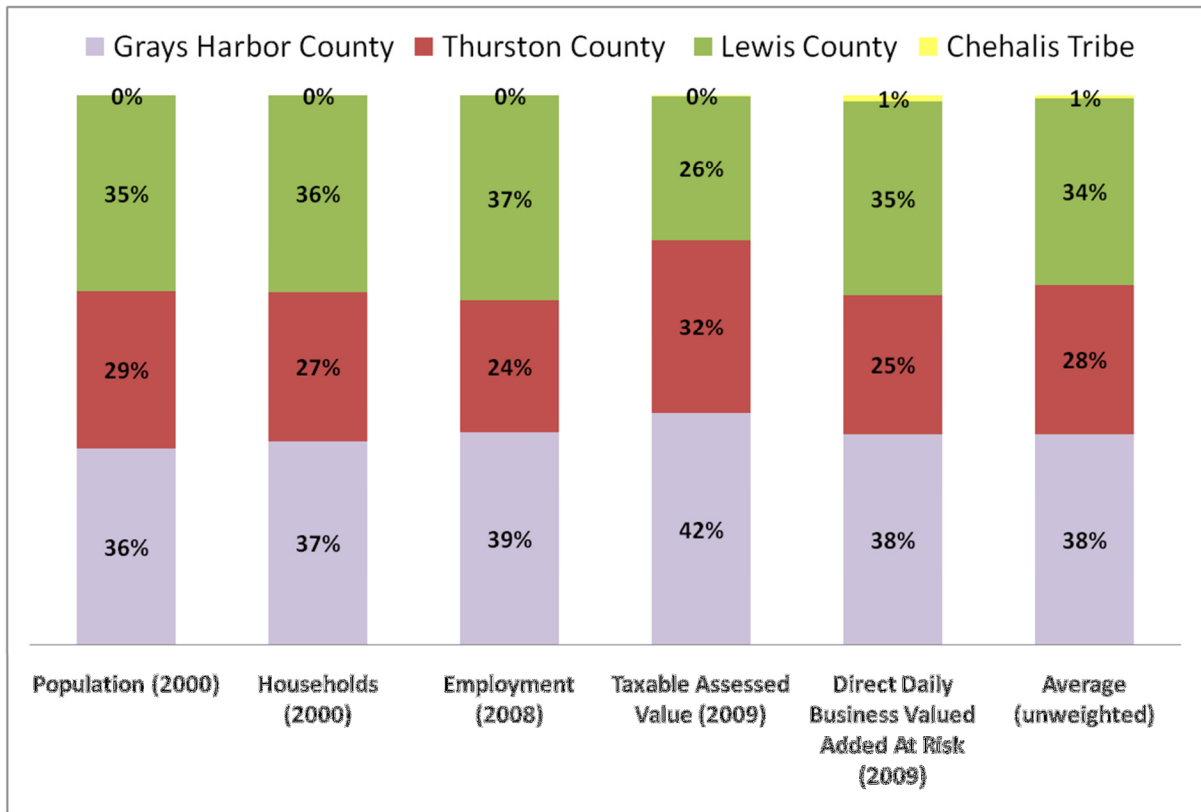
**Figure 2 – Comparison of Potential Flood Mitigation Benefit Metrics, Chehalis River Floodplain**



Source: based on the results shown in Tables 13 and 14.

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**Figure 3 – Comparison of Potential Flood Mitigation Benefit Metrics,  
Chehalis River Basin Area**



*Source: based on results presented in Tables 13 and 14.*

## B. NEXT STEPS

These preliminary findings and draft allocation methods will be presented and discussed with the Chehalis River Basin Flood Authority. Input from the Authority will serve to help refine the analysis and potential allocation methods.

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**Table 13 – Potential Flood Mitigation Benefit Metrics by Area**

Floodplain Area	Grays Harbor County	Thurston County	Lewis County	Chehalis Tribe	Total
Population <sup>1</sup>	22,209	2,400	6,837	691	32,137
Households <sup>1</sup>	8,787	982	2,470	214	12,453
Employment (at place of work) <sup>2</sup>	8,205	542	5,343	928	15,018
Land Area (acres)	236,486	50,439	93,778	n/a	380,703
Taxable Assessed Value - Total <sup>3</sup>	\$1,958,064,000	\$588,825,000	\$677,313,000	\$5,400,000	\$3,229,602,000
Taxable Assessed Value - Improvements <sup>3</sup>	\$1,214,534,000	\$316,494,000	\$344,845,000	\$3,309,000	\$1,879,182,000
National Flood Insurance Premium Losses <sup>4</sup>	n/a	n/a	n/a	n/a	n/a
Direct Economic Value Added Per Day <sup>5</sup>	\$1,950,898	\$146,446	\$2,036,831	\$128,469	\$4,262,644
Indirect & Induced Economic Value Added P	\$893,263	\$54,916	\$725,109	\$46,312	\$1,719,600
Total Economic Valued Added Per Day <sup>5</sup>	\$2,844,161	\$201,362	\$2,761,940	\$174,781	\$5,982,244
<b>Contributing Area (outside Floodplain in Basin)</b>	<b>Grays Harbor County</b>	<b>Thurston County</b>	<b>Lewis County</b>	<b>Chehalis Tribe</b>	<b>Total</b>
Population <sup>1</sup>	17,318	29,564	32,404	n/a	79,286
Households <sup>1</sup>	6,933	10,621	12,643	n/a	30,197
Employment (at place of work) <sup>2</sup>	10,813	11,360	13,001	n/a	35,174
Land Area (acres)	527,912	451,932	108,943	n/a	1,088,787
Taxable Assessed Value <sup>3</sup>	\$3,501,736,000	\$3,535,775,000	\$2,694,075,293	\$8,762,000	\$9,740,348,293
Taxable Assessed Value - Improvements <sup>3</sup>	\$2,314,466,000	\$1,854,506,000	n/a	\$5,856,000	n/a
National Flood Insurance Premium Losses <sup>4</sup>	n/a	n/a	n/a	n/a	n/a
Direct Economic Value Added Per Day <sup>5</sup>	\$2,809,102	\$3,023,554	\$2,353,169	\$128,469	\$8,185,825
<b>Basin Area</b>	<b>Grays Harbor County</b>	<b>Thurston County</b>	<b>Lewis County</b>	<b>Chehalis Tribe</b>	<b>Total</b>
Population <sup>1</sup>	39,527	31,964	39,241	n/a	110,732
Households <sup>1</sup>	15,720	11,603	15,113	n/a	42,436
Employment (at place of work) <sup>2</sup>	19,018	11,902	18,344	n/a	49,264
Land Area (acres)	764,398	502,371	202,721	n/a	1,469,490
Taxable Assessed Value <sup>3</sup>	\$5,459,800,000	\$4,124,600,000	\$3,371,388,293	\$14,162,000	\$12,969,950,293
Taxable Assessed Value - Improvements <sup>3</sup>	\$3,529,000,000	\$2,171,000,000	n/a	\$9,165,000	n/a
National Flood Insurance Premium Losses <sup>4</sup>	\$4,364,470	\$3,448,798	\$22,542,192	n/a	\$30,355,460
Direct Economic Value Added Per Day <sup>5</sup>	\$4,760,000	\$3,170,000	\$4,390,000	\$128,469	\$12,448,469

**Notes:**

<sup>1</sup> derived from U.S. Census, Census Tract Block Groups, 2000.

<sup>2</sup> derived from Census, On-The-Map, 2008 estimates.

<sup>3</sup> derived from local county assessor data, 1st quarter, 2010. Lewis County data reflects preliminary estimates by FCS GROUP based on ratios of taxable AV to total AV evidenced by Grays Harbor and Thurston County.

<sup>4</sup> based on FEMA NFIP losses from 1978-2008, reflects county total payments.

<sup>5</sup> derived using employment estimates and IMPLAN model for county portion of floodplain.

Source: compiled by FCS GROUP.

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**Table 14 – Potential Flood Mitigation Benefit Metrics by Area**

<b>Floodplain Area</b>	<b>Grays Harbor County</b>	<b>Thurston County</b>	<b>Lewis County</b>	<b>Chehalis Tribe</b>	<b>Total</b>
Population <sup>1</sup>	69%	7%	21%	2%	100%
Households <sup>1</sup>	71%	8%	20%	2%	100%
Employment (at place of work) <sup>2</sup>	55%	4%	36%	6%	100%
Taxable Assessed Value <sup>3</sup>	61%	18%	21%	0.2%	100%
Taxable Assessed Value - Improvements <sup>3</sup>	65%	17%	18%	0.2%	100%
National Flood Insurance Premium Losses <sup>4</sup>	n/a	n/a	n/a	n/a	n/a
Direct Economic Value Added Per Day <sup>5</sup>	46%	3%	48%	3%	100%
<b>Unweighted Average All Categories</b>	<b>61%</b>	<b>10%</b>	<b>27%</b>	<b>2%</b>	<b>100%</b>
<b>Contributing Area (outside Floodplain in Basin)</b>	<b>Grays Harbor County</b>	<b>Thurston County</b>	<b>Lewis County</b>	<b>Chehalis Tribe</b>	<b>Total</b>
Population <sup>1</sup>	22%	37%	41%	n/a	100%
Households <sup>1</sup>	23%	35%	42%	n/a	100%
Employment (at place of work) <sup>2</sup>	31%	32%	37%	n/a	100%
Taxable Assessed Value <sup>3</sup>	36%	36%	28%	0.1%	100%
Taxable Assessed Value - Improvements <sup>3</sup>	24%	19%	n/a	n/a	n/a
National Flood Insurance Premium Losses <sup>4</sup>	n/a	n/a	n/a	n/a	n/a
Direct Economic Value Added Per Day <sup>5</sup>	34%	37%	29%	2%	100%
<b>Unweighted Average All Categories</b>	<b>28%</b>	<b>33%</b>	<b>35%</b>	<b>1%</b>	<b>96%</b>
<b>Basin Area</b>	<b>Grays Harbor County</b>	<b>Thurston County</b>	<b>Lewis County</b>	<b>Chehalis Tribe</b>	<b>Total</b>
Population <sup>1</sup>	36%	29%	35%	n/a	100%
Households <sup>1</sup>	37%	27%	36%	n/a	100%
Employment (at place of work) <sup>2</sup>	39%	24%	37%	n/a	100%
Taxable Assessed Value <sup>3</sup>	42%	32%	26%	0.1%	100%
Taxable Assessed Value - Improvements <sup>3</sup>	n/a	n/a	n/a	n/a	n/a
National Flood Insurance Premium Losses <sup>4</sup>	14%	11%	74%	n/a	100%
Direct Economic Value Added Per Day <sup>5</sup>	38%	25%	35%	1%	100%
<b>Unweighted Average All Categories</b>	<b>34%</b>	<b>25%</b>	<b>41%</b>	<b>1%</b>	<b>100%</b>

Notes:

<sup>1</sup> derived from U.S. Census, Census Tract Block Groups, 2000.

<sup>2</sup> derived from Census, On-The-Map, 2008 estimates.

<sup>3</sup> derived from local county assessor data, 1st quarter, 2010. Excludes tribe-owned land holdings.

<sup>4</sup> based on FEMA NFIP losses from 1978-2008, reflects county total payments.

<sup>5</sup> derived using employment estimates and IMPLAN model for each local area.

Source: compiled by FCS GROUP.

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**Chehalis River Flood Funding Study**  
**Task 3 – Economic Benefit Analysis**

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**Chehalis River Flood Funding Study**  
**Task 3 – Economic Benefit Analysis**

**Interviews**

Jill Kangas, Planner, Emergency Management Department (December 16, 2010).

Chuck Wallace, Deputy Director, Emergency Management Department, Grays Harbor County (December 16, 2010).

Richard Krikava, FEMA Region X (December 16 and December 21, 2010).

John Donahue, Centralia/Chehalis Flood Damage Reduction Project Manager, Washington Department of Transportation (December 7, 2010).

Glen Connelly, Environmental Programs Specialist, Chehalis Tribes (January 21, 2011).

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## Chehalis River Flood Funding Study

### Task 3 – Economic Benefit Analysis

**Table A1 - Socioeconomic Data for Selected Cities in Grays Harbor County**

Grays Harbor County Cities Year	McCleary 2000	Elma 2000	Montesano 2000	Cosmopolis 2000	Aberdeen 2000	Hoquiam 2000	Ocean Shore 2000	Westport 2000	Oakville 2000
<b>Population and Household</b>									
Total Population	1,454	3,049	3,312	1,595	16,461	9,097	3,836	2,137	675
Total Households	586	1,215	1,392	646	6,611	3,683	1,793	989	233
Average Household Size	2.48	2.51	2.38	2.47	2.49	2.47	2.14	2.16	2.90
Median Age	38	34	39	39	35	36	52	43	32
Median Income	30,769	32,031	40,204	41,106	30,683	29,658	34,643	32,037	30,357
Individuals below poverty level	260	566	377	178	3,589	1,695	470	304	116
Civilian Labor Force	597	1,192	1,463	776	7,373	3,778	1,583	925	270
Unemployment Rate	8.54%	10.15%	5.60%	6.70%	9.93%	10.69%	5.24%	7.68%	9.26%
<b>Population by Race - One Race</b>									
White (%)	94.36%	90.98%	94.99%	93.04%	84.87%	89.32%	92.44%	92.75%	293.63%
Black or African American (%)	0.21%	0.59%	0.12%	0.13%	0.47%	0.32%	0.60%	0.33%	1.04%
American Indian and Alaskan Native (%)	0.89%	1.31%	1.87%	1.76%	3.70%	3.86%	2.19%	3.09%	9.78%
Asian (%)	0.28%	1.28%	0.48%	1.50%	2.10%	1.18%	1.23%	0.94%	2.96%
Native Hawaiian and Other Pacific Islander (%)	0.00%	0.26%	0.06%	0.06%	0.14%	0.07%	0.10%	0.05%	0.15%
Some Other Race (%)	0.76%	1.64%	0.18%	1.19%	5.15%	2.09%	0.81%	0.47%	1.48%
Two or More Races (%)	3.51%	3.94%	2.29%	2.32%	3.57%	3.18%	2.63%	2.39%	7.56%
<b>Population by Race - Race alone or in combination with one or more other races</b>									
White (%)	94.43%	90.77%	94.79%	93.08%	84.82%	88.98%	92.23%	92.65%	92.65%
Black or African American (%)	0.20%	0.95%	0.47%	0.24%	0.98%	0.72%	0.86%	0.41%	0.41%
American Indian and Alaskan Native (%)	3.12%	3.12%	3.12%	3.06%	5.24%	5.60%	3.44%	4.75%	4.75%
Asian (%)	0.60%	1.98%	0.94%	1.78%	2.61%	1.73%	1.82%	1.19%	1.19%
Native Hawaiian and Other Pacific Islander (%)	0.00%	0.35%	0.12%	0.12%	0.34%	0.46%	0.43%	0.18%	0.18%
Some Other Race (%)	1.66%	2.84%	0.56%	1.71%	6.01%	2.51%	1.21%	0.82%	0.82%
<b>Population by Race - Hispanic or Latino and Race</b>									
Hispanic or Latino (of any race)	2.20%	3.64%	1.84%	3.32%	9.22%	5.75%	1.75%	2.99%	2.99%
Not Hispanic or Latino	97.80%	96.36%	98.16%	96.68%	90.78%	94.25%	98.25%	97.01%	97.01%
White Alone	93.12%	89.34%	93.72%	91.72%	82.19%	86.45%	91.55%	90.64%	90.64%
<b>Housing Characteristics</b>									
Occupied Housing Units (%)	95.20%	89.85%	94.18%	94.71%	86.48%	90.48%	56.44%	72.39%	89.62%
Vacant Housing Units (%)	4.80%	10.15%	5.82%	5.29%	13.52%	9.52%	13.91%	27.61%	10.38%
Owner-Occupied Units (%)	63.96%	54.98%	69.08%	82.02%	58.42%	57.34%	100.00%	65.01%	67.38%
Renter-Occupied Units	36.04%	45.02%	30.92%	17.98%	41.58%	42.66%	75.35%	34.99%	32.62%
Total Housing Units (#)	583	1,330	1,408	681	7,536	4,023	3,170	1,358	260

**Notes:** Total households and unemployment rate were calculated; 2000 Census did not have that exact data;

households might be a little high, since typically total population is a little higher than household population.

The 2000 census did not provide race data with Hispanic/Latino separated from other races; the Hispanic/Latino data was either mixed in with other races, or not separated from other races.

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# **Chehalis River Flood Funding Study**

## **Task 3 – Economic Benefit Analysis**

**Table A1 - Socioeconomic Data for Selected Cities in Thurston County**

Thurston County Cities Year	Yelm 2000	Rainier 2000	Tenino 2000	Bucoda 2000	Lacey 2000	Olympia 2000	Olympia 2008	Tumwater 2000
<b>Population and Household</b>								
Total Population	3,289	1,492	1,447	628	31,226	42,514	46,529	12,698
Total Households	1,232	529	574	219	12,642	19,237	20,045	5,772
Average Household Size	2.67	2.82	2.52	2.87	2.47	2.21	2.28	2.20
Median Age	31	34	34	34	34	36	35	36
Median Income	39,453	42,955	34,526	34,286	43,848	40,846	50,843	43,329
Individuals below poverty level	333	100	132	162	2,798	4,982	7,259	1,060
Civilian Labor Force	1,566	717	671	285	14,919	22,877	26,014	6,873
Unemployment Rate	9.58%	7.81%	7.75%	14.39%	6.57%	4.95%	5.10%	5.47%
<b>Population by Race - One Race</b>								
White (%)	86.17%	92.56%	90.53%	92.04%	78.19%	85.26%	85.75%	88.41%
Black or African American (%)	1.79%	0.54%	0.83%	0.00%	4.77%	1.89%	2.59%	1.39%
American Indian and Alaskan Native (%)	2.22%	1.81%	1.17%	0.80%	1.33%	1.30%	0.94%	1.24%
Asian (%)	1.73%	0.74%	3.11%	2.71%	7.76%	5.82%	6.15%	3.90%
Native Hawaiian and Other Pacific Island	1.16%	0.27%	0.07%	0.32%	1.06%	0.29%	0.21%	0.36%
Some Other Race (%)	1.58%	0.80%	1.94%	1.27%	2.16%	1.68%	1.48%	1.50%
Two or More Races (%)	5.35%	3.28%	2.35%	3.34%	4.72%	3.76%	2.88%	3.21%
<b>Population by Race - Race alone or in combination with one or more other races</b>								
White (%)	86.07%	92.37%	90.24%	92.30%	78.17%	85.09%	85.37%	88.27%
Black or African American (%)	2.53%	0.65%	1.35%	0.00%	5.66%	2.59%	3.39%	1.91%
American Indian and Alaskan Native (%)	4.14%	3.75%	2.22%	2.77%	2.42%	2.43%	1.83%	2.22%
Asian (%)	2.90%	1.68%	3.64%	2.77%	9.24%	6.86%	7.24%	4.74%
Native Hawaiian and Other Pacific Island	1.38%	0.32%	0.27%	0.31%	1.46%	0.64%	0.53%	0.65%
Some Other Race (%)	2.99%	1.23%	2.29%	1.85%	3.05%	2.39%	1.64%	2.21%
<b>Population by Race - Hispanic or Latino and Race</b>								
Hispanic or Latino (of any race)	5.35%	3.89%	3.80%	2.06%	5.90%	4.38%	5.97%	4.08%
Not Hispanic or Latino	94.65%	96.11%	96.20%	97.46%	94.10%	95.62%	94.03%	95.92%
White Alone	83.31%	90.21%	89.29%	91.28%	75.45%	83.13%	81.85%	86.27%
<b>Housing Characteristics</b>								
Occupied Housing Units (%)	91.91%	96.19%	93.50%	92.80%	94.67%	94.59%	94.64%	95.06%
Vacant Housing Units (%)	8.09%	3.81%	6.50%	7.20%	5.33%	5.41%	5.36%	4.94%
Owner-Occupied Units (%)	55.35%	80.57%	68.52%	69.41%	55.53%	50.32%	50.73%	48.22%
Renter-Occupied Units	44.65%	19.43%	31.48%	30.59%	44.47%	49.68%	49.27%	51.78%
Total Housing Units (#)	1,323	551	615	236	13,160	19,738	21,181	5,953

**Notes:** Total households and unemployment rate were calculated except for 2008 Olympia data; 2000 Census did not have that exact data;

households might be a little high, since typically total population is a little higher than household population.

2008 Olympia individuals below poverty level were calculated, the 2008 estimates did not specifically provide a number for this statistic.

The 2000 census did not provide race data with Hispanic/Latino separated from other races; the Hispanic/Latino data was either mixed in with other races, or not separated from other races.

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## Chehalis River Flood Funding Study

### Task 3 – Economic Benefit Analysis

**Table A1 - Socioeconomic Data for Selected Cities in Lewis County**

Lewis County Cities Year	Morton 2000	Mossyrock 2000	Toledo 2000	Vader 2000	Winlock 2000	Napavine 2000	Chehalis 2000	Centralia 2000	Pe Ell 2000
<b>Population and Household</b>									
Total Population	1,045	486	653	590	1,166	1,361	7,057	14,742	657
Total Households	450	187	251	208	419	446	2,869	6,143	248
Average Household Size	2.32	2.60	2.60	2.84	2.78	3.05	2.46	2.40	2.65
Median Age	43	32	37	36	33	29	32	37	34
Median Income	31,063	29,750	29,271	30,750	30,000	40,966	33,482	30,078	27,321
Individuals below poverty level	143	88	89	145	215	171	1,289	2,591	154
Civilian Labor Force	415	180	271	238	519	579	3,139	6,334	275
Unemployment Rate	6.27%	10.00%	7.75%	10.50%	11.37%	6.56%	10.80%	9.74%	12.36%
<b>Population by Race - One Race</b>									
White (%)	95.41%	90.33%	93.26%	93.56%	88.25%	93.02%	89.56%	89.76%	93.15%
Black or African American (%)	0.00%	0.21%	0.61%	0.00%	0.17%	0.15%	1.35%	0.44%	0.30%
American Indian and Alaskan Native (%)	1.24%	1.85%	2.30%	0.34%	0.77%	1.54%	1.46%	1.25%	2.28%
Asian (%)	0.67%	0.21%	0.31%	0.00%	0.77%	0.15%	1.20%	0.94%	0.91%
Native Hawaiian and Other Pacific Islander (%)	0.00%	0.21%	0.00%	0.00%	0.00%	0.29%	0.24%	0.30%	0.61%
Some Other Race (%)	0.38%	3.50%	1.53%	1.86%	6.17%	3.31%	3.95%	4.94%	1.07%
Two or More Races (%)	2.30%	3.70%	1.99%	4.24%	3.86%	1.54%	2.24%	2.38%	1.67%
<b>Population by Race - Race alone or in combination with one or more other races</b>									
White (%)	95.14%	89.92%	93.24%	93.61%	88.52%	92.91%	89.59%	89.68%	92.99%
Black or African American (%)	0.00%	0.20%	0.75%	0.17%	0.83%	0.51%	1.55%	0.67%	0.30%
American Indian and Alaskan Native (%)	2.52%	3.16%	3.45%	2.02%	1.98%	1.81%	2.38%	2.14%	3.28%
Asian (%)	1.21%	0.59%	0.45%	0.34%	0.83%	0.72%	1.44%	1.23%	0.90%
Native Hawaiian and Other Pacific Islander (%)	0.09%	0.20%	0.00%	0.34%	0.00%	0.43%	0.42%	0.56%	0.60%
Some Other Race (%)	1.03%	5.93%	2.10%	3.53%	7.84%	3.62%	4.63%	5.72%	1.94%
<b>Population by Race - Hispanic or Latino and Race</b>									
Hispanic or Latino (of any race)	1.15%	6.79%	4.90%	6.61%	8.58%	5.73%	7.91%	10.22%	2.28%
Not Hispanic or Latino	98.85%	93.21%	95.10%	93.39%	91.42%	94.27%	93.51%	89.78%	97.72%
White Alone	94.64%	88.48%	90.35%	88.98%	86.96%	91.04%	86.24%	85.31%	92.09%
<b>Housing Characteristics</b>									
Occupied Housing Units (%)	89.73%	86.98%	93.64%	90.43%	90.91%	93.67%	93.03%	91.29%	85.81%
Vacant Housing Units (%)	10.27%	13.02%	6.36%	9.57%	9.09%	6.33%	6.97%	8.71%	14.19%
Owner-Occupied Units (%)	65.68%	63.64%	64.15%	81.25%	65.95%	78.15%	50.69%	55.33%	78.63%
Renter-Occupied Units	34.32%	36.36%	35.85%	18.75%	34.05%	21.85%	49.31%	44.67%	21.37%
Total Housing Units (#)	487	215	283	230	462	474	2,871	6,510	289

**Notes:** Total households and unemployment rate were calculated; 2000 Census did not have that exact data;

households might be a little high, since typically total population is a little higher than household population.

The 2000 census did not provide race data with Hispanic/Latino separated from other races; the Hispanic/Latino data was either mixed in with other races, or not separated from other races.

**Chehalis River Flood Funding Study**  
**Task 3 – Economic Benefit Analysis**

**Appendix Table B1 - Grays Harbor County**  
**IMPLAN Analysis based on Jobs in Floodplain (Annual Benefits in 2009 \$)**

<b>Agriculture, Forestry, Fishing and Hunting</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	172	\$7,617,680	\$9,105,975	\$18,616,656
Indirect Effect	47.5	\$2,150,135	\$3,306,925	\$6,592,186
Induced Effect	40.1	\$1,469,887	\$2,595,317	\$4,300,566
Total Effect	259.6	\$11,237,702	\$15,008,218	\$29,509,408
<b>Utilities</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	195	\$4,951,184	\$20,804,286	\$190,169,935
Indirect Effect	367.4	\$15,249,346	\$24,228,787	\$46,260,002
Induced Effect	79.1	\$2,906,437	\$5,123,700	\$8,503,295
Total Effect	641.5	\$23,106,967	\$50,156,773	\$244,933,231
<b>Construction</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	649	\$33,363,918	\$39,142,004	\$84,282,099
Indirect Effect	126.6	\$5,228,466	\$8,808,990	\$16,290,248
Induced Effect	150	\$5,513,875	\$9,720,330	\$16,131,720
Total Effect	925.6	\$44,106,260	\$57,671,325	\$116,704,068
<b>Manufacturing</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	817	\$57,349,472	\$88,707,106	\$333,459,314
Indirect Effect	535.5	\$25,750,759	\$39,742,684	\$85,604,072
Induced Effect	326.5	\$11,999,988	\$21,160,195	\$35,108,181
Total Effect	1,679.10	\$95,100,219	\$149,609,984	\$454,171,567
<b>Wholesale Trade</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	220	\$12,502,378	\$21,586,305	\$32,143,679
Indirect Effect	40.3	\$1,746,230	\$3,060,940	\$5,348,242
Induced Effect	55.1	\$2,026,074	\$3,571,221	\$5,927,579
Total Effect	315.4	\$16,274,681	\$28,218,467	\$43,419,500
<b>Retail Trade</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	1,403.00	\$45,564,679	\$73,013,327	\$85,479,412
Indirect Effect	46.5	\$1,912,671	\$3,992,008	\$6,790,930
Induced Effect	183.3	\$6,740,094	\$11,880,585	\$19,719,113
Total Effect	1,632.80	\$54,217,443	\$88,885,920	\$111,989,456
<b>Transportation and Warehousing</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	218	\$9,899,352	\$13,150,143	\$26,598,271
Indirect Effect	43.2	\$1,878,574	\$3,080,219	\$5,975,375
Induced Effect	46.8	\$1,719,880	\$3,033,802	\$5,031,872
Total Effect	308	\$13,497,806	\$19,264,164	\$37,605,518

**Chehalis River Flood Funding Study**  
**Task 3 – Economic Benefit Analysis**

**Appendix Table B1 – Grays Harbor County (continued)**

<b>Information</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	163	\$7,555,493	\$18,097,403	\$34,607,946
Indirect Effect	47.9	\$1,814,741	\$3,577,312	\$6,436,038
Induced Effect	35.6	\$1,308,359	\$2,304,742	\$3,827,739
Total Effect	246.5	\$10,678,593	\$23,979,456	\$44,871,724
<b>Finance and Insurance</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	457	\$26,559,857	\$53,694,904	\$97,571,107
Indirect Effect	143.6	\$6,122,247	\$11,698,875	\$20,747,282
Induced Effect	132.3	\$4,856,462	\$8,570,651	\$14,208,800
Total Effect	732.9	\$37,538,565	\$73,964,430	\$132,527,189
<b>Real Estate and Rental and Leasing</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	95	\$1,677,656	\$31,122,294	\$44,071,247
Indirect Effect	43.3	\$1,806,736	\$4,095,736	\$6,961,475
Induced Effect	14.1	\$519,358	\$916,409	\$1,519,517
Total Effect	152.4	\$4,003,750	\$36,134,439	\$52,552,238
<b>Professional, Scientific, and Technical Services</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	140	\$6,079,389	\$8,705,879	\$12,963,720
Indirect Effect	14.4	\$522,977	\$1,050,619	\$1,825,076
Induced Effect	26.4	\$969,552	\$1,710,648	\$2,836,642
Total Effect	180.8	\$7,571,918	\$11,467,145	\$17,625,438
<b>Management of Companies and Enterprises</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	6	\$581,044	\$708,011	\$1,163,566
Indirect Effect	1.4	\$53,030	\$109,079	\$183,082
Induced Effect	2.4	\$88,072	\$155,130	\$257,663
Total Effect	9.8	\$722,146	\$972,219	\$1,604,311
<b>Administration &amp; Support, Waste Management and Remediation</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	231	\$7,819,553	\$10,991,912	\$19,618,638
Indirect Effect	29.6	\$1,096,456	\$1,981,032	\$3,636,585
Induced Effect	34.2	\$1,259,294	\$2,219,199	\$3,684,230
Total Effect	294.9	\$10,175,303	\$15,192,144	\$26,939,453
<b>Educational Services</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	1,078.00	\$17,038,628	\$22,760,205	\$41,559,451
Indirect Effect	56.2	\$2,238,552	\$5,128,729	\$8,824,910
Induced Effect	75.3	\$2,767,852	\$4,880,209	\$8,097,825
Total Effect	1,209.50	\$22,045,032	\$32,769,143	\$58,482,185

# Chehalis River Flood Funding Study

## Task 3 – Economic Benefit Analysis

**Appendix Table B1 – Grays Harbor County (continued)**

<b>Health Care and Social Assistance</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	573	\$27,912,274	\$29,880,324	\$53,592,504
Indirect Effect	70	\$2,821,026	\$6,137,959	\$10,631,247
Induced Effect	118.1	\$4,342,323	\$7,652,720	\$12,704,043
Total Effect	761.1	\$35,075,624	\$43,671,003	\$76,927,794
<b>Arts, Entertainment, and Recreation</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	122	\$1,878,979	\$3,354,323	\$5,887,377
Indirect Effect	11.1	\$360,859	\$675,639	\$1,169,746
Induced Effect	8.7	\$318,813	\$561,960	\$932,736
Total Effect	141.8	\$2,558,650	\$4,591,922	\$7,989,859
<b>Accommodation and Food Services</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	754	\$14,861,809	\$22,192,505	\$44,728,385
Indirect Effect	70.2	\$2,907,323	\$5,421,417	\$9,906,053
Induced Effect	68.4	\$2,515,024	\$4,432,442	\$7,358,046
Total Effect	892.6	\$20,284,155	\$32,046,364	\$61,992,484
<b>Other Services (excluding Public Administration)</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	442	\$12,013,875	\$13,197,402	\$23,746,763
Indirect Effect	32.5	\$1,312,150	\$2,663,355	\$4,697,863
Induced Effect	53.6	\$1,969,525	\$3,475,574	\$5,762,316
Total Effect	528.1	\$15,295,550	\$19,336,332	\$34,206,941
<b>Public Administration</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	470	\$23,855,930	\$27,019,286	\$43,972,929
Indirect Effect	43.3	\$1,911,568	\$3,236,335	\$6,207,626
Induced Effect	97	\$3,569,405	\$6,286,863	\$10,442,597
Total Effect	610.3	\$29,336,903	\$36,542,485	\$60,623,151
<b>Total</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	8,205	319,083,150	507,233,594	1,194,232,999
Indirect Effect	1,771	76,883,846	131,996,640	254,088,038
Induced Effect	1,547	56,860,274	100,251,697	166,354,480
Total Effect	11,523	452,827,267	739,481,933	1,614,675,515

**Chehalis River Flood Funding Study**  
**Task 3 – Economic Benefit Analysis**

**Appendix Table B2 - Lewis County**

**IMPLAN Analysis based on Jobs in Floodplain (Annual Benefits in 2009 \$)**

<b>Agriculture, Forestry, Fishing and Hunting</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	24	\$785,116	\$892,697	\$2,018,379
Indirect Effect	6.7	\$238,755	\$375,060	\$737,123
Induced Effect	4.8	\$173,516	\$306,373	\$492,411
Total Effect	35.6	\$1,197,387	\$1,574,129	\$3,247,913
<b>Mining, Quarrying, and Oil and Gas Extraction</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	85	\$5,836,798	\$12,485,708	\$24,642,337
Indirect Effect	28.5	\$1,291,879	\$2,898,422	\$4,982,118
Induced Effect	33.1	\$1,188,655	\$2,097,772	\$3,373,264
Total Effect	146.6	\$8,317,331	\$17,481,901	\$32,997,720
<b>Utilities</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	257	\$37,895,119	\$130,703,480	\$203,070,577
Indirect Effect	233.9	\$10,132,363	\$16,750,010	\$31,288,248
Induced Effect	221.2	\$7,936,005	\$14,002,302	\$22,521,587
Total Effect	712	\$55,963,487	\$161,455,792	\$256,880,412
<b>Construction</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	221	\$10,463,160	\$12,282,273	\$27,434,685
Indirect Effect	44	\$1,601,084	\$2,678,902	\$4,345,499
Induced Effect	57.1	\$2,044,394	\$3,609,495	\$5,801,701
Total Effect	322.1	\$14,108,637	\$18,570,670	\$37,581,885
<b>Manufacturing</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	249	\$14,151,575	\$19,961,681	\$72,323,041
Indirect Effect	116.1	\$4,835,297	\$7,988,872	\$14,975,272
Induced Effect	87.6	\$3,144,989	\$5,549,038	\$8,925,177
Total Effect	452.70	\$22,131,862	\$33,499,591	\$96,223,490
<b>Wholesale Trade</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	143	\$77,226,186	\$133,120,647	\$199,400,428
Indirect Effect	303.1	\$12,003,730	\$20,520,043	\$34,827,242
Induced Effect	414.7	\$14,872,473	\$26,246,465	\$42,206,418
Total Effect	860.80	\$104,102,389	\$179,887,155	\$276,434,089
<b>Retail Trade</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	1,494.00	\$45,934,358	\$72,838,685	\$85,352,186
Indirect Effect	55.8	\$2,140,927	\$4,442,617	\$7,329,291
Induced Effect	224.2	\$8,037,298	\$14,186,140	\$22,808,832
Total Effect	1,774.00	\$56,112,582	\$91,467,442	\$115,490,310

**Chehalis River Flood Funding Study**  
**Task 3 – Economic Benefit Analysis**
**Appendix Table B2 – Lewis County (continued)**

<b>Transportation and Warehousing</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	49	\$2,272,179	\$2,975,723	\$5,877,234
Indirect Effect	11.1	\$448,481	\$716,392	\$1,273,345
Induced Effect	12.9	\$462,233	\$816,138	\$1,311,751
Total Effect	73	\$3,182,893	\$4,508,253	\$8,462,330
<b>Information</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	4	\$214,292	\$482,824	\$925,230
Indirect Effect	1.5	\$51,463	\$96,271	\$167,607
Induced Effect	1.2	\$44,346	\$78,258	\$125,848
Total Effect	6.7	\$310,101	\$657,353	\$1,218,685
<b>Finance and Insurance</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	25	\$1,190,587	\$2,446,807	\$4,526,882
Indirect Effect	7.4	\$274,127	\$509,573	\$905,042
Induced Effect	7	\$251,908	\$444,904	\$714,876
Total Effect	39.4	\$1,716,622	\$3,401,285	\$6,146,801
<b>Real Estate and Rental and Leasing</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	42	\$798,488	\$13,697,301	\$19,419,016
Indirect Effect	21.8	\$807,008	\$1,868,725	\$3,122,830
Induced Effect	7.9	\$281,002	\$496,408	\$797,439
Total Effect	71.7	\$1,886,497	\$16,062,433	\$23,339,285
<b>Professional, Scientific, and Technical Services</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	60	\$2,342,223	\$2,900,864	\$4,656,071
Indirect Effect	7.2	\$239,214	\$459,793	\$779,290
Induced Effect	12.6	\$448,790	\$792,929	\$1,273,580
Total Effect	79.7	\$3,030,227	\$4,153,586	\$6,708,941
<b>Management of Companies and Enterprises</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	48	\$3,001,373	\$3,655,341	\$7,016,391
Indirect Effect	12.3	\$432,604	\$846,677	\$1,410,584
Induced Effect	15.8	\$565,527	\$997,671	\$1,604,915
Total Effect	76.1	\$3,999,503	\$5,499,689	\$10,031,890
<b>Administration &amp; Support, Waste Management and Remediation</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	14	\$359,196	\$485,508	\$841,840
Indirect Effect	1.5	\$49,097	\$85,923	\$149,541
Induced Effect	1.9	\$68,875	\$121,588	\$195,457
Total Effect	17.4	\$477,168	\$693,019	\$1,186,837

**Chehalis River Flood Funding Study**  
**Task 3 – Economic Benefit Analysis**

**Appendix Table B2 – Lewis County (continued)**

<b>Educational Services</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	108	\$1,949,190	\$2,353,086	\$4,318,794
Indirect Effect	6.1	\$245,756	\$642,896	\$1,025,237
Induced Effect	10.2	\$366,164	\$646,226	\$1,039,131
Total Effect	124.30	\$2,561,110	\$3,642,209	\$6,383,162
<b>Health Care and Social Assistance</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	1,341	\$68,015,933	\$74,526,443	\$132,988,319
Indirect Effect	197.1	\$7,189,387	\$15,682,015	\$25,684,276
Induced Effect	350.6	\$12,570,879	\$22,187,195	\$35,674,625
Total Effect	1,888.70	\$87,776,200	\$112,395,654	\$194,347,221
<b>Arts, Entertainment, and Recreation</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	62	\$738,318	\$1,083,604	\$2,150,929
Indirect Effect	5.6	\$163,700	\$303,264	\$515,854
Induced Effect	4.2	\$150,448	\$265,507	\$426,955
Total Effect	71.8	\$1,052,466	\$1,652,375	\$3,093,738
<b>Accommodation and Food Services</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	655	\$13,399,140	\$19,407,608	\$38,457,603
Indirect Effect	62.8	\$2,405,266	\$4,786,798	\$7,955,722
Induced Effect	73.2	\$2,626,859	\$4,635,471	\$7,454,742
Total Effect	791	\$18,431,265	\$28,829,877	\$53,868,067
<b>Other Services (excluding Public Administration)</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	150	\$4,127,503	\$4,679,864	\$10,511,225
Indirect Effect	20.4	\$736,436	\$1,490,898	\$2,502,345
Induced Effect	23.7	\$846,015	\$1,494,712	\$2,400,833
Total Effect	194	\$5,709,954	\$7,665,473	\$15,414,403
<b>Public Administration</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	312	\$16,431,398	\$18,595,786	\$25,215,200
Indirect Effect	18.9	\$786,490	\$1,422,468	\$2,459,557
Induced Effect	78.8	\$2,827,423	\$4,988,036	\$8,023,961
Total Effect	409.7	\$20,045,312	\$25,006,290	\$35,698,718
<b>Total</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	5,343	307,132,132	529,575,930	871,146,367
Indirect Effect	1,162	46,073,064	84,565,619	146,436,023
Induced Effect	1,643	58,907,799	103,962,628	167,173,503
Total Effect	8,147	412,112,993	718,104,176	1,184,755,897

**Chehalis River Flood Funding Study**  
**Task 3 – Economic Benefit Analysis**

**Appendix Table B3 – Thurston County**  
**IMPLAN Analysis based on Jobs in Floodplain (Annual Benefits in 2009 \$)**

<b>Agriculture, Forestry, Fishing and Hunting</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	145	\$6,583,144	\$8,190,519	\$15,804,001
Indirect Effect	20.3	\$978,582	\$1,826,079	\$3,037,194
Induced Effect	34.2	\$1,360,735	\$2,478,167	\$3,763,406
Total Effect	199.4	\$8,922,461	\$12,494,765	\$22,604,601
<b>Construction</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	14	\$720,240	\$846,291	\$1,820,585
Indirect Effect	2.6	\$117,339	\$191,490	\$293,483
Induced Effect	3.8	\$150,476	\$273,949	\$416,099
Total Effect	20.4	\$988,055	\$1,311,731	\$2,530,168
<b>Wholesale Trade</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	31	\$2,849,024	\$4,903,943	\$7,140,116
Indirect Effect	10.2	\$522,613	\$862,921	\$1,357,534
Induced Effect	15	\$599,806	\$1,090,977	\$1,657,811
Total Effect	56.20	\$3,971,443	\$6,857,840	\$10,155,461
<b>Retail Trade</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	12	\$369,663	\$581,572	\$680,924
Indirect Effect	0.4	\$19,747	\$39,533	\$61,057
Induced Effect	1.7	\$69,333	\$126,143	\$191,657
Total Effect	14.20	\$458,743	\$747,248	\$933,638
<b>Transportation and Warehousing</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	16	\$717,014	\$981,530	\$1,840,705
Indirect Effect	2.7	\$124,448	\$203,117	\$324,202
Induced Effect	3.8	\$151,193	\$275,241	\$418,071
Total Effect	22.5	\$992,655	\$1,459,888	\$2,582,978
<b>Real Estate and Rental and Leasing</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	5	\$80,959	\$1,395,923	\$1,963,757
Indirect Effect	2.3	\$101,608	\$224,044	\$363,074
Induced Effect	0.8	\$33,094	\$60,250	\$91,513
Total Effect	8.2	\$215,661	\$1,680,216	\$2,418,343
<b>Administration &amp; Support, Waste Management and Remediation</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	3	\$75,773	\$96,541	\$168,894
Indirect Effect	0.3	\$11,346	\$19,380	\$31,718
Induced Effect	0.4	\$15,623	\$28,437	\$43,196
Total Effect	3.7	\$102,741	\$144,358	\$243,808

**Chehalis River Flood Funding Study**  
**Task 3 – Economic Benefit Analysis**

**Appendix Table B3 – Thurston County (continued)**

<b>Health Care and Social Assistance</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	5	\$265,486	\$288,823	\$495,562
Indirect Effect	0.7	\$32,130	\$66,651	\$104,192
Induced Effect	1.3	\$53,182	\$96,783	\$147,031
Total Effect	7.10	\$350,798	\$452,257	\$746,784
<b>Accommodation and Food Services</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	9	\$198,427	\$289,773	\$557,644
Indirect Effect	0.9	\$44,050	\$79,414	\$122,503
Induced Effect	1.1	\$43,207	\$78,601	\$119,430
Total Effect	11	\$285,684	\$447,788	\$799,576
<b>Other Services (excluding Public Administration)</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	16	\$639,663	\$701,219	\$1,101,627
Indirect Effect	1.4	\$62,335	\$122,017	\$195,297
Induced Effect	3.2	\$126,245	\$229,885	\$349,133
Total Effect	20.6	\$828,244	\$1,053,121	\$1,646,057
<b>Public Administration</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	286	\$17,457,956	\$19,799,845	\$21,145,262
Indirect Effect	3	\$143,546	\$239,538	\$379,518
Induced Effect	77.9	\$3,115,591	\$5,665,625	\$8,610,224
Total Effect	366.9	\$20,717,093	\$25,705,008	\$30,135,004
<b>Total</b>				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	542	29,957,349	38,075,979	52,719,077
Indirect Effect	45	2,157,744	3,874,184	6,269,772
Induced Effect	143	5,718,485	10,404,058	15,807,571
Total Effect	730	37,833,578	52,354,220	74,796,418