

Economic Connections Between the King County Floodplains and the Greater King County Economy

Prepared for

King County Water and Land Resources Division

by

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Executive Summary

King County Water and Land Resources Division (“the Division”) contracted with ECONorthwest to address the regional economic benefits related to implementing the countywide 2006 King County Flood Hazard Management Plan. Given time and resource constraints, the analysis focuses on evaluating the regional economic benefits by analyzing the level of economic activity that exists in the King County floodplains, the degree to which economic activity in the floodplains is connected to the greater King County economy, and the importance of economic activity in the floodplains to the economic vitality of the county.

The analysis is composed of three related sub-analyses which examine: (1) employment and payroll in the floodplain areas, (2) the potential short-run impact to the countywide economy of a one-day work stoppage in the floodplain areas (as a proxy for a flood event), and (3) the long-run impact to the countywide economy of a permanent change (either positive or negative) in aerospace employment within the floodplain areas.

Each of the analyses describes the interactions among economic activities (for example the activities of households, businesses, and government) that occur in the floodplain areas and their interactions with the rest of the County. The results of the three analyses are not cumulative. They cannot be summed together to provide an overall effect or impact. Rather, each of the analyses is intended to provide a different view of the extent to which the economy of the floodplain areas is part of the larger King County economy and the extent to which a change in the level of economic activity in the floodplain would have immediate and potentially long lasting effects on the countywide economy.

SUMMARY OF FINDINGS

The three separate sub analyses indicate that there is substantial economic interaction between the floodplains and the rest of King County, and suggest that there are economic benefits to the County of protecting the floodplain.

- **The floodplain region has greater importance to the County as a commercial center than as a residential center.** The region has many jobs but relatively few residents. Because the floodplain region employees many people who live elsewhere in King County, the benefits of flood hazard management accrues beyond the floodplain areas, to the entire County economy.
- Approximately 2% of King County’s population lives in the floodplain (32,000 persons). Most employees working in floodplain areas commute from other parts of King County or surrounding counties.
- Approximately 6% of the county’s employment is located in the floodplain region (65,000 jobs).

- 20% of the County’s total manufacturing employment and 30% of the County’s aerospace employment is located in the floodplains.
- Manufacturing pays wages higher than the County average and aerospace pays the highest wages of any employment sector in King County.
- Nearly 7% of King County’s total annual wage and salary income is generated within the floodplain (\$3.7 billion).
- **A one-day shutdown of economic activity in the King County floodplain areas would result in at least \$46 million in foregone economic output in King County.** Economic output in the floodplain region would decline by \$43 million. Economic output from businesses located in King County, but outside the floodplain would decline by \$3 million. This is a conservative estimate because it does not account for impacts associated with persons living inside the floodplains who are unable to commute to jobs outside floodplain areas, businesses outside that rely on goods and services produced by businesses inside floodplain areas, the value of damaged or destroyed property or equipment, and multi-day flood impacts.
 - Much of the effect of an economic shock (flood) would be felt in foregone wages paid to employees. Most of these workers live outside the floodplains, in other King County communities.
 - Business income and taxes paid to state and local governments throughout the County would be also be negatively impacted.
 - The ten industry sectors in King County, located outside floodplain areas, most clearly affected by a shutdown in economic activity in the floodplain, are all oriented toward business services, pay wages that are higher than the County average, and are predominately located in the County’s major cities.
- **A change in aerospace employment within the floodplain would have long-term impacts on employment and personal income growth in King County and the Puget Sound region.**
 - Aerospace employment in the Puget Sound region has a positive causal relationship to employment in other sectors of the economy.
 - Thirty percent of King County’s aerospace employment is located in the floodplains (30%).
 - Public investment in flood hazard management would likely affect long-term business location decisions of aerospace manufacturers currently located in the floodplains.

- A 10% change in aerospace employment in the King County floodplains would lead to a \$160 million change in personal income in King County.

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The King County Water and Land Resources Division contracted with ECONorthwest to study the regional economic benefits related to implementing King County's 2006 Flood Hazard Management Plan.¹ Due to limited time and resources, the analysis does not attempt to quantify the full suite of benefits brought about by the flood plan. The purpose of the economic analysis is to demonstrate the economic importance to the region of protecting the floodplains. It does this by providing information about the level of economic activity that exists in the King County floodplains, the degree to which economic activity in the floodplains is connected to the greater King County economy, and the particular importance of the floodplains to the economic vitality of the region. The analysis is composed of three related sub-analyses:

Sub-analysis 1, Employment & Payroll Data: estimate employment levels and annual payroll by major industry sector for the floodplain regions of King County and compare those levels to all of King County. The results of this sub-analysis will inform the county about the economic structure of the floodplains relative to the rest of the county. For example, is the distribution of employment by industry sector in the floodplains similar to that observed for all of King County?² Does the average annual wage paid to an employee working in the floodplain differ from the countywide average? This is an especially important issue as the economic efficiency of protecting employment from disruption due to flooding increases as the value (based on wage levels) of employment increases.

Sub-analysis 2, Input-Output Model: develop input-output economic models for the King County floodplains using IMPLAN software.³ Using these sub-county models and a corresponding economic model for all of King County, estimate the impact of an economic shock—negative or positive—occurring within the floodplains. The purpose of this analysis is to estimate the economic impact to the floodplain “sub-economy,” the economic impact that spills over into the rest of King County, and the economic impact that spills out of King County. The results of this sub-analysis will provide information about the degree to which a disruption in economic activity within the floodplain will affect business activity located outside the floodplain, but in King County.⁴

¹ To learn more about the 2006 King County Flood Hazard Management Plan please click on the following link:
<http://dnr.metrokc.gov/wlr/flood/fhmp/>

² County employment levels are based on covered employment reported by the Washington Department of Employment Security.

³ Input-output modeling is an economic modeling framework that provides an empirical representation of a local or regional economy based on the observed relationships among the various industry sectors, final consumers, and the greater (regional or national) economy.

⁴ Although we have not extended the IMPLAN model to examine the economic impacts that spill out of King County, but remain in the Puget Sound region (i.e., Pierce, Snohomish, Kitsap counties), doing so would be relatively straightforward.

Sub-analysis 3, Long-term Aviation Employment Impacts: examine the impact that a small (permanent) change in aviation employment in the floodplains would have on the long-term economic growth of King County and the Puget Sound Region. While the business decision on where to site aviation manufacturing activities depends on a suite of factors, one of these factors is likely to be the degree to which the area has sound infrastructure and is less prone to disruptive disasters such as floods.

This sub-analysis relies on the Puget Sound Economic and Demographic Forecasting Model (“the forecasting model”), developed by ECONorthwest for the Puget Sound Regional Council (PSRC). The forecasting model is a theoretically-based, macro-economic representation of the regional economy. Aviation employment is considered exogenous to the regional economy due to its overwhelming reliance on national and international economic forces. Because of this unique characterization within the model framework, we are able to consider the long-term economic impact to the rest of the regional economy due to a change in aviation employment levels. For sub-analysis 3, we consider the long-term impact to King County and the entire Puget Sound region from a 10% change (either positive or negative) in aviation employment in the flood plain areas of King County. There are two opposite and competing counterfactual scenarios that one might consider.

- a. **The Flood Hazard Management Plan is implemented:** Aviation sector manufacturers perceive the King County floodplains to be safer from severe flooding, leading to increased investment in manufacturing capacity in the floodplains (or anywhere else in the region).
- b. **The Flood Hazard Management Plan is not implemented:** Aviation sector manufacturers perceive the King County floodplains to be insufficiently safe from severe flooding (relative to manufacturing centers outside of the Puget Sound region), leading to a dislocation of manufacturing capacity to a region outside of King County or Washington State.

The results of these counterfactual scenarios are compared to the baseline forecast developed for PSRC to obtain estimates of the economic impacts to the King County and Puget Sound regional economies of a change in aviation employment within the flood plain regions of King County.⁵ Of particular importance in this analysis are the impacts to total employment and real personal income within King County and the Puget Sound Region.

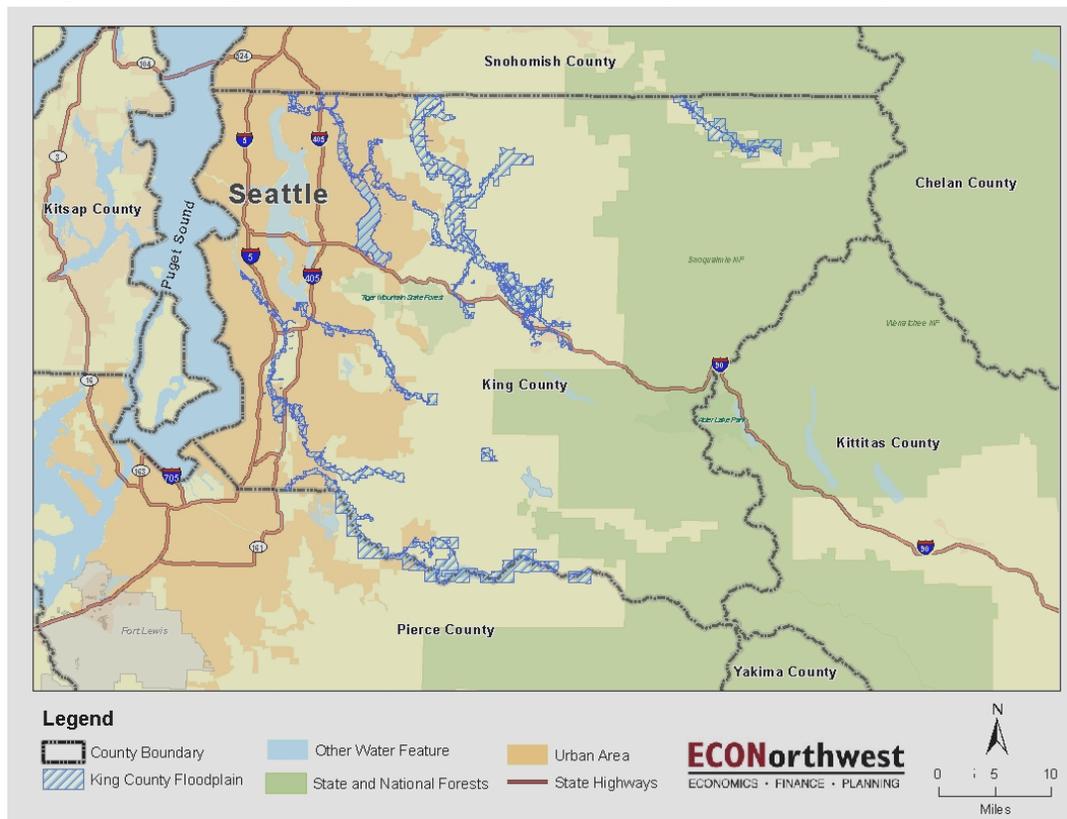
⁵ Again, an underlying assumption in this analysis is that the change in employment (either positive or negative) is a net change for the entire region. That is, a hypothetical increase (decrease) in employment is not a shift from (to) another part of the Puget Sound region.

The effects of a major flood event would affect the entire Puget Sound region, because of its economic integration. The focus of the report, however, is narrowed to King County because this analysis is being conducted for King County.⁶ Understanding (a) the economic interactions between the floodplain areas and the rest of the county, and (b) the economic impacts to King County associated with economic activities within the floodplain areas are very important when considering public investment in flood protection infrastructure.

THE STUDY AREA

Figure 1 shows the floodplains in King County based on GIS data sent to ECONorthwest by the Division. Based on our analysis, only about 5% of the county is covered by the mapped floodplains. Most of the floodplain areas are located in the western, more developed portion of the county, with a small, relatively undeveloped floodplain area in the northeastern corner of the county.

Figure 1: King County, the 100-Year Floodplains, and Adjacent Counties*



*Kitsap, Pierce, and Snohomish counties, along with King County, represent the Puget Sound region.

The floodplain areas in King County are comprised of six major river basins:

⁶ The economic impacts to the rest of the Puget Sound region (Kitsap, Pierce, and Snohomish counties) are also examined, but are not the focus of the study.

- South Fork Skykomish
- Snoqualmie
- Sammamish
- Cedar
- Green
- White

Information about each of these river basins, including location within King County, recent past flooding events, public safety and health, critical facilities, and basic economic information can be found in the 2006 King County Flood Hazard Management Plan.⁷

ORGANIZATION OF THE REPORT

The remainder of the report is organized as follows:

Chapter 2: Evaluation Framework, discusses principles used in analyzing the regional economic impacts of implementing a plan for flood management.

Chapter 3: Analysis, describes and presents the results of the analyses that were undertaken, which illustrate the economic structure of the floodplain regions of King County and why the floodplains are economically important to the rest of the county.

⁷ See URL in footnote 1.

This chapter discusses fundamental principles for evaluating public-investment decisions, with a focus on principles that directly affect the analysis of the economic impacts of implementing a plan for flood hazard management.

The *identification* of the potential effects of a large project is difficult. Estimating the *direction* of its effects (positive or negative, and on whom?) compounds the analytical challenge and estimating the *magnitude* of those effects (how big is that positive or negative impact?) often requires multiple (sub) analyses.

This chapter has two sections:

- **Goals of evaluation** discusses the broad goals of any evaluation of the full costs of a large public investment decision.
- **Key issues affecting this analysis** describes the key components of the analysis that will be taken into account when determining the economic impacts of investments in flood hazard management.

GOALS OF EVALUATION

The goal of public policy is, in broad terms, to improve the quality of life of the constituent populations. The presumption is that collective action in some areas will yield results superior to the results of no collective action. That is the justification for taxing people: government will provide some desirable services that individuals might otherwise be unable to provide by themselves (e.g., flood management infrastructure), or would not provide very efficiently (e.g., a regional highway system). In economic terms, the goal of government policy is to increase *welfare*: the economic and social well-being of the citizens it serves.

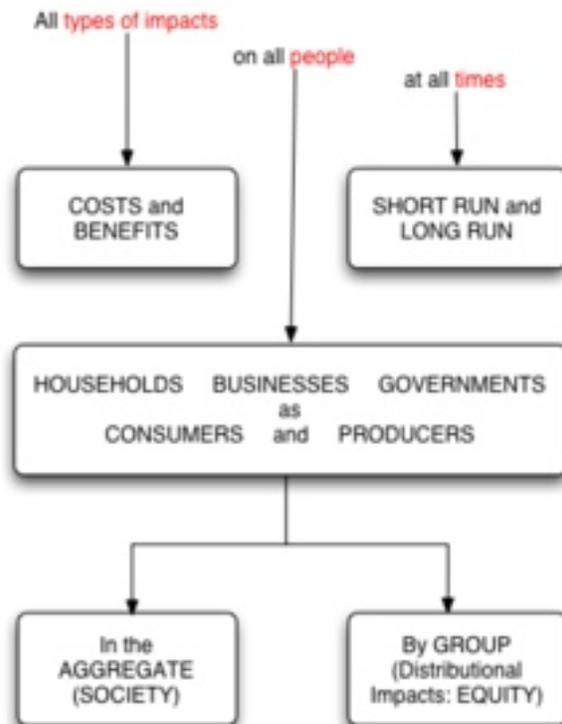
Policymakers, and the public they represent, would like to know the benefits and costs associated with public investments. They want to know what they get (benefits) for what they give up (costs). Ideally, the study should identify and quantitatively estimate the complete set of benefits associated with the investments. In practice, particularly with environmental projects, many benefits cannot be easily identified or quantified in dollar terms—such as the benefits of ecosystem services, long term benefits to public health, or other non-market benefits. This analysis does not attempt to measure or even address many of the benefits associated with the Plan. Rather, the analysis focuses only on market-based economic benefits.

To estimate the benefits of a large public investment, one must compare its benefits to what would happen without the investment. In practice, identifying the with/without scenarios can also be problematic. Without the flood management measures in place, there is an increased probability of damaging flood events. Moreover, existing structures could deteriorate further, increasing risk from

current levels. Such an analysis itself would demand complex modeling and is beyond the scope of this study.

Figure 2 illustrates the challenge for policy evaluation: to measure all types of impacts, on all types of people, over all time periods, for all the relevant areas of impact. Achieving that goal completely is impossible. One cannot know the future: there exist dozens of possibilities, given reasonable differences in assumptions. The number of possible impacts and the data and techniques for estimating them, however, overwhelm any reasonable evaluation.

Figure 2: Goals of policy evaluation: What, Who and When



Source: ECONorthwest.

Figure 2 shows the ideal policy evaluation scenario. However the ideal cannot be fully achieved in practice without substantial investment of time and resources. The practical goals of policy evaluation, therefore, are to identify important impacts to measure and to cost-effectively estimate reasonable measures of those impacts. As will be discussed below, the analysis focuses on the identification of regional (King County) economic benefits of existing land use and activities within the floodplain, using traditional market-based economic tools and procedures. Costs associated with implementing the Plan are not discussed and *net* benefits are not estimated. The identification of the regional economic importance of the existing land use and activities within the floodplains and the benefits of the flood management plan was the key question driving the analysis.

KEY ELEMENTS OF THE ANALYSIS

This study aims to demonstrate the complex and not-always-apparent linkages in the King County economy and to estimate the direction and magnitude of the benefits (or cost foregone) associated with the Flood Hazard Management Plan. Estimated economic impacts and benefits depend on the logic and assumptions those estimates are based on. This section identifies key elements of the analytical framework, and concludes with a summary of the specific sub analyses conducted.

THE BASE CASE

The future in which no new action occurs (no improved flood hazard management infrastructure) is known as ‘the base case.’ In this analysis, the ‘base case’ assumes that King County does not implement the Flood Hazard Management Plan. The differences in impacts between the base case and the alternative are the net impacts of implementing the Plan.

It is important to note that *no action* is not the same as *no change*. The no-action base case represents the world without implementing the flood risk reduction projects identified in the Plan. The environment is likely to change under the base case, and these changes should be considered, to the extent practicable, to accurately assess the impacts unique to the project. Changes will occur even without implementing the projects in the Plan because of other planned or likely projects, population growth, economic shifts, increased travel, and many other factors not directly attributable to or even related to the projects identified in the Plan. In this analysis we assume that the base case for King County is represented by the 2006 PSRC long-term forecast. It is important to note, however that the PSRC forecast implicitly assumes that the level of flood protection enjoyed by the County’s floodplains over the past three decades will continue over the next three decades, which may not be the case if the Plan is not implemented. Because of this, the base case may actually overstate the benefits of not implementing the Plan.

ATTRIBUTION OF CAUSALITY

Establishing a base case affects an analyst’s ability to properly identify cause-and-effect relationships. Attributing effects to causes, and doing so only once (i.e., avoiding double counts), is essential to evaluating impacts.

Properly identifying the cause-and-effect relationship for natural systems is not simple. Flood events can cause unexpected damage, because the scientists and planners may not understand all the interactions between natural forces and man-made flood management systems. After Hurricane Katrina in New Orleans, professionals debated the causes behind the levee failures. These complicated interactions are now better understood in that region *because* there was a terrible flood event.

In the case of King County's Flood Hazard Management Plan, this analysis assumes that the improvements to the levees and revetments would provide the flood protection services they are designed to provide. This analysis explicitly assumes that the Flood Hazard Management Plan successfully reduces risks of major flooding in the floodplain areas to an appropriate level.

Analysis of the probability of a major flooding event is beyond the scope of this study.

STUDY AREA BOUNDARY

Different types of impacts affect different geographies. The impacts of an action will differ depending on how the area being evaluated is defined. In the case of a major flood event, an analysis could focus specifically on the flooded area. But the employees at the affected businesses live all over King County and even in adjacent counties. The businesses purchase supplies and sell goods and services beyond the floodplain, affecting businesses and households in other parts of the county and beyond.

The focus of this analysis is on King County. The actual effects of a major flood event would greatly impact the entire Puget Sound region, because of its economic integration. The focus of the analysis, however, is narrowed to King County because this analysis is being conducted for King County.⁸

DIRECT AND INDIRECT IMPACTS

In regional economic analysis, some impacts are *direct* (primary impacts). For example, a large flood event in the floodplains will prevent the businesses located there from operating. Economic output will not be generated by these businesses, employees will not be paid, and business income will not be generated for owners. Other impacts are *indirect* (secondary impacts): the directly affected firms will purchase fewer goods and services from other businesses in the region and less economic output will be produced, most of which would be distributed to employees in the form of wages. It is because of both the direct and indirect impacts that protecting the floodplain areas has true regional importance.

LONG RUN VERSUS SHORT RUN

Economic impacts occur over time. Likewise, the service of flood protection provided by the Flood Hazard Management Plan and the changes the Plan institutes will occur over time.⁹ In sub analysis 2 we examine the short-run impacts to the King County economy of a major flood event, which hypothetically may occur without investment to levies and revetments. We also

⁸ The economic impacts to the rest of the Puget Sound region (Kitsap, Pierce, and Snohomish counties) are also examined, but are not the focus of the study.

⁹ That is, investments made in flood protection are intended to provide protective services for many years.

examine the long-run impacts to the countywide economy of increased (or decreased) investments by businesses in the floodplain. In sub analysis 3, we hypothesize that:

1. An increase in investment is possible if businesses perceive flood risks to be lower due to the Flood Hazard Management Plan.
2. Some degree of divestment is possible if businesses perceive flood risks to be too high due to the Flood Hazard Management Plan not being implemented.¹⁰

SUMMARY: FOCUS OF THE ANALYSIS

A primary motivation of the study was to (a) demonstrate the complex and not-always-apparent linkages in the King County economy and (b) estimate the direction of and magnitude of the benefits (or cost foregone) associated with the Flood Hazard Management Plan.

1. Using micro-level employment data for King County, we examine employment and income by industry sector within the floodplain regions and compare them to the county as a whole. We discuss the importance of business activity in the floodplains to the economic vitality of the rest of the county.
2. Using an economic input-output model, we estimate the direct and some of the indirect impacts associated with a major flood event.
3. Using the Long Term Economic and Demographic forecasting model for the Puget Sound region, we examine the impact that a small change in aerospace employment in the King County floodplains would have on the Puget Sound and King County economies.

¹⁰ Although we do not discuss the possible effects of global warming on the probability or severity of future condition flooding within the King County floodplains, this would likely be of concern to businesses making investment decisions in a historically flood prone area.

SUMMARY

In this chapter we examine the economic structure of the floodplain regions of King County and the ways in which the floodplains economically interact with the rest of the county. We use three separate, but related, sub-analyses, which show that economic value generated in the floodplain regions has large, positive benefits for households and businesses in the rest of the county. Each of the sub-analyses uses different methods and underlying assumptions. However, they share three important attributes: the analyses are based on principles of economic theory, they rely on actual empirical data at the county, sub-county and Puget Sound regional level, and all underlying assumptions are clearly stated and conservative. A brief description of each sub-analysis is as follows:

1. **Sub-Analysis 1** estimates employment and average payroll by industry sector and compares it to countywide data.
2. **Sub-Analysis 2** develops a short-run, input-output model to estimate the impact that a flood event might have on the economic output of businesses located in the floodplain and the spillover impacts that would affect the rest of King County.
3. **Sub-Analysis 3** describes the long-run impact that a change in aerospace employment in the floodplains would have on employment and personal income for all of King County and the Puget Sound region.

1. EMPLOYMENT & PAYROLL LOCATED IN KING COUNTY FLOODPLAINS

In Sub-Analysis 1, we overlay the geographical boundary file of the floodplain regions with grid cell level employment data for King County.¹¹ The purpose of this geographical information system (GIS) analysis is to identify employment and annual incomes by industry sector within the floodplain regions and to compare them to employment and incomes for the county as a whole. The information developed in this sub-analysis will provide a basic—but clear—picture of the economic structure of the floodplains and will indicate the relative contribution of the businesses operating in the floodplain to King County's economy.

King County's mapped floodplains account for only about 5% of the total land area, but much of this area is located within the highly-developed portions of the county. Because of this, almost 6 % of the county's employment is located inside

¹¹A grid cell is a 500 feet per side square.

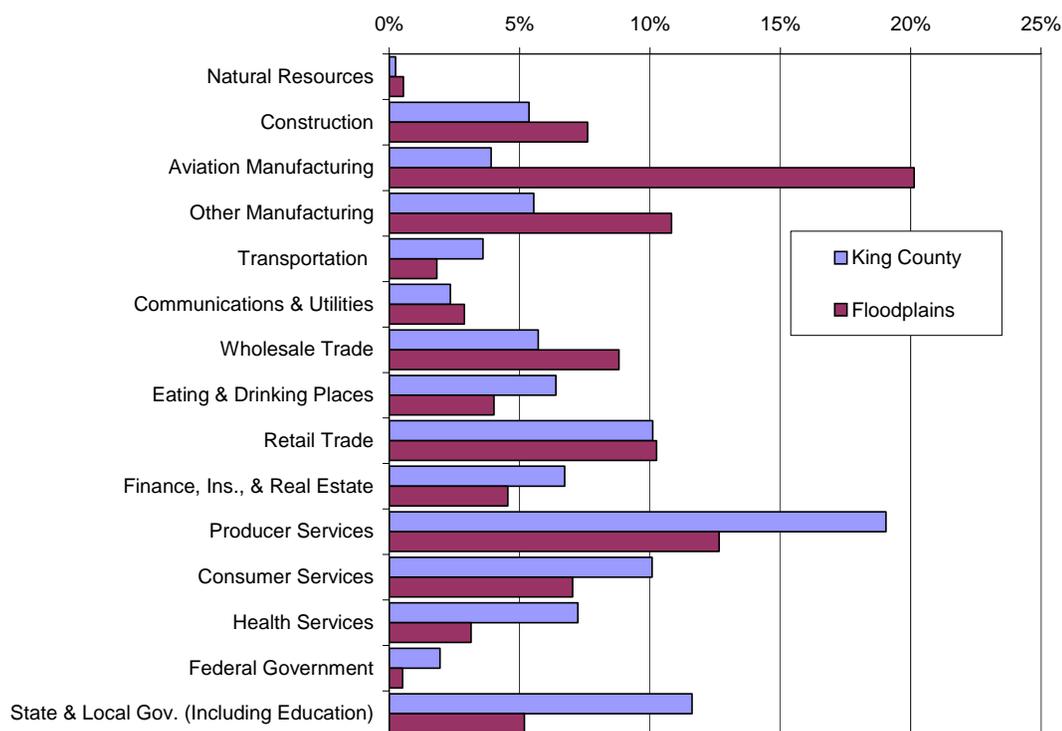
the floodplain.¹² The distribution of employment by industry sector within the floodplain regions differs greatly from the employment distribution for the county as a whole.

Employment levels by industry sector vary greatly within the floodplains: 30% of the county's aviation manufacturing employment is located within the floodplain, but less than 3% of state and local government employment and less than 2% of federal government employment is located within the floodplain (see Figure 3 and Table 1). Employment in the floodplain is more heavily weighted toward the private sector than in the county as a whole (94% versus 86%). The floodplains also have a much higher concentration of manufacturing employment than the county as a whole. One in every three private sector jobs in the floodplain is in manufacturing, whereas at the countywide level, only 11% of private sector jobs are in the manufacturing sector. Offsetting the relatively high proportion of employment in the manufacturing sector, the floodplains have a lower proportion of employment in the consumer-oriented service sectors than does King County as a whole.¹³

¹² The analysis was conducted based on “covered” employment—those employees covered by Washington Employment Security Law and by the program of Unemployment Compensation for Federal Employees (UCFE). Total employment is likely 3% to 10% greater than the covered employment total.

¹³ These include: Eating and Drinking Places (4.0% versus 6.4%), Finance, Insurance, and Real Estate (4.6% versus 6.7%), Consumer Services (7.0% versus 10.1%), and Health Services (3.1% versus 7.2%).

Figure 3: Employment Distribution by Industry Sector, King County and the Floodplains, 2005



Source: Washington Department of Employment Security <http://fortress.wa.gov/esd/portal/>

Much of the income earned by workers in the floodplains is used to purchase goods and services from businesses located outside of the floodplains. Businesses in the floodplain are also an important source of tax revenue for state and local government, which have a much greater presence outside of the floodplain than inside (see Figure 3 and Table 1).

The differences in the distribution of employment by industry sectors between the floodplains and the rest of King County are due to differences in the physical attributes of the respective areas, historic precedent, and the economic benefits of clustering—this is especially the case for the proportionally large share of manufacturing in the floodplain regions. The result is that the floodplain areas are disproportionately important to the economic diversity and resiliency of the King County economy.¹⁴ Even as lower-end manufacturing jobs continue to disappear across the Puget Sound region and the entire U.S., higher-end manufacturing jobs—such as those in aerospace manufacturing—continue to be a source of economic strength.¹⁵

¹⁴ Economic resiliency refers to the ability of a community to adjust to changing economic conditions and/or economic shocks. In general, the more diverse a regional economy is, the more resilient it is to change or shocks.

¹⁵ In the February 2006 report *Puget Sound Economic and Demographic Forecast Detailed Forecasts and Methodology* prepared for the Puget Sound Regional Council by Dick Conway & Associates, the authors state: “The Puget Sound economy is particularly dependent upon Boeing and Microsoft, the region’s two large private employers.”(Appendix b6).

Table 1: % King County Employment in the Floodplain

Industry Sector	King County Employment	Floodplain Region Employment	Percent King Employment	Employment Proportionally Greater in Floodplain Than in County as a Whole?
Natural Resources	2,720	355	13.1%	Yes
Construction	59,855	4,941	8.3%	Yes
Aviation Manufacturing	43,646	13,073	30.0%	Yes
Other Manufacturing	61,923	7,033	11.4%	Yes
Transportation	40,155	1,188	3.0%	No
Communications & Utilities	26,151	1,872	7.2%	Yes
Wholesale Trade	63,832	5,721	9.0%	Yes
Eating & Drinking Places	71,407	2,611	3.7%	No
Retail Trade	112,881	6,659	5.9%	No
Finance, Ins., & Real Estate	75,116	2,957	3.9%	No
Producer Services	212,759	8,219	3.9%	No
Consumer Services	112,640	4,568	4.1%	No
Health Services	80,789	2,042	2.5%	No
Federal Government	21,804	338	1.5%	No
State & Local Gov. (Including Education)	129,671	3,369	2.6%	No
Not Elsewhere Classified	1,241	NA	13.1%	NA
Total Employment	1,116,590	64,947	5.7%	

*Based on calendar year 2005 data. These are the most recent data available at the very small-area (block) level. Many smaller industry sectors were combined so as to not present an overwhelming amount of detail.

Source: Washington Department of Employment Security <http://fortress.wa.gov/esd/portal/>

Because of the high proportion of manufacturing—especially aerospace manufacturing—the average annual wage of workers in the floodplain is 13% higher than the countywide average (see the last three rows of Table 2). Not only does aerospace have the highest average annual income of any major industry sector in King County, it also represents one in five jobs located in the floodplain.¹⁶ Comparatively, only one in twenty five jobs in King County as a whole is in the aerospace sector (see Figure 3).

¹⁶ There are of course many occupations that have higher average annual incomes than the annual average for aerospace.

Table 2: Average and Total Annual Payroll by Industry Sector for the Mapped Floodplains in King County, 2005

Industry Sector	Average Annual Wage	Total Annual Payroll in Floodplains*	Floodplain Percent of King County Employment	Employment Proportionally Greater in Floodplain Than in County as a Whole?
Natural Resources	\$60,000	\$21,300,000	13.1%	Yes
Construction	\$48,108	\$237,701,270	8.3%	Yes
Aviation Manufacturing	\$85,760	\$1,121,146,183	30.0%	Yes
Other Manufacturing	\$50,669	\$356,357,748	11.4%	Yes
Transportation	\$47,745	\$56,721,046	3.0%	No
Communications & Utilities	\$73,125	\$136,890,582	7.2%	Yes
Wholesale Trade	\$61,416	\$351,360,388	9.0%	Yes
Eating & Drinking Places	\$16,609	\$43,366,141	3.7%	No
Retail Trade	\$31,829	\$211,949,939	5.9%	No
Finance, Ins., & Real Estate	\$63,922	\$189,018,734	3.9%	No
Producer Services	\$68,694	\$564,593,408	3.9%	No
Consumer Services	\$27,813	\$127,051,555	4.1%	No
Health Services	\$45,342	\$92,587,483	2.5%	No
Federal Government	\$60,750	\$20,533,609	1.5%	No
State & Local Gov. (Includes Education)	\$45,622	\$153,701,808	2.6%	No
King County Average & Total Payroll	\$50,143	\$55,989,600,000		
Floodplains Average & Total Payroll	\$56,726	\$3,684,300,000		
Floodplain Payroll as a percent of King County	113%	6.6%		

Source: Washington Department of Employment Security <http://fortress.wa.gov/esd/portal/>. Data are based on employment covered by the State's unemployment insurance program, which represents more than 90% of all workers in the county.

*Estimated based on county-level average wages

The higher-than-average wages received by workers in the floodplains and the proportionately lower concentration of consumer-oriented businesses, shows the importance of the floodplain economy to the economy of the entire county. Workers in the floodplains have greater disposable incomes than the average worker in King County but there are fewer consumer-oriented businesses in the floodplain for workers to purchase goods and services.¹⁷ Based on the analysis of commute patterns by King County staff, 52,500 persons in King County commute into or out of the (100-year) floodplains for work. Because the population within

¹⁷ This assumes similar demographic and household structures between floodplain and non-floodplain workers.

the floodplain areas is only 32,000,¹⁸ most of those workers must be commuting into the floodplains.

These workers and the members of their households are likely to conduct most of their consumer-oriented activity with businesses outside of the floodplain. As an example of the economic importance of these workers to the businesses located outside of the floodplain, consider if only 10% of the total floodplain payroll was spent in businesses outside the floodplain. In this example, since total payroll for employees working in the floodplains in 2005 was approximately \$3.7 billion; multiplying this by 10% results in \$370 million in annual spending at businesses located outside the floodplains. The impact to the county economy is likely much greater, given that mortgage and rent payments, local taxes, charitable donations, and other spending are likely to be more widely distributed throughout the county. Thus, workers in the floodplain contribute significantly to businesses outside the floodplain.

2. POTENTIAL SHORT-TERM ECONOMIC IMPACT OF A MAJOR FLOOD EVENT

A large flood event acts like a shock to local and regional economies. Businesses, government offices, and schools may have to close temporarily due to direct damage to buildings and infrastructure (including public utilities) by floodwaters. Workers may be unable to commute to their jobs because of flooded roads and public transportation routes. Many other businesses are affected indirectly by flooding when their goods and services are not able to reach customers within the flooded areas, or when the goods and services provided by governments and businesses in the affected area are no longer available to them. For communities within the floodplain or made up largely of floodplains, a large flood event may temporarily halt essentially all economic activity. The economic impacts of such an event to the local economy and the regional economy can be examined by use of input-output analysis.

Input-output modeling is an economic modeling framework that estimates the direct, indirect, and induced economic outputs (changes to income and employment) associated with an industry sector, an individual business, or a proposed or actual project. Input-output models provide an empirical representation of an economy and the relationships among the various industry sectors, final consumers, and the larger (regional or national) economy.

In order to model the input-output relationships of county and regional economies special data techniques have been developed to estimate the necessary empirical relationships from a combination of national, technological relationships and county-level measures of economic activity. This planning framework, called IMPLAN (for IMPact analysis for PLANning), is commonly

¹⁸ Floodplain population based on information from: *County Assessment: Economic Value of Flood Protection*, October 17, 2006. King County Department of Natural Resources Internal Issue Paper. See Appendix A of this report for a brief discussion of this analysis and a summary of the key results.

used in regional economic analyses. IMPLAN is the model King County applied to estimate the economic value of flood protection as it pertains to commuting patterns to and from the floodplain areas.¹⁹ The underlying assumption of the analysis is that a large-scale flood event would temporarily prevent individuals living in the floodplains from commuting to jobs outside the floodplains and prevent individuals living outside the floodplains from commuting to jobs inside the floodplains. One key outcome of the analysis was the finding that there is a substantial economic interconnectedness among local business and residential centers within King County.

In Sub Analysis 2 (SA2) we also use IMPLAN to examine the economic costs of a large-scale flood event in the King County floodplains. However, instead of focusing on the impacts to those commuting either into or out of the floodplains to jobs, we consider the impacts that a large flood event would have on the “local floodplain” economies and the spillover effects that the flood event would have on the rest of King County. As was the case with the King County Department of Natural Resources Internal Issue Paper from October 17, 2006,²⁰ SA2 does not estimate the entire economic impact to the County associated with a major flood event, but provides some sense of the magnitude of benefits. And like the County’s Internal Issue Paper, SA2 portrays the economic interconnectedness of all economic centers within the county and some of the effects on the countywide economy.²¹

In SA2 we examine the economic impacts of a one-day shutdown of all business activity in the King County floodplains. This is a simplifying assumption. In reality, a flood event would probably impact only a portion of businesses in the floodplains, but would likely last more than a day. This simplifying assumption is necessary in order to more clearly isolate and illustrate the economic impacts of a flood event. The analysis does not consider damage to homes or businesses or public infrastructure associated with a flood event, but rather the magnitude of foregone economic activity associated with the one-day shutdown and the distribution of the economic impacts between the floodplain areas, the remainder of King County, and the remainder of the Puget Sound region (i.e., Kitsap, Pierce, and Snohomish counties). The results of the analysis are shown in Table 3.

¹⁹ *County Assessment: Economic Value of Flood Protection*, October 17, 2006. King County Department of Natural Resources Internal Issue Paper. See Appendix A of this report for a brief discussion of this analysis and a summary of the key results.

²⁰ *County Assessment: Economic Value of Flood Protection*, October 17, 2006. King County Department of Natural Resources Internal Issue Paper.

²¹ Partial equilibrium effects are those economic effects felt by participants in the market(s) directly affected by the flood event (i.e., King County). Implicit in the analysis is that the King County economy is very small relative to the greater economy (i.e., national) and the impact of the flood would have little impact on the greater economy.

Table 3: Direct Economic Impacts of a One-Day Shutdown of Business Activity in the King County Floodplains (2007 Dollars)

Type of Impact	Floodplain Impact	Elsewhere in King County Impact*	Total King County Impact	Impact Elsewhere in Puget Sound Region*
Total Output	\$42,742,065	\$3,003,180	\$45,745,245	\$546,890
Value-Added Output	\$23,278,794	\$1,646,992	\$24,925,786	\$202,253
Wages	\$6,057,993	\$6,405,682	\$12,463,675	\$1,544,566
Business Income	\$1,603,241	\$158,713	\$1,761,954	\$20,166
Person Hours of Work	156,949	18,926	175,875	5,055
Indirect Business Taxes	\$1,532,232	\$81,931	\$1,614,163	\$6,347

* Includes all portions of King County not within the floodplain areas. The economic impacts do not include any foregone economic activity associated with: (1) floodplain residents not being able to reach jobs outside of the floodplain, (2) foregone floodplain outputs that serve as inputs for businesses located outside the floodplain, but in King County or the Puget Sound region.

A one-day shutdown of all business activity in the King County floodplains would result in a loss of approximately \$46 million in output or \$25 million in value-added output in King County, in year 2007 dollars.²² Most of the foregone output would be from businesses located within the floodplain (\$42.7 million). Business located in King County, but outside the floodplain would experience approximately \$3 million in daily foregone output.

The estimated impacts on businesses located outside of the floodplain of a one-day shutdown of all business activity in the King County floodplains should be considered a lower bound estimate. The IMPLAN analysis considers only the economic value of the foregone inputs floodplain businesses would have used if the one-day shutdown had not occurred. It does not consider the impact of that lost day on the production process of businesses located outside the floodplain, but which rely on goods and services produced by businesses located in the floodplain areas. Stated another way, IMPLAN looks backward, but it does not look forward. It does not recognize that foregone outputs may be inputs to other businesses. In addition, unlike the King County Department of Natural Resources Internal Issue Paper from October 17, 2006,²³ which explicitly considers the impact on economic output when movement into and out of the floodplain is disrupted, Sub Analysis 2 does not consider the economic impact of employees who live in the floodplain, but commute to jobs outside the floodplain. Because of these reasons, the results of SA2 should be regarded as partial impacts of the effect of a major flood event in the floodplain areas of King County.

²² Economic output (“output”) is equal to all intermediate purchases from other businesses and any additional value added to these purchased by the businesses being studied. Value added output (“value added”) is equal to employee compensation plus proprietor income plus other property income (e.g. rents, royalties, dividends) plus indirect business taxes. A one-day shutdown of all business activity in the King County floodplains would result in a loss of approximately \$25-million in value-added output (approximately \$23 million in the floodplain and \$1.6 million outside the floodplain).

²³ *County Assessment: Economic Value of Flood Protection*, October 17, 2006. King County Department of Natural Resources Internal Issue Paper. See Appendix A of this report for a brief discussion of this analysis and a summary of the key results.

A substantial portion of the foregone economic output would be wages paid to employees. In fact, foregone wages constitute approximately half of the total foregone value-added output for King County (\$12.5 million of \$25 million). And, as Table 3 shows, slightly more than half of this total would have been paid to employees who live in King County, but outside the floodplain area. The estimates of foregone wages should be considered lower bound estimates as they do not include the foregone wages of persons living in the floodplains who would not be able to commute to jobs outside the floodplain.

Table 4 shows the ten King County industry sectors located outside the floodplains that would experience the greatest impact from a shutdown of economic activity in the floodplains. All ten sectors are service oriented, which is indicative of the interaction of businesses within the floodplain—which are much more likely than the rest of the county to be manufacturing related—and the rest of the County. The results presented in Table 4 show that businesses located in the floodplain areas rely heavily on business services firms located in other parts of the County, such as Seattle and Bellevue.

Table 4: King County Economic Sectors Located Outside of the Floodplains That Would Be Most Impacted by a Shutdown in the Activity of Businesses Located Inside the Floodplain Regions*

Rank	Economic Sector	1-Day Foregone Economic Output (2007 Dollars)	Percent of Total Foregone Economic Output
1.	Legal services	\$350,336	11.7%
2.	Non-depository credit intermediation	\$224,512	7.5%
3.	Securities- commodity contracts- investments	\$191,648	6.4%
4.	Architectural and engineering services	\$168,992	5.6%
5.	Accounting and bookkeeping services	\$154,176	5.1%
6.	Radio and television broadcasting	\$134,400	4.5%
7.	Management consulting services	\$102,112	3.4%
8.	Real estate	\$100,192	3.3%
9.	Advertising and related services	\$81,216	2.7%
10.	Employment services	\$80,928	2.7%
Total Top 10 Industry Sectors		\$1,588,512	53%
Total Foregone Economic Output		\$3,003,180	

* Does not include any foregone economic activity associated with: (1) floodplain residents not being able to reach jobs outside of the floodplain, (2) foregone floodplain outputs that serve as inputs for businesses located outside the floodplain, but in King County or the Puget Sound region.

3. POTENTIAL LONG-TERM ECONOMIC IMPACT OF A CHANGE IN AEROSPACE EMPLOYMENT IN THE FLOODPLAINS

The Puget Sound regional economy is comprised of complex, ever-evolving interactions between and among businesses and consumers. The regional economy is influenced by economic, demographic, and social factors originating within the region, as well as factors exogenous to (outside of) the region. Each of the region's business sectors affects and is affected by the actions and reactions of every other industry sector.

These simultaneous internal relationships between industry sectors, as well as the relationships with other economic and demographic factors (e.g. inflation, personal income, population growth) can be studied using relatively complex econometric techniques. Such regional models can be useful for understanding the influence of external factors on the regional economy and for understanding how a change in one part of the regional economy might affect other sectors of the economy. Using the 2006 Puget Sound Economic and Demographic Forecasting Model, developed by ECONorthwest for the Puget Sound Regional Council (PSRC), we performed such an analysis with respect to a hypothetical change in employment in the aerospace manufacturing sector.

Thirty percent of aerospace employment in King County is located within the floodplain region. Total aerospace employment within the four-county Puget Sound region is approximately 73,000, of which 60% is located in King County. Thus, approximately 18% of the region's aerospace employment is located in the King County floodplains. We consider the impact of a 10% change in the employment within the floodplain region (this amounts to about 1.8% of total regional aerospace employment). There are many factors that influence business investment decisions; this hypothetical change could be an increase in employment in response to strong national or international demand for aerospace products (e.g. Boeing's new 787 commercial airliner). However, the assumption here is that this 10% increase is due to the confidence of the region's aerospace employers that the floodplains are adequately protected from severe flooding. Alternatively, this hypothetical 10% change in employment could be a decrease in employment due to the employer's perceived risk that the floodplains are not adequately protected against a potential severe flood event—regardless of strong demand for aerospace products.²⁴

²⁴ For the purposes of this analysis, it is assumed that the hypothetical decrease in employment in the floodplain would not be shifted to another part of the Puget Sound region, but rather would be moved out of the region. This assumption is deemed reasonable due to the relatively high cost of acquiring and developing suitable land in the Puget Sound region. It is further assumed that the decrease in employment is not simply in response to change in the demand for aerospace products, which might affect employment regardless of perceptions of the adequacy of the flood hazard management systems. In the ever-increasing global marketplace, manufacturers have become increasingly mobile, showing a strong willingness to move manufacturing to lower cost and/or lower risk areas in the U.S. or abroad. For example, the Boeing 787 is assembled in the Puget Sound region from components manufactured in the U.S., Asia, and Europe. In addition to the Puget Sound region, Boeing maintains manufacturing operations in Kansas and South Carolina.

Aerospace was chosen for this hypothetical impact analysis for three reasons. First, it is a major employer in King County and the Puget Sound region. Second, the average annual wages paid in the aerospace sector are higher than virtually all other industry sectors and much higher than the regional average. Third, although located within the region, the forecasting model treats aerospace employment as exogenous to the region because virtually all of the demand for this sector's products is derived from outside the Puget Sound region. That is, few airplanes and associated products are sold to businesses within the region. Rather, they are sold into markets across the U.S. and the world. Because of this, aerospace affects the Puget Sound economy much more than aerospace is affected by the Puget Sound economy.

The baseline projection of economic growth for King County, prepared for PSRC in 2006, is for average annual employment and (nominal) personal income growth of approximately 1.0% and 5.5%, respectively through 2040. These results are partially based on expectations of strong national and international economic growth over this period and the assumption that the relationships between the regional and national/international economies will remain stable. The economic forecast also assumes that the statistically estimated, historical relationships between and among the region's economic sectors and demographic structures remain valid.

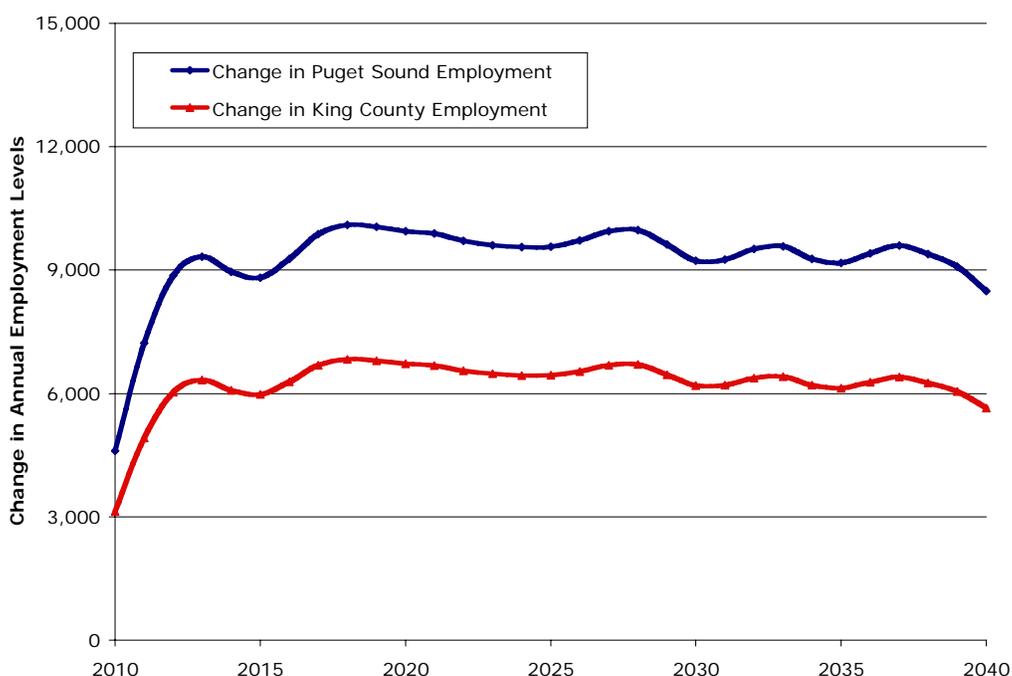
EMPLOYMENT

Figure 4 shows for Puget Sound and King County the projected change in employment from the baseline forecast for each year between 2010 and 2040 due to a 10% change in aerospace employment within the King County floodplain areas.²⁵ The impact on county and regional employment would be felt relatively quickly as other industry sectors respond to the change in aerospace employment by adjusting their own employment levels. Within a few years, the King County and regional economy would adjust to the shift in aerospace employment and the rate of employment growth would revert to approximately the baseline rate albeit from a lower employment base. The employment changes shown in Figure 4 are not cumulative. They represent the annual difference between the baseline (*no action*) and the alternative (a 10% change in aerospace employment in the floodplain areas).²⁶

²⁵ Note: if aerospace employment was increased by 10%, the change in King County and Puget Sound employment would be positive, as indicated by the positive values in the graph. The projected impact of a 10% decrease in aerospace employment would be of the same magnitude, but negative.

²⁶ Again, it is important to remember that *no action* is not the same as *no change*. Change will occur in the economic structure of the floodplain areas; the current flood hazard management infrastructure will continue to depreciate; risks associated with flooding will continue or even increase due to the effects of global climate change.

Figure 4: Projected change in employment between the baseline and the alternative forecast, Puget Sound and King County, 2010-2040



Source: Puget Sound Regional Council.

*The alternative forecast assumes a 10% (permanent) change in aerospace employment in the floodplain areas of King County.

PERSONAL INCOME

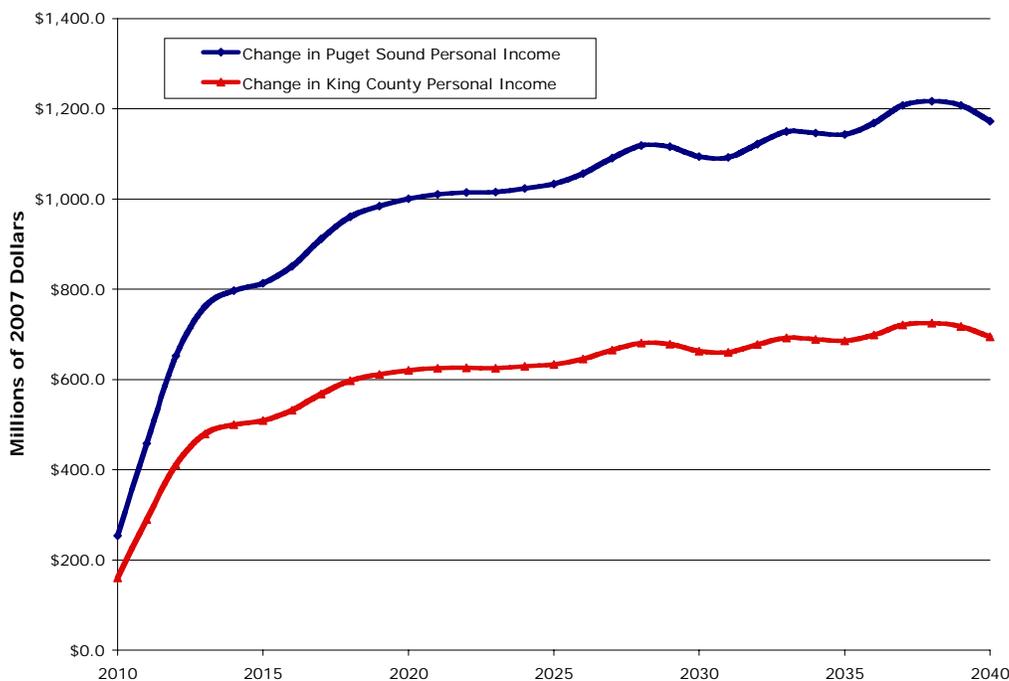
Personal income is composed of wage and salary incomes, other labor income, proprietor income, investment income, and transfer payments. Part of the difference between the baseline and alternative forecast of personal income shown in Figure 5 is explained by the (hypothetical) change in aerospace employment—and the relatively high average annual wages paid in the industry. In addition, changes in aerospace employment impact employment in other industries. As discussed in Sub-analysis 2, King County’s service sectors (which are disproportionately outside of the floodplain areas) are sensitive to changes in business activity within the floodplains. Change in employment would also affect tax revenues paid to the state and local governments and incomes earned by business owners and local investors, resulting in less available funds for reinvestment into the county. The difference between the baseline and alternative forecasts continues to grow over time (in real dollars) because of the effect of compounding growth (i.e., change in personal income today, results in change in investments today, which result in changes in personal incomes tomorrow).

The impact of a change in aerospace employment (within the floodplain areas) on personal income in King County and the region would be greater than the impact on jobs and would persist longer. Figure 5 shows the projected annual

impact on personal income in the county and region between 2010 and 2040.²⁷ Rather than flattening after several years, the difference in personal income between the baseline forecast and the alternative forecast would continue to grow in real terms from \$160 million in 2010 to nearly \$700 million by 2040 for King County. For the Puget Sound region as a whole, the impact on personal income would grow from \$254 million in 2010 to \$1.2 billion in 2040.

Over the 31-year forecast period (2010 to 2040), the total net present value (NPV) in 2007 dollars of the change in personal income resulting from a 10% change in aerospace employment (in the floodplain areas) is projected to grow to nearly \$19 billion and \$31 billion dollars, respectively, for King County and the Puget Sound region.²⁸

Figure 5: Projected difference in personal income between the baseline and alternative* forecast, Puget Sound and King County, 2010-2040 (2007 Dollars)



Source: Puget Sound Regional Council.

*The alternative forecast assumes a 10% (permanent) change in aerospace employment in the floodplain areas of King County.

²⁷ The annual dollar impacts are discounted to 2007 dollars based on Global Insight’s long-term projections of the U.S. Consumer Price Index (CPI).

²⁸ Changes in persona income for future years are discounted to 2007 using the Global Insight projection of the U.S. Consumer Price Index (CPI) from 2005.

SUMMARY

A change in aerospace employment in the floodplain areas of King County would affect employment and income in the rest of the county and the Puget Sound region as a whole. In Sub-analysis 3, we developed long-run estimates of these impacts based on two equal, but opposite, hypothetical scenarios: that employment in aerospace manufacturing in the floodplains of King County will either increase or decrease by 10%. Using the 2006 Puget Sound Economic and Demographic Forecasting Model, developed by ECONorthwest for the Puget Sound Regional Council (PSRC), we simulated a hypothetical 10% change in employment in the aerospace manufacturing sector and observed the impact of such a change on projected employment and incomes for King County and the Puget Sound region. These results are summarized for the years 2010 and 2040 in Table 5.

Table 5: Summary of Impacts to King County and the Puget Sound Region of a 10% Change in Aerospace Employment in King County Floodplains, 2010 and 2040

Economic Variable	Impact to King County		Impacts to the Puget Sound Region	
	2010	2040	2010	2040
Total Employment	3,100	5,600	4,600	8,500
Goods-Producing Employment	1,400	2,100	2,100	3,100
Service-Producing Employment	1,700	3,600	2,500	5,300
Personal Income (Millions of 2007 Dollars)	\$160.6	\$695.0	\$254.0	\$1,172.0
Population	1,400	6,500	2,800	12,600

APPENDIX A: COUNTY ASSESSMENT: ECONOMIC VALUE OF FLOOD PROTECTION, OCTOBER 17, 2006, KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS INTERNAL ISSUE PAPER

In October 2006, staff at the King County Department of Natural Resources and Parks prepared an analysis of the economic value of flood protection in specific areas of the County. The purpose of the analysis was to illustrate the “*vital economic resources and residential areas afforded protection by flood [protection] facilities and programs.*”

An input-output model was developed using IMPLAN to estimate the (value added) economic activity of individuals who commute from the floodplains to jobs in the 39 cities and vice versa. It was reasoned that an estimate of the daily amount of market-based economic activity (e.g., employee compensation, income to business owners, taxes paid to local governments) generated by workers commuting to and from the floodplains would be a good approximation of the economic importance of the floodplains to the cities.

Information on commuting patterns were obtained from the Puget Sound Regional Council (PSRC) for all each of the County’s Transportation Analysis Zones (TAZ). These data allowed the Division to estimate the total number of persons either living within the floodplain and commuting to jobs in one of the 39 cities or living in one of the 39 cities and commuting to a job located in the floodplain. According the County’s analysis of the TAZ data, there were approximately 52,500 workers commuting between the floodplains and the 39 cities.

The economic analysis then assumes that—but for the flood-prevention strategy—a flooding event could prevent people from commuting either to or from the floodplain for work. This would occur by the flood disrupting the traffic network or by damaging the homes and vehicles of those living in the floodplain.

The findings from the County’s analysis are presented below.

COUNTYWIDE ASSESSMENT: ECONOMIC VALUE OF FLOOD PROTECTION

OCTOBER 17, 2006

- **Data**
 - Block group data, the smallest data entity available for commuter data patterns, was obtained from PSRC
 - Block groups were identified that intersected with King County's 100 year floodplains
 - Many of these block groups exceed the boundaries of related 100 year floodplains
 - It is not possible to determine the distribution of residential areas and workplace areas within the floodplain portion of each block group
 - Countywide, 100 year floodplains comprise 17% of the total area of block groups that intersect w/floodplains

- **Population:**
 - Total King County population (2000): 1.7 M
 - Countywide, total block group population for those block groups that intersect a 100 year floodplain: 187,700 (9.25% of total KC population)
 - Countywide, total 100 year floodplain population (17% of 187,700): 32,000 (1.8% of total KC population)

- **Employment:**
 - a. Employment King County (2003): 1,460,000 jobs
 - b. In-and-out commuters (2000) for all block groups that intersect a floodplain: 309,000 jobs (21.2% of total KC jobs).
 - c. In-and-out commuters for 100-year-floodplain areas (17% of 309,000): 52,500 jobs (3.6% of total KC jobs).

- **Economic impacts:**
 - a. Total economic output of residents within those block groups that intersect 100 year floodplains:
 - i. \$54 M per day for all block groups
 - \$ 18.5 M per day is wages and salaries
 - ii. \$9.2 M per day for 100 year floodplain portion of block groups (17% of \$54M)
 - \$ 3.1 M per day is wages and salaries
 - b. Total economic output of commuters who live outside of block groups that intersect with 100 year floodplains:
 - i. \$64.5 M per day for all block groups that intersect floodplains
 - \$22.2.M per day is wages and salaries
 - ii. \$11 M per day for 100 year floodplain portion of block groups (17% of \$64.5M)

APPENDIX B: ECONORTHWEST

ECONorthwest is the Pacific Northwest's largest economics consulting firm. Since 1974, the firm has completed more than 1,500 projects in economics, finance, planning, and policy evaluation. ECONorthwest has a reputation for objective analysis. Its economists have provided expert analysis to both plaintiffs and defendants in legal disputes and have provided objective analysis to a wide range of public and private clients with widely diverging objectives.

Dr. Ted Helvoigt joined ECONorthwest in 2002. He specializes in econometric and statistical analysis and mathematical optimization. He has applied these methods in a wide range of projects dealing with natural resource economics and policy, benefit-cost analysis of transportation projects, real-estate valuation, regional economic and demographic forecasting, and financial analysis and revenue forecasting. Prior to joining ECONorthwest, Dr. Helvoigt worked as an economist/manager for American Express in their International Risk Management Department. In this position, he was responsible for all underwriting and risk analysis pertaining to consumer and small-business card acquisition in Australia, New Zealand, and Thailand.