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Flood Damage in the Skykomish Watershed: A Benefit-Cost Analysis of Interventions in the Lower Skykomish Reach

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*Snohomish County Sustainable Lands Strategy
Executive Committee*

Prepared By:



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List of Abbreviations

BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
ES	Ecosystem Services
ESV	Ecosystem Services Valuation

Executive Summary

In 2010, the Sustainable Lands Strategy (SLS) was established to bring fish, farm, and flood management advocates together to work on solutions to pressing issues in Snohomish County. Primarily focused on protecting productive lands, improving fish habitat, and mitigating potential damages from flooding, the Sustainable Lands Strategy is looking for “win-win” solutions that benefit a diverse group of stakeholders.

Benefit-cost analysis is a common tool for evaluating potential courses of action. When used effectively, it can also be used to tie together various stakeholder interests and perspectives in a single comprehensive analysis. Snohomish County and the SLS stakeholders are currently considering several courses of action that address floodplain management in the Lower Skykomish reach. Earth Economics has been asked to provide a holistic benefit-cost analysis framework that incorporates benefits and costs associated with economic, environmental, and social impacts to be used as a decision support tool. **A holistic benefit-cost analysis is key to advancing the SLS goals of safeguarding the agricultural sector, restoring and protecting salmon habitat, and reducing flood damage.**

Introduction

The Skykomish River is a critical part of Snohomish County's ecosystem and economy. As a central source of clean water in the Snohomish Watershed, the river provides an array of natural goods, including agricultural products, salmon, timber, and drinking water. Moreover, the river provides services critical to the vitality of the county's economy, including food production, recreation opportunities, water filtration, and natural beauty. The Lower Skykomish, fed by a corresponding sub-basin, comprises a critical area of the lower Skykomish River, particularly for local farmers.



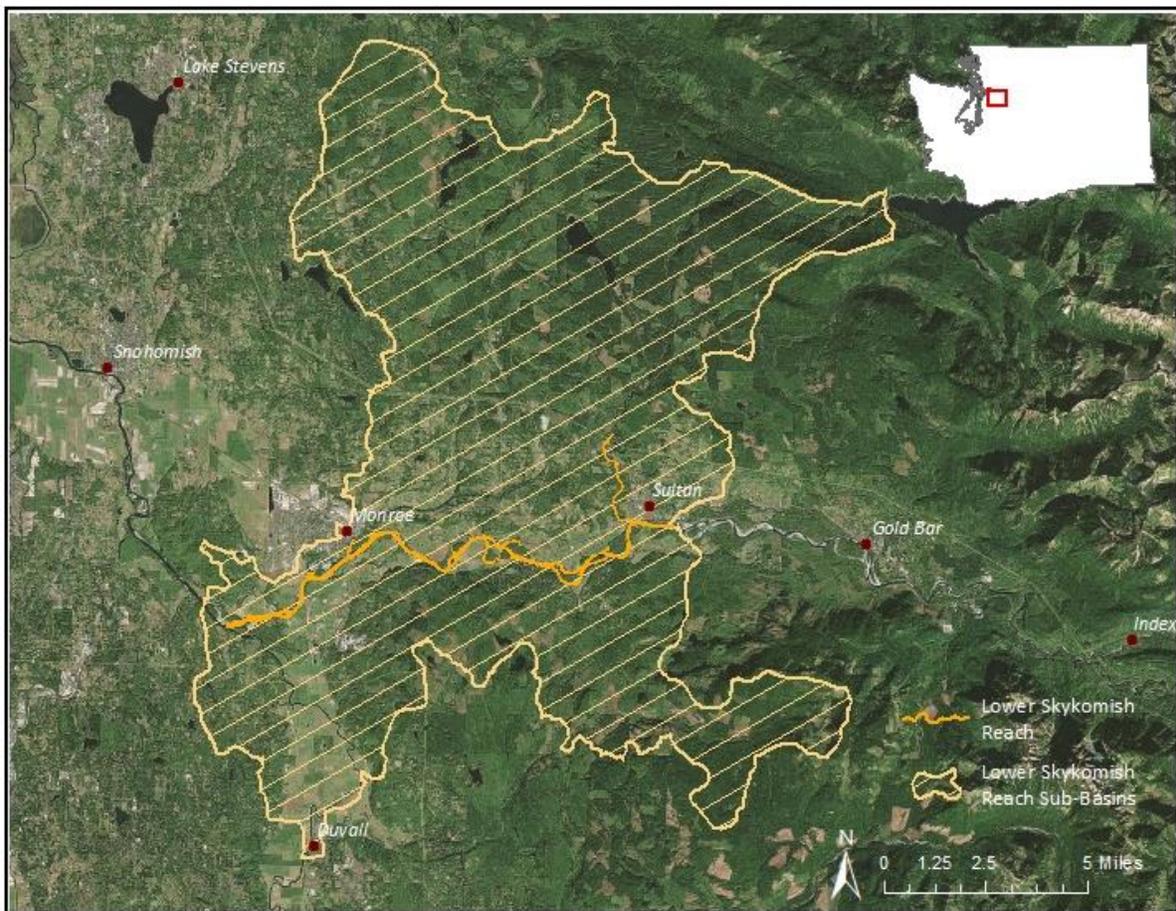
Challenges arise when heavy precipitation events increase the Skykomish's flow. Unbounded by riparian buffers, the Skykomish cuts away at the productive lands that border its banks. Local farmers estimate losses of 15 feet of bank per year in some areas since 1990 (averaged at 7.5 feet per year overall). Moreover, the area is prone to overbank flooding. Although floods are natural and sometimes even beneficial to ecosystems, they can also cause significant damage to private property and public infrastructure. The County reports that in 2006 alone, flooding was responsible for over \$25 million worth of damage in the Snohomish Watershed.

To address these issues, the County, the Tulalip and Stillaguamish Tribes, state and federal agencies, and agricultural and environmental stakeholders created the Sustainable Lands Strategy (SLS). The SLS works across sectors to develop natural resource management plans that support farmers, protect and establish fish habitat, and reduce the risk of flooding. Recognizing the importance of bringing together many stakeholders and perspectives in a single comprehensive analysis, the County contracted with Earth Economics to develop a sample benefit-costs analysis (BCA) framework to assess potential courses of action that would reduce the risk of flooding, address the impacts of soil erosion on local farms, and improve and protect fish habitat. **Given the broad impact of flooding and erosion in the study site area, Earth Economics is advocating for a holistic BCA that accounts for economic, environmental, and social benefits and costs.**

Site Overview – The Lower Skykomish Reach

The Lower Skykomish Reach represents the portion of the Skykomish River from river mile zero to 13.5 (Figure 1). The five sub-basins that flow into this reach are aggregated to create a larger sub-basin; these sub-basins include Snoqualmie Mouth, Lower Mainstem Skykomish, Lower Sultan River, Woods Creek, West Fork Woods Creek, and Lower Woods Creek. This group of sub-basins includes the urban areas of Monroe and Sultan, as well as significant agricultural lands in the fertile Skykomish River floodplain. Lake Chaplain, a water source for the City of Everett, is also included in this sub-basin.

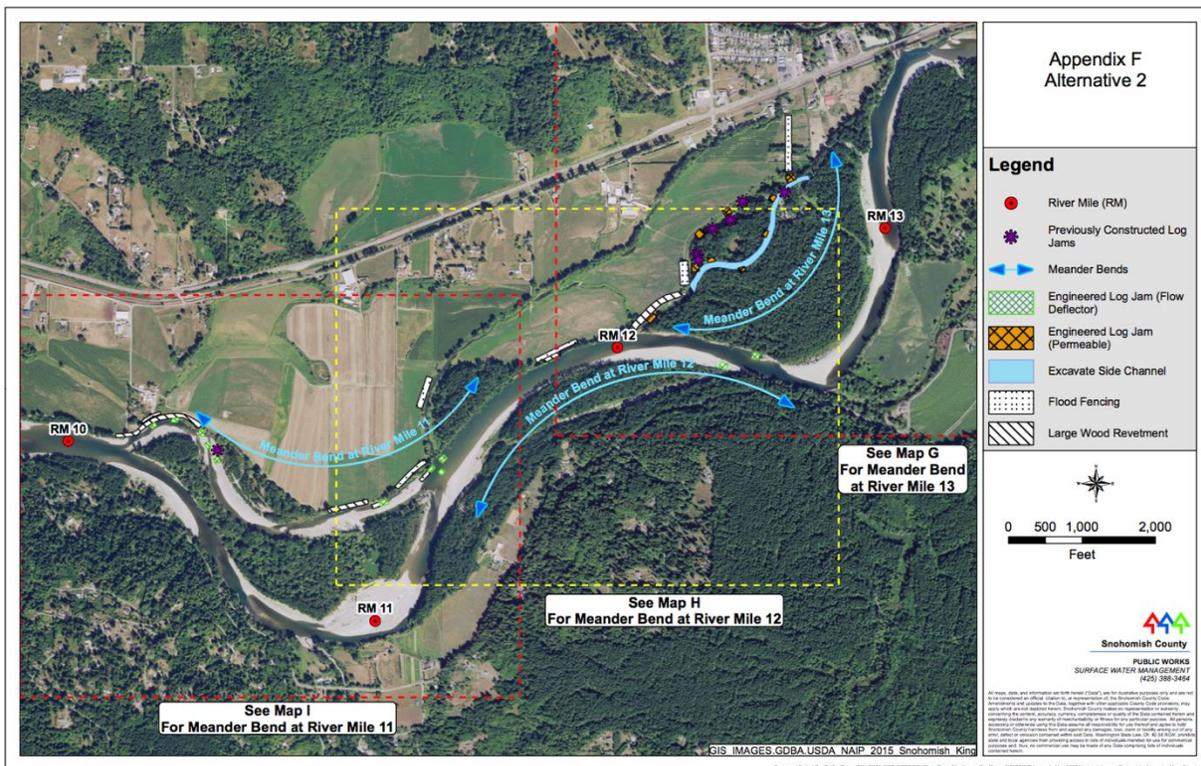
Figure 1. Study Area, Lower Skykomish Reach with Associated Sub-basin



The particular site analyzed in this BCA is between river miles 10 and 13 in the Lower Skykomish Reach (Figure 2). Residents of this area are primarily engaged in growing corn silage and raising dairy cows. The rapid erosion, estimated at 15 feet per year in some areas, and flood damage

occurring at this site threaten the profitability of farmers in the area. Some flood mitigation infrastructure still exists from prior attempts to manage this section of the Skykomish Reach. However, residents desire a more effective flood and erosion risk management solution for this area. A holistic benefit-cost analysis will enable stakeholders to assess and identify the most appropriate risk management solution.

Figure 2. Restoration Site in the Lower Skykomish Reach



Holistic Benefit-Cost Analysis

Many BCAs are framed to exclude all benefits and costs that occur outside of a traditional market, including ecosystem services and social impacts. However, it is critical that non-market benefits be incorporated into environmental policy decisions because ultimately, environmental and social benefits can be just as tangible and real as economic benefits.¹ Among others, this view is shared by the U.S. Forest Service, which recently reported that accounting for the non-market benefits of federal land was in line with the economic objectives

of federal land management, which require that lands are managed to “maximize net public benefits”.²

Earth Economics has produced a variety of benefit-cost analyses that incorporate non-market benefits. For example, Mojica et al. conducted a BCA of four dams on the Lower Snake River, correcting an earlier BCA that excluded non-market costs and benefits. When the BCA incorporated the recreation benefits lost as a result of the dams, the benefit-cost ratio of the dams sank to 0.15, indicating that every dollar spent provided a benefit of only 15 cents.³ Other work included a BCA of floodplain protection activities in the Lake Champlain Basin,⁴ a BCA and return on investment analysis of flood managed practices in Pierce County,⁵ and a report to evaluating the effect of including environmental benefits in applications for FEMA hazard mitigation funding.⁶

A holistic BCA is key to advancing the SLS goals of safeguarding the agricultural sector, restoring and protecting salmon habitat, and reducing flood damage. If non-market benefits are excluded from public policy analysis, it is very possible that decisions made will have net negative economic returns. Moreover, these negative returns are likely have a greater impact in local communities that rely on ecosystems for their livelihoods. In the case of Snohomish County, failure to include non-market benefits could result in County action that leads to net negative returns for the agricultural sector, salmon habitat, and local landowners impacted by flooding events. Incorporating economic, environmental, and social benefits and costs into policy analysis and public investment decision-making provides a more comprehensive perspective of what people value, whether or not a market transaction occurs.

Benefit-Cost Analysis Framework

To evaluate potential courses of action, Earth Economics prepared a BCA framework that will allow the County and SLS stakeholders to identify and value the gamut of benefits and costs associated with each scenario. This framework, built into an Excel workbook, is a “living document” that will continue to be updated and applied as the County and SLS stakeholders refine potential courses of action and improve benefit and cost estimates. While specific benefit and cost estimates and benefit-cost ratios are not included in this report, an overview of the elements that comprise the BCA, and examples of the types of benefits and costs that should be considered, are outlined below.

Action Scenarios

Given the diverse perspectives and goals of the various stakeholders within the SLS, any County action to respond to potential flood damages and high levels of erosion must pursue multiple goals simultaneously. The action scenarios identified for consideration in this report seek the primary goals of reducing land loss due to erosion, expanding and improving salmon habitat, and mitigating flood damages to private property and public infrastructure. In keeping with the SLS strategy, these scenarios hope to achieve a “win-win” result, in which all stakeholders see more gain than loss. As a baseline, the project area for each scenario encompasses approximately 570 acres within the 100-year floodplain. While a combination of approaches is possible, our BCA framework considered three distinct action scenarios listed below. References to “County” mean the public sector, as opposed to private landowners.

1. **No-Action Scenario:** This scenario provides baseline benefit and cost estimates for public and private stakeholders, if the County does not pursue any potential interventions. Costs in this scenario are slightly mitigated by the County's previous floodplain management installations (2015). However, this scenario assumes no future protective measures or repairs of existing installations. Under this scenario, on average, about 1.4 acres is removed from agricultural production each year, as bank areas erode or become too wet to farm. This translates to about 28 acres within 20 years, or 5% of the floodplain area.
2. **Passive Scenario:** This scenario emphasizes conservation easement acquisitions and riparian replanting to mitigate flood damage and reduce the economic impact of erosion on local farms. Under this plan, the County (or other organization) would place easements along the river banks and replant the riparian corridor, paying farmers for their loss in agricultural productivity while enhancing the ecosystem services provided by riparian landcover, including improving water quality and fish habitat. This scenario assumes that the County would take some active measures to facilitate natural floodplain reconnection and reforestation; however, bank erosion will continue to a lesser degree. Additional site-specific floodplain reconnection is expected to help attenuate flows and reduce risks to infrastructure. Under this scenario, about 11% percent of floodplain areas (65 acres) are removed from agricultural production within 20 years.
3. **Engineered Scenario:** This scenario adopts the engineered alternatives recommended in Aaron Kopp's memo to Snohomish County, dated January 3, 2017, which entails fixing

existing damaged flood protection infrastructure and construction of additional bank armoring and flood fencing.⁷ This scenario assumes that construction will take place by 2023 and accounts for the flood damage and loss of land that will occur prior to implementation. Under this scenario, about 85% of floodplain areas (485 acres) will be protected by the suite of recommended engineered installations; leaving about 15% (85 acres) vulnerable to agricultural production losses.

In the BCA framework, identified action scenarios are placed on individual tabs where the benefits and costs associated with a scenario can be calculated. Detailed maps for each scenario can be found in Appendix A.

Project Timeline

Across all action scenarios, the benefits and costs included in our framework are interpreted within the context of a 75-year project timeline. While any action taken today is likely to have an impact beyond the project timeline, the ability to estimate costs and value benefits decays with time. A 75-year project timeline allows the BCA to consider long-term impacts while maintaining a high bar for the certainty of estimates included in the analysis. This time period also reflects ecosystems' stability and productivity over long periods of time.

For various benefits and costs, assumptions must be made about what year the estimates will be valued. For example, under an engineered scenario, the County must make assumptions on how long it will take to secure permits, develop plans, secure funding, and build the flood mitigation structures. Assumptions on the distribution of benefits and costs across time need to be carefully considered because of the effect a discount rate will have on a benefit or cost's present value.

Discount Rates

Discounting allows benefits and costs occurring in different time periods to be compared by expressing the values in present terms. In other words, discounting shows how much future sums of money are worth today.

The choice of discount rate is critical as it heavily influences the outcome of the present values of benefits which occur over a long period of time. In general, lower discount rates better demonstrate the value of long-term assets, as benefits in the future are discounted at a smaller

rate. To consider multiple perspectives, our BCA framework presents results based on two discount rates. A three percent discount rate will present a conservative estimate of the present value of future benefits and costs. A zero percent discount rate will provide a point of comparison and reflect the values of benefits and costs, assuming that people in the future will value things just as much as we do today.

Benefits and Costs

Ecosystem Services

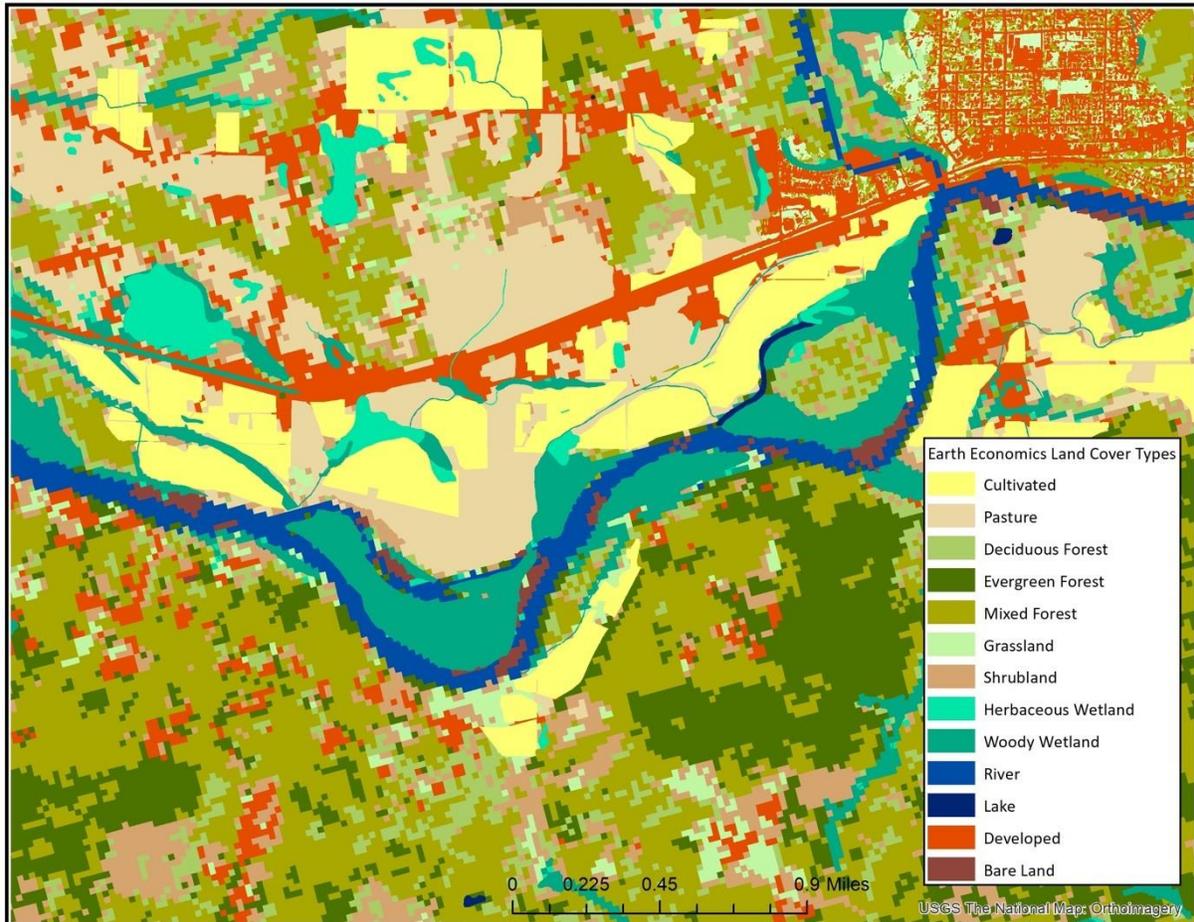
Unlike traditional BCAs, our framework includes potential benefits and costs associated with changes to ecosystem services. Earth Economics specializes in the valuation of goods and services provided by natural landscapes. In a recent report produced for the County, entitled “*Nature’s Value in the Skykomish Watershed: An Ecosystem Services Valuation of the Lower Skykomish and Braided Reach*” (September 2017), Earth Economics valued ecosystem services provided by the Lower Skykomish Reach and its associated sub-basins. **Our analysis revealed that the Lower Skykomish Reach ecosystem provides between \$470 million and \$852 million in economic value every year.**

Given the immense value of the natural capital in the project area, it is important that any potential impact to ecosystem services under the action scenarios be included in the BCA framework, particularly as the loss of natural capital translates into real economic impacts felt by local communities. Changes in the value of ecosystem services are primarily reflected by changes in the identified landcover type (i.e. river, grassland, forest). The existing landcover for the project site is reported

- *Example (Benefit): Under the passive scenario, portions of land near the Skykomish River, purchased from local farmers, would be converted from “pasture” to “riparian forest” through conservation easements and reforestation. Riparian forestland provides highly valuable ecosystem goods and services, including mitigation of flood damage, that result in a net public benefit that can be included in the BCA.*
- *Example (Cost): Under a no-action scenario, acres of productive land near the Skykomish River would convert from “pasture” to “river”, leading to a reduction in agricultural*

production capacity for landowners. A reduction in harvest can be translated into a loss of income that can be included as a private cost in the BCA.

Figure 3: Existing Landcover at the Restoration Site



Social Benefits and Costs

Our holistic BCA framework also includes the estimated values for social impacts from flooding and bank erosion. These benefits and costs are not always distributed evenly across communities, raising questions regarding environmental justice, equity, and community cohesion. Often defined as indirect costs, the social impacts of flooding and bank erosion are important elements of a BCA framework.

- *Example (Benefit): Under a passive or engineered scenario, the County anticipates additional fish habitat, leading to potential increases in salmon populations. Salmon populations, many of which are threatened, are an important cultural resource for the region's fishing and tribal communities. The value of increasing salmon populations can be estimated and included as a public benefit in the BCA.*
- *Example (Cost): Residents that are injured or become ill as a result of flooding may need to pay for health services that otherwise would not be needed. The anticipated cost of treatment should a flood event occur can be included as a private cost in the BCA framework.*

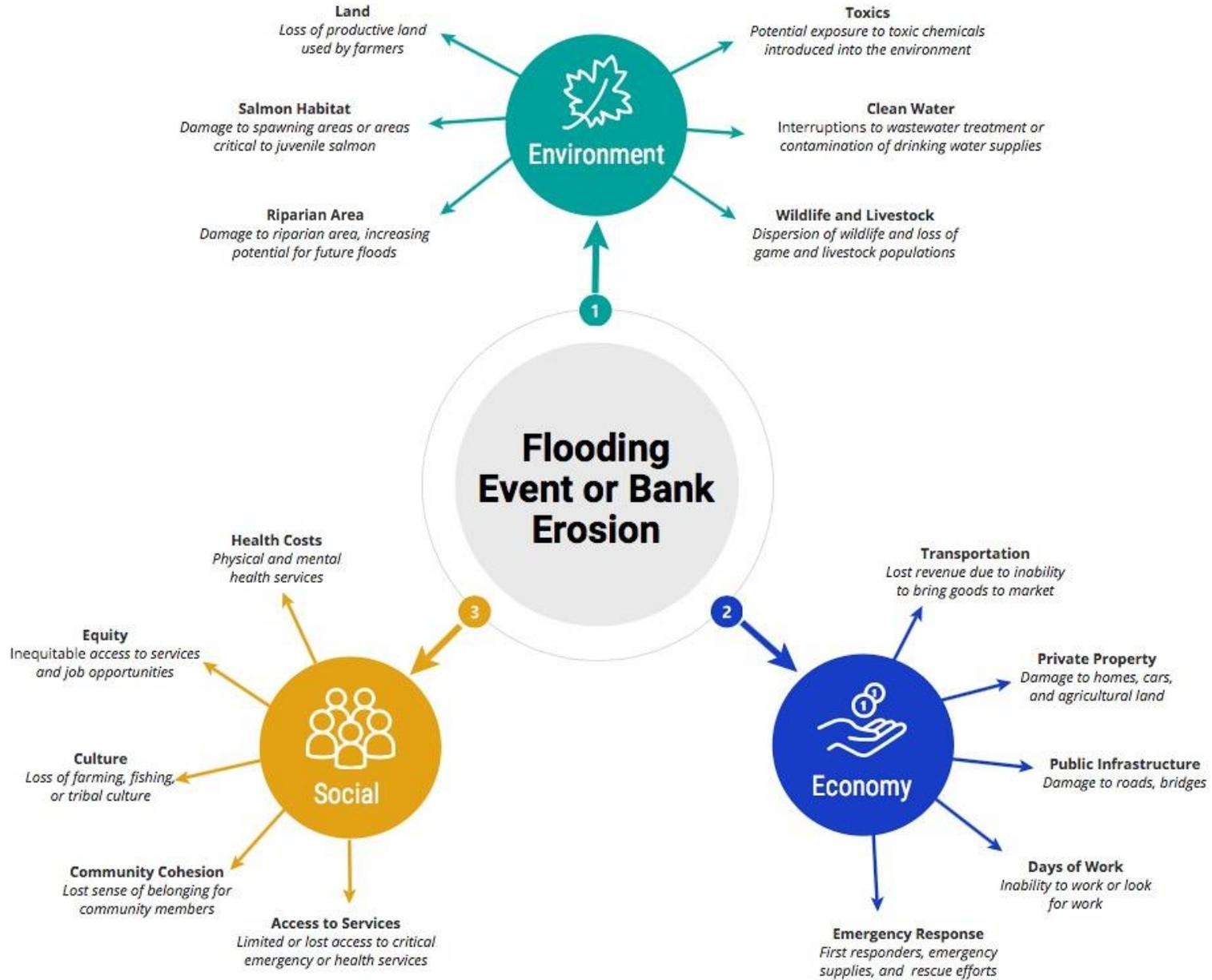
Traditional Benefits and Costs

Like all BCAs, our framework also includes the traditional market transactions that would occur under the identified scenarios.

- *Example (Benefit): Under the passive scenario, farmers would receive easement payments from the County to offset revenue lost from a reduction in productive land. The total payments received by landowners should be estimates included as a private benefit.*
- *Example (Cost): Under the engineered scenario, the County is predicted to spend \$5.5 million for initial construction, and double this to rebuild flood control structures throughout the project site in another 60 years. The cost of construction can be included in the BCA as a public cost.*

Figure 4 presents some additional examples of the types of economic, environmental, and social impacts that the County and SLS stakeholders may wish to value to maximize utility of the BCA framework as a decision-support tool.

Figure 4. Snohomish County BCA Framework



Using the BCA Framework

As the County and SLS stakeholders determine the types and benefits and costs they would like consider in their holistic analysis, the BCA framework, built into an Excel workbook, can be updated and amended. The elements of the workbook, and several points of consideration, are presented below.

Change Log

The Change Log tab provides a running list of updates and changes that have been made to the BCA workbook. Columns allow users to document their updates and cite any necessary sources.

Scenario Overview

The Scenario Overview tab provides a brief narrative description of the identified action scenarios. At the time of this report, the County had identified three potential courses of action.

Adding Benefits and Costs

The sample BCA framework created by Earth Economics was built to incorporate an array of costs and benefits across multiple action scenarios. As estimates become available, they can be added to the workbook on the corresponding scenario tab(s). To understand how benefits and costs impact various stakeholder groups, and to provide transparency on how estimates were calculated, the BCA framework suggests the following template for each line item:

- *Program*: A classification of the type of benefit or cost. Current categories include Flood, Land, Fish, Forest, Regulation, and Capital Costs. Including a program categorization scheme will allow for a nuanced perspective on the distribution of benefits and costs across stakeholder groups.
- *Category*: Indicates whether the item is a public or private benefit or cost. Public benefits and costs are any estimates that would impact the County or the natural assets that are valued by the general public.
- *Name*: Name describing the benefit or cost.

- *Rationale for Inclusion:* A brief explanation of why the benefit or cost is included. This section is particularly important for non-market benefits and costs.
- *Basis/Methodology:* For transparency, the framework provides users the opportunity to document how an estimate was calculated and any assumptions that were made.
- *Monetized Benefit:* The present value of the benefit or cost, dictated by the selected discount rate.
- *Certainty:* On a scale of one to five, how certain is the estimated value associated with the benefit or cost?

The Nuance of Benefit-Cost Valuation

While preparing a BCA is a relatively straightforward task, estimating the actual benefits and costs is a nuanced process. As the County and the SLS Stakeholders determine the values to be included in this framework, they must also take into account the following considerations.

- *Viewpoint:* When considering the inclusion of a benefit or cost, it is important to clarify the viewpoint from which the estimate originates (i.e. who pays for the cost or receives the benefit). There is an important distinction to make between benefits and costs that affect the party of interest, and the benefits and costs that impact other parties but not the party whose viewpoint is being considered. For example, if the BCA only considered the private perspective, avoided flood damages to landowners would be a prominent benefit, but County-incurred costs for reducing flood risk would be omitted.

To distinguish stakeholder viewpoints, this BCA framework separates benefits and costs into public and private perspectives. However, results are reported for all perspectives combined to ensure that Snohomish County and the SLS stakeholders move forward with a floodplain management plan that benefits everyone.

- *Granularity:* Those using the BCA workbook will often need to make judgment calls on the level of granularity for estimated benefits and costs. While detailed information tends to be better, there is often a tradeoff between using a reasonable estimate and going to lengths to get an exact number that has a minimal marginal impact on the BCA results. It is important to remember that benefits and costs, more often than not, are estimates that can provide useful information, even if they are not exact.

- *Benefit, Cost, or Both:* Occasionally, someone's loss is someone else's gain. While the SLS is dedicated to seeking "win-win" solutions to farm, fish, and flood problems, the framework will often show a benefit to one party that involves a cost to another. For example, in the passive scenario, the estimated value for the cost of easements incurred by the County also shows up as a benefit for private landowners.

Data Summary

The present value of benefits and costs estimated for the 75-year timeline of each scenario is aggregated in the Data Summary tab. This tab reports the present value of benefits and costs according to the predetermined discount rates (zero and three percent), and breaks down estimates into the public and private perspective. For a more nuanced view of the benefits and costs, the Data Summary tab also breaks down the total estimated benefits and costs for each scenario by "program" type (i.e. flood, land, capital costs).

The benefit-cost ratios (BCR) reported on the Data Summary tab provide an overview of the return on investment for the action scenarios. BCRs of less than 1.0 indicate a negative return on investment. BCRs above 1.0 indicate a positive return on investment.

Recommendations and Next Steps

This report provides context for the BCA framework provided to Snohomish County and SLS stakeholders and explores the importance of including ecosystem services and social impacts in the County's decision-making process. Earth Economics' earlier work revealed that the Lower Skykomish Reach and its associated sub-basin provide a significant amount of goods and services to the area every year. **Any decision with the potential to affect the value of the goods and services provided by this important ecosystem must consider the entire range of benefits and costs to ensure that a course of action will maximize net public benefits.**

Understanding the immense value of ecosystem services, which ultimately shape the regional economy, is a critical first step in developing policies, investing public dollars, and making decisions regarding natural resource management and flood mitigation. The sample BCA framework created for this project covered a subset of the potential economic, environmental, and social benefits and costs arising from the implementation of the County's identified

scenarios. However, more work needs to be done to quantify the impacts of the potential courses of action.

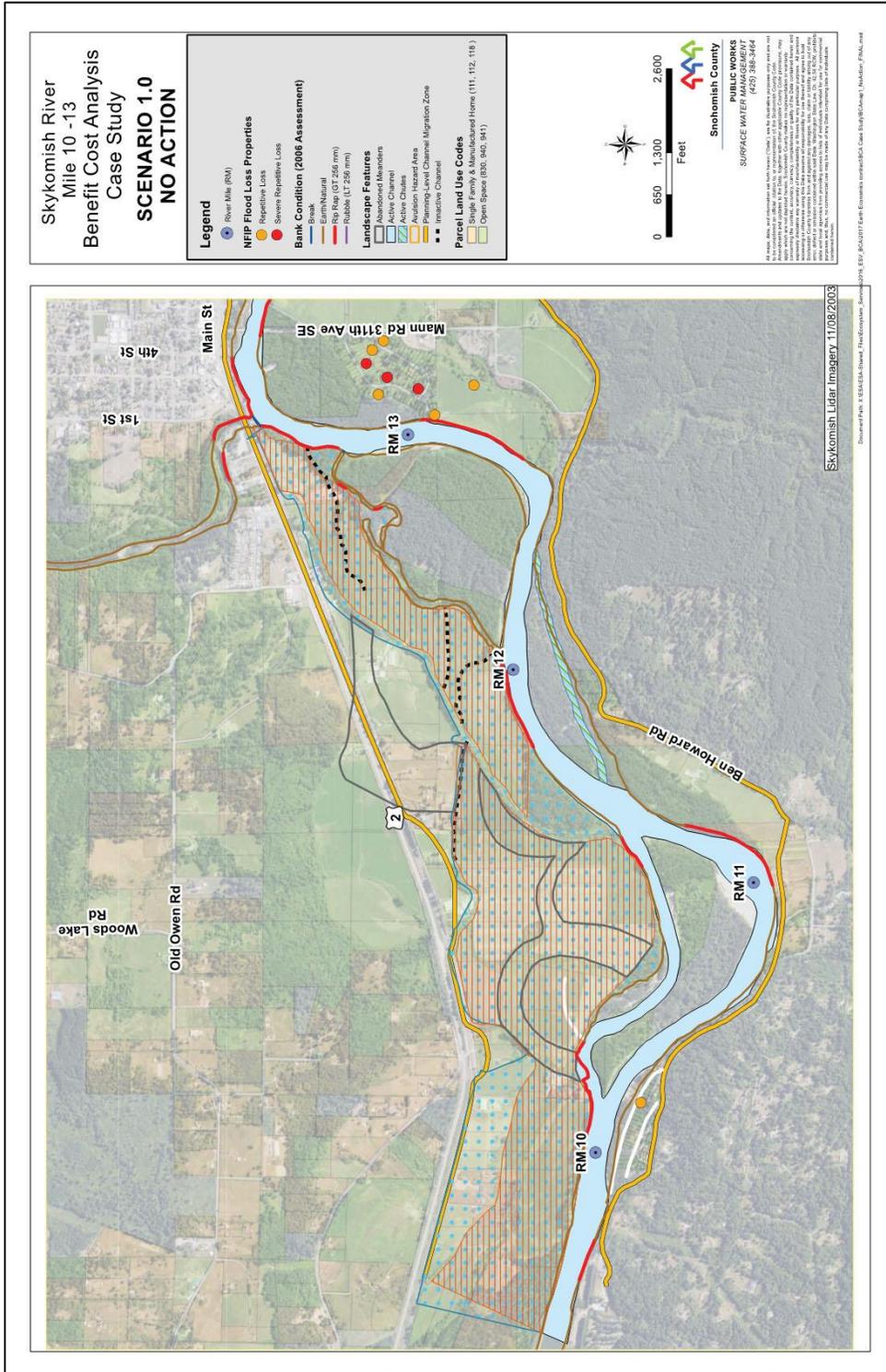
Earth Economics recommends the following next steps:

- **Include Ecosystem Services and Social Benefits in Future Benefit-Cost Analyses.** As county officials and SLS stakeholders consider courses of action to address floodplain management needs in the region, they should consider the costs and benefits of their actions with regard to ecosystem services. BCAs that incorporate ESV can provide governments, organizations, and private landowners a way to calculate the true rate of return on conservation and restoration investments. Including ecosystem services values also allows for the full consideration of green and grey alternatives to infrastructure projects. A handful of state and federal agencies, including FEMA, already include ESV in their formal BCAs (Mitigation Policy FP-108-024-01, 2013). Snohomish County should join the ranks of these leading agencies and include ESV in future BCAs.
- **Develop Predictions for Anticipated Landcover Changes.** Many of the benefits of a healthy ecosystem are identified through landcover classifications (i.e. wetlands, river, and pasture). To understand how the goods and services provided by a specific landcover will change under different action scenarios, the County and SLS stakeholders need to develop predictions of future landcover. Will easement properties be converted into riparian forests? Will erosion turn portions of the existing agricultural lands into river area? The answers to these questions will provide meaningful estimates of the expected changes in the value or ecosystem services provided by different landcover types.
- **Incorporate Ecosystem Services Values into Valuations of Productive Land.** Snohomish County and SLS stakeholders are considering purchasing easements from local farmers under one of the identified action scenarios. Any attempts to place a fair market value on productive land must also consider the value that the land provides in terms of ecosystem services. Traditional valuations fail to account for the immense contribution of a single acre of land to the health and vitality of local ecosystems, which in turn support the health and vitality of the local economy. To ensure farmers are fairly and adequately compensated when selling easements, the value of ecosystem services provided by their land must be considered.

- **Engage Stakeholders to Expand Benefits and Costs Under Action Scenarios.** Ultimately, a holistic BCA for the Lower Skykomish Reach is meant to support the County’s decision-making process and base its decisions on what people value, as opposed to solely the market transactions that take place. While our framework included some initial benefits and costs for each scenario identified by Snohomish County, additional work is needed to ensure that all benefits and costs that can be attributed to an action scenario are included in the document.
- **Protect and Restore Natural Capital.** Farmland preservation, salmon habitat restoration, and flood damage mitigation are priorities for the County and SLS stakeholders. SLS partners can help accelerate this work by advocating for the acceptance and application of ecosystem services valuation and a holistic approach to benefit-cost analysis in the County’s planning process. Taking this approach will lead to additional conservation efforts throughout the County and support the long-term economic growth of the region.

Resilient communities and economic sustainability rely on healthy ecosystems. The Lower Skykomish and its associated sub-basins provide goods and services to Snohomish County and the greater region. Protecting this area from flood damage, and restoring the Skykomish Watershed, are critical steps to improving quality of life for residents and to securing sustainability, justice, and economic progress in the region.

Appendix A



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