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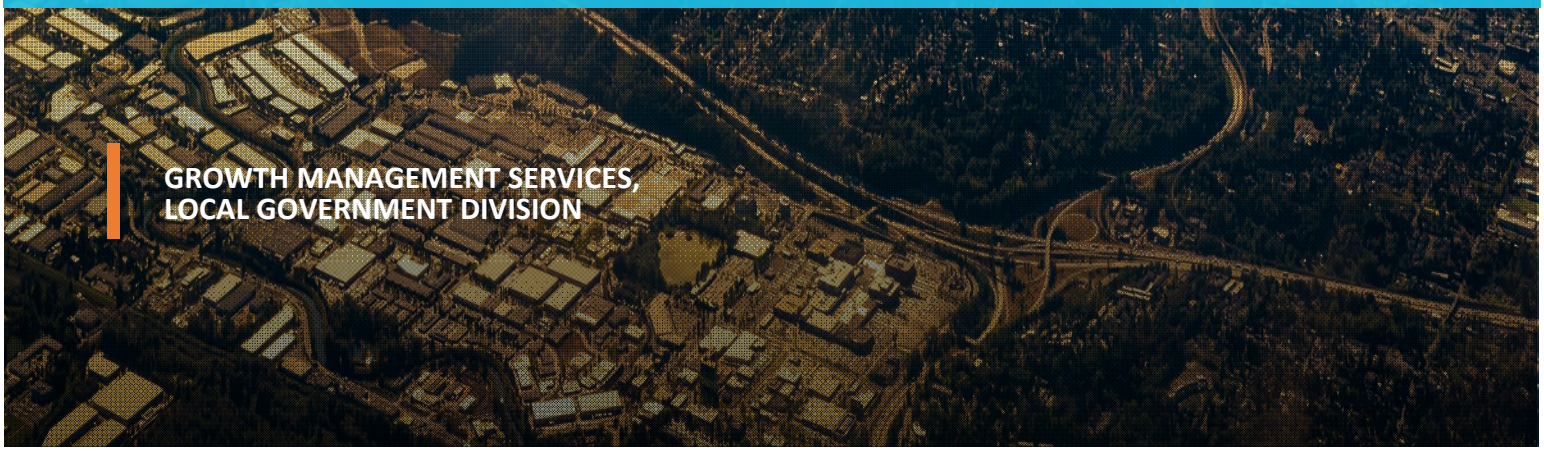
Decision Support Tool for Critical Areas & Land Use Planning:

Prospectus for Tool Development



GROWTH MANAGEMENT SERVICES,
LOCAL GOVERNMENT DIVISION

Decision Support Tool for Critical Areas and Land Use Planning

Tool Development Prospectus

NTA # 2018 – 0735

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Table of Acronyms

API	Application Programming Interface
BAS	Best Available Science
B-IBI	Benthic Index of Biotic Integrity
CAO	Critical Areas Ordinance
C-CAP	Coastal Change Analysis Program
DAHP	Department of Archaeology and Historic Preservation
EEMS	Environmental Evaluation Modeling System
EMDS	Ecosystem Management Decision Support System
FEMA	Federal Emergency Management Agency
GUI	Graphic User Interface
GIS	Geographic Information System
GMA	Growth Management Act
HCI	Hydrologic Condition Index
HRCD	High Resolution Change Detection
HRLC	High Resolution Land Cover
OCIO	Office of the Chief Information Officer
OSAT	Open Space Assessment Tool
NHD	National Hydrography Dataset
NOAA	National Oceanic and Atmospheric Administration
NWI	National Wetlands Inventory
PHS	Priority Habitats and Species
PSMP	Puget Sound Mapping Project
PSP	Puget Sound Partnership
PSWC	Puget Sound Watershed Characterization
REST	Representational State Transfer
RFI	Request for Information
RFP	Request for Proposals
SMA	Shoreline Management Act
SMP	Shoreline Master Program
TDR	Transfer of Development Rights
UGA	Urban Growth Area
WDFW	Washington Department of Fish and Wildlife
WISAARD	Washington Information System for Architectural and Archaeological Records Data
WRIA	Water Resource Inventory Analysis

EXECUTIVE SUMMARY

Local governments are experiencing significant challenges with planning for growth and development while also protecting critical areas, due to limited land resources, development pressures, and complex planning processes. Finding solutions requires evaluating and balancing many competing factors and requirements to find the best plans for land use. While there are a number of modeling and mapping tools available to help jurisdictions with the planning process, the tools are not well integrated. Planners are often unaware of all the spatial analysis tools available and lack the capacity and/or expertise to put them together for decision making. This prospectus outlines a plan for developing a web-based spatial decision support tool to help local planners evaluate multiple scenarios and parameters for comprehensive land use planning in the Puget Sound region. Prior to full development, Commerce wanted to ensure that efforts would be worthwhile and achievable, and that we fully considered the associated barriers and risks. This prospectus 1) conceptualizes the tool, 2) presents the priority needs of users, 3) demonstrates that technologies, consultants, and institutional capabilities are available to develop the tool, 4) identifies the risks, barriers, and solutions associated with developing the tool, and 5) describes a plan for tool development. This prospectus is based on input from stakeholders, end users, and an advisory team of local government planners, resource agencies, and tool developers. In all, we worked with over 135 individuals from 64 different organizations.

Needs and Priorities for the Tool

Our extensive stakeholder engagement process confirmed the need for an integrated land use planning tool and allowed us to prioritize the functionality and end uses that the tool should be able to support. 116 stakeholders surveyed said that an integrated, regional tool would provide added value for their work, and more than 100 stakeholders believe developing such a tool is extremely or very important. Planners anticipate using the tool throughout multiple planning processes, including supporting comprehensive and shoreline master planning decisions, integrating city and county planning, improving planning at the watershed scale, and restoration and recovery planning.

The most important need is to bring together the best available science (BAS) for critical areas planning into one tool and provide a decision framework to help planners put that information together in support of local planning processes. The most important general uses for the tool include:

1. **Identifying and protecting critical areas** by mapping critical areas and landscape connections, showing the most significant areas for ecological functions, and providing recommendations for managing development while protecting critical areas.
2. **Improving protection and compliance** by showing where development and disturbance has impacted critical areas and sensitive watersheds, assessing no net loss of shoreline and critical areas, and assessing where regulatory changes are needed.
2. **Informing development density decisions** by identifying the most appropriate areas for development based on multiple end user goals and needs, assessing the impacts of zoning and buildout scenarios, and linking land use decisions with their effects on critical areas.
3. **Informing restoration decisions** by determining the highest value places to restore, assessing alignment of zoning and development with restoration priorities, and evaluating benefits of restoration for ecosystem services.

The design for the tool is structured to support these four general uses by including the requested functionality and data to answer key questions for each of them. Tool functionality will help users find areas of compatibility for competing goals and interests, calculate cumulative effects of land use decisions over time, and more effectively communicate information to decision makers and stakeholders.

Conceptual Design for the Tool

The tool will integrate existing maps, models, and datasets to allow users to view and analyze the relationships between multiple points of interest. It will also include a web interface that allows planners to use datasets in a decision support framework and assess alternative land use planning scenarios. The proposed structure includes several interconnected components:

1. **A web mapping application/user interface**, which will display map layers and metrics based on user inputs, help users understand data, allow users to export data and share new data, provide querying and filtering tools, and guide users through decision analyses.
2. **A landscape prioritization tool**, which will show the best areas for development, protection, and restoration actions based on planning priorities, resource management recommendations, potential ecological and land use impacts, and landscape features and condition.
3. **A scenario analysis tool**, which will allow users to define zoning, regulatory, and restoration scenarios to calculate their effects on metrics related to land use, critical areas, and ecosystem services.
4. **Ecosystem services modeling tools**, which will provide function and values analysis to show which areas are most important for ecosystem services.

This functionality can be used to support multiple specific planning decisions, including Urban Growth Area (UGA) expansions, upzoning, rural zoning density, selection of restoration/mitigation sites, and Critical Areas Ordinance (CAO) updates. We researched similar products and tools that can be used as examples or adapted to build each feature, and found at least four existing platforms we can build from to create the proposed tool. We will continue to engage stakeholders throughout the tool development process to ensure that we deliver a useful product that meets the needs of planners and agencies.

Tool Architecture and Key Data

Tool architecture will include a web client, a web server, and a map server. The client will present a graphic user interface (GUI) for viewing and downloading data, metrics, and maps in a web browser and guiding users through the decision support tools. The web server will house the web application and scenario definitions, and will provide decision analysis and scenario processing engine services. We have identified multiple products that could be used as the back end processing and integration engine and several tools that can be used to build an effective GUI. An ArcGIS map server will provide services for more complex maps. Server-side components may be hosted on Commerce's servers or in the cloud, depending on processing needs, the platform selected, and final decisions about where the tool should be housed. Tool architecture will be finalized based on the vendor and platform selected in the next phase.

Most data will be shared with the tool via web services hosted by the originating agencies. However, jurisdictions will likely have some datasets that need to be uploaded and hosted locally, with appropriate data sharing agreements. Our research suggests that most data will be open and publicly available, but

we will include a sign in process for secure data. All data included in the tool will contain metadata that follows best practices. Metadata and security for data brought to the tool will be the responsibility of the organization that provides it. We will develop a data dictionary and other guidance to help users understand the data and models and their appropriate uses.

We have done initial research and coordination on data and models from agencies and jurisdictions that can be used as starting points for the scenario analysis tool. These include critical areas maps from resource agencies and local governments, standardized land use and zoning maps, hydrologic and watershed condition indices, high resolution land cover and change detection maps, cultural resource information, recovery and restoration maps, climate change maps, and ecosystem services models. These have all been identified as important components of the tool, and initial coordination with agencies and jurisdictions indicates that they can all be integrated. However, there will be a substantial effort needed to gather all the necessary data, coordinate with jurisdictions and agencies on data sharing, and translate inconsistent attributes for use in the tool.

Tool Maintenance

The tool and the data it relies upon will need to be sustainable. There will be maintenance and updates needed for the tool itself, the data the tool uses from other agencies, and the data created and stored by the tool. Long-term funding and a committed steward will be needed for repairs, maintenance, and updates to the tool. We have identified three viable options for tool ownership and housing, including hosting the tool on Commerce's servers, our vendor's servers, or through a contract with WaTech. We believe hosting the tool on our vendor's servers may be the best option for ongoing maintenance, but the final decision on where to host the tool may depend on the vendor and platform selected.

Most data used in the tool will be linked to web services hosted by the originating agencies or organizations so they can update their own data and keep internal data maintenance needs minimal. Agreements and processes will be developed to ensure datasets are updated frequently enough to be useful in the tool, and that updated versions remain compatible with it. Models will be designed to run using any dataset with the same structure. When links or data structure change between updates, some minor maintenance may be needed to update the link or ensure proper functionality within the tool. A user interface will be included to facilitate mapping of any newly structured or added datasets to the correct format. The tool will also need to be able to handle cases when data is not available.

We will build in capacity to update and expand the tool, and we will gather analytics to inform future updates. We plan to build a platform that can be expanded to include additional questions, use cases, data, and models over time.

Use of the Tool

Commerce will provide detailed guidance on use of the tool and data to support planning decisions, both within the tool and as supporting documents, as well as disclaimers about appropriate use. We will work with planners to ensure that tool outputs can be correctly and consistently applied to several specific planning decisions by providing a decision support framework and guidance that includes needed information and agency recommendations. Results will be viewable in real time, allowing planners to analyze and compare alternative planning scenarios during planning meetings.

Target end users are long-range planners, and the tool will be tailored to support broad and mid-scale planning needs. It will also be useful for regional planning, restoration and recovery conservation efforts, review of plans by regulatory agencies, and some permitting processes. We intend for the tool to also be usable by citizens to facilitate public participation and understanding of critical areas issues. To prevent misuse of the tool and data we will keep analyses at appropriate scales and limit choices based on BAS. Tool design will be user-centered for quick and easy use, both for looking up critical areas information and for more complex scenario analysis. Because regional data is often too coarse for local use, we will provide transparency and allow jurisdictions to use their own data.

To encourage local adoption, we will provide programs for training and technical assistance, and may develop the tool in a way that provides safe harbor and assurances. A good outreach and marketing campaign will be needed to tell decision makers and planners how the tool will make their jobs easier, and we will solicit and respond to feedback from end users throughout the development process.

Tool Development Process and Business Architecture

We have completed the preliminary phase of concept development and feasibility research for the tool and are ready to move on to tool development. The first phase will include: working with a vendor to develop detailed workflows and finalize the tool architecture; data compilation, assessment, and formatting tasks; and complete buildout and testing of a beta version of the tool. The beta version will bring together several key data variables and provide limited scenario analysis functionality in support of at least two specific planning decisions. Following successful completion of the beta tool, we will pursue full build-out in the second phase, develop a plan for ongoing support and maintenance, and develop a training and marketing program. The final product will be a fully functional web-based spatial decision support system capable of handling all the priority use cases, and to which additional scenario analysis functionality can be added in future updates.

We have identified the management team structure needed to implement this process and ensure quality control. It will include: a) one or two contractors for tool design and development, which may include separate contractors for back end development and GUI development, if necessary; b) one contractor experienced in geospatial technology to serve as project manager and complete data management tasks; c) Commerce project owners and advisors; d) partner agencies and local jurisdictions; e) a stakeholder/advisory committee; and f) a consultant experienced in helping local jurisdictions with their planning processes to provide guidance on meeting local needs. We will also work with the Office of the Chief Information Officer (OCIO).

Addressing Potential Barriers and Risks

Based on our research and input from advisors and other stakeholders, we have identified unique challenges to consider for scoping the tool, data and model inclusion, use of the tool, tool development, funding, and maintenance. Several of the key risks and challenges include the following:

> **Scoping risks and challenges** include trying to take on too much, missing important questions, changing priorities, and project team changes. We have already invested significant effort into narrowing the focus to support stakeholder priorities, and we developed a phased implementation approach to ensure that we deliver an achievable initial product. We will build the tool as a platform to which new data and functionality can be added over time to address new

questions and priorities. We will continue to engage stakeholders and partners, using a governance structure to help make decisions. Project vision and scoping decisions will continue to be documented in case of future project team changes.

Data and model risks and challenges include accuracy, consistency, availability, scale, errors, limitations, and differences between models and reality. Preliminary review indicates data and models to answer all key questions are available and can be integrated, and we will build the tool as a platform that allows data and models to be swapped out as better sources become available. We plan to use regional data for coverage, but end users can add and use more accurate local data where available. Analyses will be aligned with data at appropriate scales. We will use existing validated models and document new assumptions. Areas of uncertainty will be shown and we will provide transparency about limitations. The biggest challenge will be gathering and standardizing data from various sources, and we have built in time and budget to address these tasks.

Tool use risks and challenges include difficulty applying information to decisions, user differences, citizen use, misuse, and local adoption. We will work with planners to provide a decision framework and guidance for applying the tool. The tool will be useful both as a look-up resource and for scenario analysis to meet needs of different users, and will include a user-friendly interface for ease and speed of use. To prevent misuse by planners and citizens, we will limit analyses based on scale and BAS, provide guidance, and develop disclaimers, and we may place some restrictions on access. To promote use of the tool by local governments, we will provide training and technical assistance programs, and allow use of local data.

Tool development risks and challenges include securing sufficient funding, finding a suitable contractor, database interoperability, processing power, and data security. Securing sufficient funding remains the biggest risk of this project, but we have taken steps to reduce this risk by developing a phased implementation approach and adapting existing software platforms to reduce costs. Our research indicates that there are at least 15 interested contractors with the experience and expertise to build the tool, minimizing the risk of not finding a suitable contractor. We will include interoperability requirements and set up a standard data structure with translation tools to facilitate database interoperability, incorporate a login system to limit access to secure data, and obtain additional processing power through cloud computing services if needed.

Maintenance risks and challenges include securing long-term funding and stewardship to keep the tool and data up to date. We have identified multiple options for hosting the tool, including hosting it on our vendor's servers to facilitate maintenance and updates. We will link to datasets hosted by originating organizations as much as possible to reduce the internal data update burden. The tool will include a mechanism for users to update data links and match changed data attributes with the required structure. We will gather analytics for improvements and leave room for new features to be added. Unknown availability of long-term funding remains the biggest risk for tool maintenance.

This plan describes solutions for mitigating and addressing these barriers and risks. Our research of similar products and vendors has already shown that all needed tool requirements can be implemented by vendors using existing platforms. After careful consideration of the risks, barriers, and solutions, we

believe that the risks are acceptable and there are no barriers that will prevent us from developing a tool that is useful and sustainable, given sufficient funding for development and maintenance.

Prospectus Outcomes

We have developed a conceptual design for a decision support tool for critical areas and land use planning based on needs and priorities of local governments and resource agencies. Through our work researching and developing this prospectus, we established that 1) there is significant demand for the proposed tool from more than 100 stakeholders, 2) there are at least four existing platforms that we can build upon for tool development, and many more examples that can be used as a guide, and 3) there are at least 15 skilled contractors that can be utilized to build the tool. The technology and data needed to build the tool are readily available and we have developed solutions to mitigate and address risks and barriers. The biggest remaining risk is securing adequate funding for tool development and long-term maintenance, and we have taken steps to reduce this risk through phased development, utilization of existing platforms, and hosting decisions. We have carefully considered the need for and benefits of the tool alongside the remaining risks and barriers, and concluded that tool development is both worthwhile and achievable. Providing this tool for local planners would improve decision making by allowing better integration of critical areas planning with other comprehensive planning elements, improving access to and use of BAS, and allowing planners to show their work and justify decisions for stakeholders and reviewers. It would improve efficiency in local planning processes, saving individual jurisdictions time and money.

1. INTRODUCTION

The Washington State Department of Commerce coordinates the implementation of the Growth Management Act (GMA; RCW 36.70A). In this role, Commerce provides technical assistance and tools to local governments for meeting their critical environmental area protection and other land use planning requirements. Local governments are experiencing significant challenges with planning for growth and development while also protecting critical areas, due to limited land resources, development pressures, and complex planning processes. While there are a number of modeling and mapping tools available to help jurisdictions with the planning process, the tools have not been integrated to provide for efficient, balanced, and comprehensive planning. In addition, our research shows that planners are often unaware of all the tools that exist and lack the capacity and/or expertise to put them together in support of decision processes.

In 2019, Washington State Department of Commerce received funding through the Environmental Protection Agency in partnership with the Puget Sound Partnership and Washington Department of Ecology to scope and develop a prospectus for a new web-based spatial decision support tool to aid local planners in evaluating multiple planning scenarios and parameters for comprehensive land use planning in the Puget Sound region. The tool will integrate existing maps, models, and datasets to allow users to view and analyze the relationships between multiple points of interest. It will also include a web interface that allows planners to use datasets in a decision support framework and assess alternative land use planning scenarios. Providing such a tool would improve decision making by allowing better integration of critical areas planning with other comprehensive planning elements, improving access to and use of best available science (BAS), and allowing planners to show their work and justify decisions for stakeholders and reviewers. Because our initial funding came through the Puget Sound Partnership, the project currently focuses on the greater Puget Sound region, but it could be expanded statewide.

Project Overview

- Year 1: Research and scope the feasibility of developing an integrated decision support tool for land use planning.
- Goal: Show that an integrated tool is needed and achievable.
- Future efforts (*funding dependent*):
  1) Develop modeling and spatial programs to integrate existing maps and models into a decision support tool for comprehensive planning.
  2) Develop a web-based interface to allow for end user analysis of multiple planning scenarios.

Prior to tool development, Commerce wanted to **ensure that efforts would be worthwhile and achievable, and that we fully considered the associated barriers and risks in a prospectus**. The next phase will involve further scoping to line out the details of how to link datasets and models to achieve the proposed concept, and outline a plan for implementation.

The goals of developing this prospectus were to:

1) **Understand end user needs** and priorities for the tool, in order to understand the demand for a decision support tool and develop a business case for its development (i.e. justification for the project based on benefits and risks).
2) **Identify potential risks**, barriers, and challenges that will need to be addressed in the development of the tool, in order to incorporate solutions into project planning.
3) **Develop a conceptual design** for the tool that meets needs and addresses barriers.

4) **Research similar tools** and products that could be used as an example or incorporated, in order to show the feasibility of developing the proposed tool and reduce costs.
5) **Identify consultants** with the experience and expertise to develop the proposed tool, in order to show that there is sufficient availability of interested and qualified contractors who could be utilized.
6) **Draft a plan** for developing the tool

> *"I can't imagine a single planner that wouldn't be extremely excited about this project. It is possibly the most important tool to develop. It would save individual jurisdictions enormous amounts of time and money." – County Planner*

To develop the prospectus, we worked with stakeholders and an advisory team of local government planners, resource agencies, and tool developers. We also solicited information from local jurisdictions through end user surveys, conducted individual interviews, and researched similar tools and consultants. Through this work, we established that **1) there is great demand for the proposed tool, 2) there are existing tools and frameworks we can use as a guide or build upon for tool development, and 3) there are skilled contractors that can be readily utilized to build the tool** (Table 1). We have carefully considered this information along with the risks and barriers, and concluded that **tool development is both worthwhile and achievable.** The following sections line out the needs and priorities for the tool, a conceptual design that meets those needs, initial ideas for tool architecture and data, the development process, maintenance considerations, development of training programs and materials to promote use of the tool, solutions to barriers and risks, business architecture and costs, and partners and endorsements.

Prospectus Process

- Advisory meetings
- End user surveys
- Individual interviews
- Similar product research
- Request for Information (RFI)

Table 1. *Prospectus for Tool Development Goals and Outcomes*

Goal	Process	Outcome
Overall Goal: Show that tool development is worthwhile and achievable	Collaboration with stakeholders, advisors, and end users to research needs, risks, similar products, and contractors, and to write a prospectus for tool development	Conclusion: tool development is both worthwhile and achievable
1: Understand end user priorities and needs	Online survey, advisory committee meetings, individual discussions with stakeholders	Strong support and demand for the tool from local governments and resource agencies
2: Identify and address risks and barriers	Advisory committee meetings, online survey, discussions with stakeholders and tool developers, research	Workarounds and solutions to identified barriers, and plans to minimize identified risks.
3: Develop a conceptual design for the tool	Analysis of end user needs and priorities, compared with existing products and technology.	Conceptual design that meets priority needs, addresses barriers, and can be built using existing technology.
4: Research similar tools	Online research and exploration of similar tools, interviews with tool developers	Several existing platforms and tools can be incorporated to speed up development and reduce costs
5: Determine availability of qualified contractors	Request for Information (RFI), interviews with tool developers	Identified a pool of contractors with experience and expertise.

2. NEEDS AND PRIORITIES FOR THE TOOL

Commerce assembled a large advisory committee and conducted an extensive outreach and stakeholder process to assess needs and priorities for a critical areas and land use planning decision support tool. We received input from 135 planners and scientists affiliated with 64 different organizations, including 10 counties, 28 cities, 9 state agencies, 2 federal agencies, and 16 other organizations. This chapter provides a brief summary of information gathered through discussions with our advisory committee and end users, and our online end user survey(s). More detail and a list of participating organizations can be found in Appendix A: Summary of Needs & Barriers for the Tool.

Input from 135 planners & scientists affiliated with 64 organizations:

- 10 Counties
- 28 Cities
- 9 State Agencies
- 2 Federal Agencies
- 16 Organizations

2.1 General Need for the Tool

Planners are striving to follow state and local regulations and guidelines, meet multiple land use goals, and manage their growth with limited land resources. Some are moving beyond planning on a site by site or jurisdictional basis to solve problems at the watershed scale or integrate city and county planning. Others seek to implement restoration actions where they will have the most benefit for species and Puget Sound recovery. Many wish to assess and monitor how well their critical areas regulations are working. Many tools, maps, models, and datasets have been built to address individual challenges, but they have not been integrated to provide an interrelated picture of the multiple variables that need to be considered in land use planning.

"A tool like this sounds like it would be helpful for informing long-range projects and plans like PSRC's Vision 2050 and county comprehensive plans. Often there is a sense of where growth should occur theoretically, but having a richer, more integrated dataset would help identify where land use designations make the most sense on the ground." – City Planner

Our survey results and discussions confirmed the need for an integrated tool for land use planning. More than 80 percent of survey respondents (102 individuals) said that the tools they need for effective planning are not integrated and easy to use, and that developing an integrated tool is extremely or very important. The two biggest limitations preventing use of existing mapping and analysis tools are that potential users are not aware of all the available tools and the existing tools are not integrated, making combined viewing and analysis difficult.

Limitations of Existing Tools

- Not aware of all tools
- Tools are not integrated

92% of survey respondents: "an integrated, regional tool would provide added value."

End users need a tool that:

1) Includes current and regularly updated data
2) Is easy to use
3) Includes all information in one tool
4) Makes their work more efficient
5) Provides the ability to analyze and show relationships between datasets, layers, and tools

After exploring some of the proposed functionality, 92 percent of survey respondents (116 individuals) said that an integrated, regional tool would provide added value for their work.

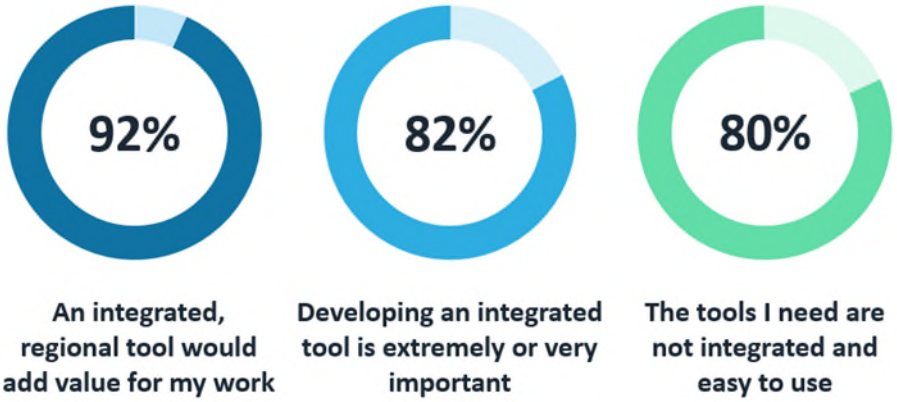

Figure 1. *Responses to survey questions about the need for an integrated tool.*

2.1.1 Bringing Together Information for Critical Areas Planning

Our analysis indicates that the most important need is to pull together all the information for critical areas planning into one tool. Long range planners are often scrambling to find information, or missing information. Many **models and databases already exist and are waiting to be used, but we are missing a platform for linking them**. Stakeholders believe the goal should be an authoritative one-stop platform that promotes use of BAS, identifies any data discrepancies, shows which data have been verified, allows jurisdictions to upload the latest local information, and is used at all jurisdictional levels. The tool will help communicate the data available to assist in planning processes, and this could be especially useful for smaller jurisdictions.

2.1.2 Using the Tool in Planning Processes

Survey respondents said they would use the tool throughout planning processes for multiple needs (Table 2). Most stakeholders believe the tool would be used regularly by local, regional, and state jurisdictions and agencies. The tool should be available to and well integrated within planning departments, natural resource organizations, realtors, businesses, and the citizenry to ensure the use of BAS and get everyone working with the same knowledgebase.

Table 2. *Potential uses of the tool*

Planning Processes	
Comprehensive Planning	Shoreline Planning
UGA Expansions	Buildable Lands Analysis
Critical Areas Regulations	Plan & Ordinance Review
Restoration Planning	Permit Review
Sub-Area Plans	Monitoring
Zoning Code Amendments	Feasibility, Design, & Budgeting
Puget Sound Recovery Planning	Communication

"Too much planning is done using poor quality information or is based on the 'these four other jurisdictions did it so it must be right' method. We've got lots of science and data but it needs to be useful to the practitioners and decision makers." – City Planner

2.2 Priorities for the Tool

Our research shows that the most important general uses for the tool include:

Figure 2. *Priority uses for the tool and key questions.*

The design for the tool was structured to support these four general uses and key questions (Figure 2). However, **other uses are also important to users, including planning for climate change, providing a tool for landowners to identify critical areas and conservation opportunities, analyzing changes in land use over time, and assessing the effects of land use decisions on regional recovery needs.** These needs and key questions have been recorded, and some may be addressed as add-ons in later phases of tool development, if time and funding allow.

2.2.1 Identify and Protect Critical Areas

Planners are required to identify and protect critical areas under the GMA, and this was the highest priority use of the tool for most stakeholders, including more than 85 percent of survey respondents (108 individuals).

#1 Use of Tool: Identify and Protect Critical Areas (108 respondents)

- Locations of critical areas and buffers
- Associated species & habitats
- Ecosystem services provided
- Impacts of development on critical area functions
- Benefits and land use impacts of regulatory scenarios
- Comprehensive regional critical area map for cross-jurisdictional planning
- Access to information on hazards
- Inventory of regulations and recommendations

Map Critical Areas and Landscape Connections

A comprehensive map of critical areas across jurisdictional boundaries would facilitate cross-jurisdictional planning and help develop connectivity and corridors. Users need a tool that shows the most significant areas for ecological functions to help guide restoration, mitigation, and protection efforts. It will be important to include hydrologic and landscape connections that affect critical area functions and health, and are needed to follow GMA requirements for protecting downstream resources. **The tool could be a powerful way to encourage jurisdictions to do both site by site planning and evaluate ecological connections to the whole system.**

Provide Information to the Public

The general public should be able to access information on critical areas, along with recommendations for how to manage land located in these areas. The tool could also be useful for showing where there are gaps in knowledge about natural hazards, and insurance underwriters and bankers might be interested in using it for risk assessment.

2.2.2 Inform Development Density Decisions

Informing decisions about where to allow more intense development was a high priority for most stakeholders, including 77 percent of survey respondents (98 individuals).

Find the Best Areas for Development

Users need a tool that guides them through the process of determining the most appropriate areas for development based on multiple goals and needs, including identifying opportunities for development, avoiding natural hazards, and minimizing impacts on critical areas and ecosystem services. Stakeholders believe the tool should help protect other important resources, such as aggregate and cultural resources, alongside critical areas for better integration of planning assessments. The tool could provide important information for buildable lands analysis.

#2 Use of Tool: Inform Development Density Decisions (98 respondents)

- Determine most appropriate areas based on multiple goals & needs
- Minimize impacts on critical areas & ecosystem services
- Avoid natural hazards
- Assess buildout & zoning scenarios
- Show land use connections to landscape & watershed processes

Show Impacts on Critical Areas and Ecosystem Services

Users need to assess the impacts of development on the response variables people care about, such as critical areas, hydrology, and connectivity. Land use decisions that occur outside critical areas can affect critical area functions, and some urban areas where planners presume density can be increased because there are no critical areas present are actually extremely important hydrologically. At the permit scale, more pressure is put on protection decisions when high density zoning is in place, so it is important to ensure that high density zoning designations are located in the most appropriate areas. Planners need to evaluate land use and zoning standards and policies along with their

connections to landscape processes and the health of watersheds in the region to find the best ways to allocate development in the future.

2.2.3 Inform Restoration Decisions

A priority for 80 percent of survey respondents (102 individuals) is to use the tool to determine the most important areas for restoration, assess how zoning and development aligns with restoration priorities, and evaluate the benefits of restoration in terms of ecosystem services and economic values. The tool could help focus restoration efforts in the best areas to achieve multiple benefits, and could align local restoration efforts with regional recovery needs. This application of the tool will become increasingly important if Net Ecological Gain becomes the new standard. It could also help justify restoration and mitigation projects by providing information on return on investment.

#3 Use of Tool: Restoration Planning (102 respondents)

- Determine most important areas for restoration
- Align zoning & development with restoration priorities
- Benefits of restoring areas in terms of ecosystem services
- Limitations from climate change
- Assess return on investment
- Apply solutions to causes of problems

Provide Recommendations for Solving Problems

Restoration actions are generally attempts to solve problems, but there is an issue of treating symptoms without getting to the root causes. Planners need access to recommendations for land use practices that can be applied to problems like flooding, erosion, or sedimentation in specific areas.

2.2.4 Compliance and Improved Protection

Monitoring and adaptive management are the most effective and efficient way to ensure that regulations are actually protecting critical areas and other sensitive areas over time. Compliance monitoring and identifying where sensitive areas need more protection was a high priority for 80 percent of survey respondents (102 individuals).

#4 Use of Tool: Compliance and Monitoring (102 respondents)

- Monitoring & adaptive management
- Development & disturbance in sensitive areas
- Vegetation removal in riparian areas
- Water bodies not meeting standards due to land use
- Impervious surface in sensitive watersheds
- Development in hazardous areas
- No Net Loss of shoreline and critical areas

Inform Critical Areas Ordinance Updates

During the Critical Areas Ordinance (CAO) update cycle, planners need to consider whether policy changes are needed to protect critical areas. Planners need to know where land cover change has occurred in or near critical areas, whether changes were in compliance with regulations, and the effects of those changes on ecological functions. Measuring net loss or gain of shoreline and critical areas would help determine if regulations are working.

2.2.5 Priority Tools and Scenario Planning Functions

To support these needs, **querying capability** and **ability to overlay many layers** are almost universally important to users. The top scenario planning functions users need include:

1) Cumulative Analysis of Land Use Decisions. Users need a tool to calculate cumulative effects of land use decisions over time and help communicate that information to decision-makers. Planners could use this information to inform land use activities or zoning. Analysis of cumulative impacts could be rolled up to track large scale changes over time and see how the region is doing on its priorities and no net loss.

2) Evaluate Buildout Scenarios. Planners need to assess alternative options for zoning in terms of their effects on critical areas and ecological functions over time. To allow planners to prioritize and differentiate between areas on the landscape, models will be linked in a way that recognizes that not every piece of ground has the same ecological or development value.

"[This tool is] very much [needed]…Our planning and permitting is still very much oriented to site by site review which cannot solve environmental problems that have their roots at the broad scale." – Resource Agency

3) Find Areas of Compatibility or Conflict for Competing Goals and Interests. Local government planners are especially interested in a tool that can help find win-win outcomes for allocating land to competing interests and requirements over the long term. Over time, jurisdictions will need to consider additional factors, so it will be important for the tool to be able to incorporate new variables in analyses as needed. For areas where competing goals and interests conflict, the tool can provide transparency in decision making processes by helping planners provide justification for decisions. The tool should be able to demonstrate to stakeholders how emphasizing a certain resource or priority over another changes land use and restoration decisions.

4) Calculate Benefits of Protecting Critical Areas or Doing Restoration Work. Allowing planners to calculate benefits and ecosystem service values of protecting critical areas or doing restoration work would provide a very powerful communication tool for explaining ecological processes and the need to protect them. The tool should use science to evaluate land use alternatives in terms of the effects on biological elements, as well as the risks, costs, and benefits for people. Stakeholders believe a tool that could report both ecological and economic impacts of different regulatory scenarios is needed to more effectively communicate with decision makers and citizens.

"Having a regional tool would allow us to compare apples to apples so we can figure out how to provide assistance that's most useful for each jurisdiction." – Resource Agency

5) Normalize and Standardize Land Use Effects. A related priority is to normalize or standardize the way land use effects are tracked and reported, creating a time and space context across land uses and jurisdictions at multiple scales. This will create a common ruler that can be applied around Puget Sound to compare one watershed or jurisdiction to another, which would benefit scientists as well as planners. Normalizing ecological functions would allow users to see the links between changes in land use, watershed functions, critical areas, and ecosystems, and could provide the ability to assess no net loss.

2.2.6 Supporting Planning Decisions in Local Jurisdictions

The tool will be structured to support long range planning processes by informing revisions to critical areas ordinances (CAOs), shoreline master programs (SMPs), urban growth area (UGA) expansions, and rural zoning density. It will help counties and cities determine whether changes in these regulations would protect and provide for no net loss of critical area functions and values.

Supporting Local Planning

- Structure to support specific comprehensive and long range planning decisions
- Decision framework for planners to put information and tools together
- Provide Best Available Science
- Show reasoning to the public
- Include local data

Provide a Decision Framework for Using Tools and Data Together

Local planning advisors said a decision framework that prioritizes areas to restore, areas to develop, and critical areas for protection based on BAS and knowledge of watershed processes would be useful.

Identify Best Available Data, Allow Data Uploads

Local planners requested easy access to standard information and BAS from resource agencies in an integrated platform. The platform should inform local governments about the available data and how it translates to their requirements. However, local governments also need to be able to use their own data in the platform, because local information is often more refined and detailed than regional datasets.

2.2.7 Opportunities for Commerce and Other Agencies to Guide Local Planning Efforts

Local planners on our advisory committee said the tool could provide an important opportunity for Commerce to guide the questions and information the agency wants local jurisdictions to consider during comprehensive planning, CAO and SMP updates, and for iterative decisions between updates. The tool should also be aligned with other city, county, and state agency mandates and could be used to bring the values of other agencies into the local planning process (Figure 3).

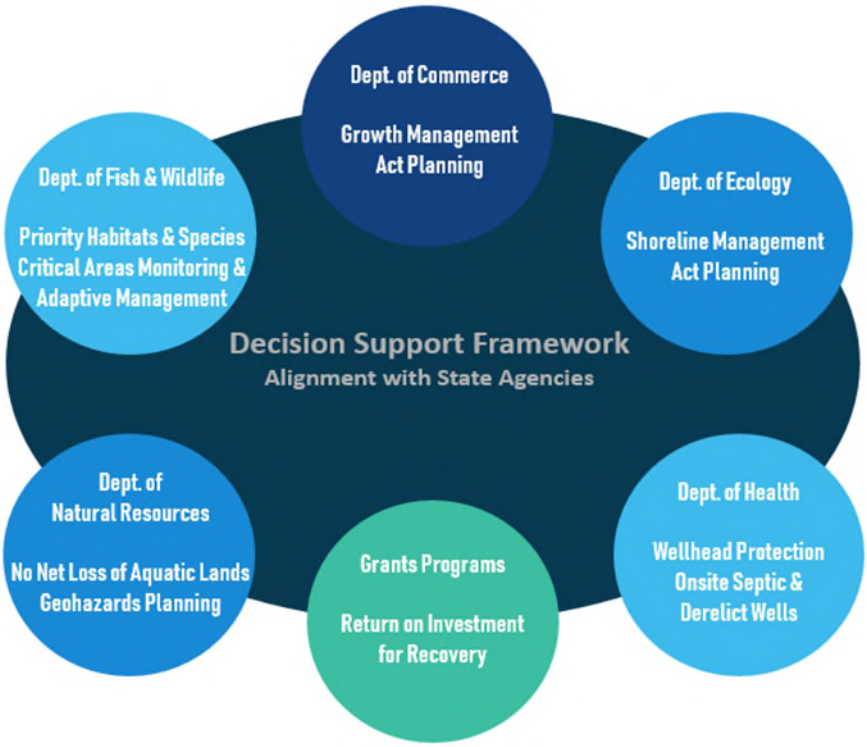

Figure 3. *Examples of decision support framework alignment with state agency values and regulations.*

Incorporate Best Available Science into Updates

A priority use of the tool for regulatory agencies and environmental organizations is as a means to incorporate BAS into CAO and comprehensive plan updates. By directing local governments to use the BAS, the tool could provide a standardized way of getting everyone operating on the same knowledge base. For data producers, the tool could help make sure users of their data are using it in a meaningful way. The tool could be used to document use of BAS and could allow agencies to review plans more efficiently. Some suggest that assurances or safe harbors could be provided if jurisdictions use BAS tools.

2.2.8 Tool Outputs: Online Mapping Application and Scenario Dashboard

The most requested tool output was an online mapping application (requested by 92% of survey respondents). The online mapping application should include a dashboard that allows users to experiment with different scenarios. Another important output is data downloads (63%), including the ability to download post-analysis GIS data from the tool for the user's study extent. Other important outputs include links to supporting documents (56%), printable reports (52%), and recommendations (44%).

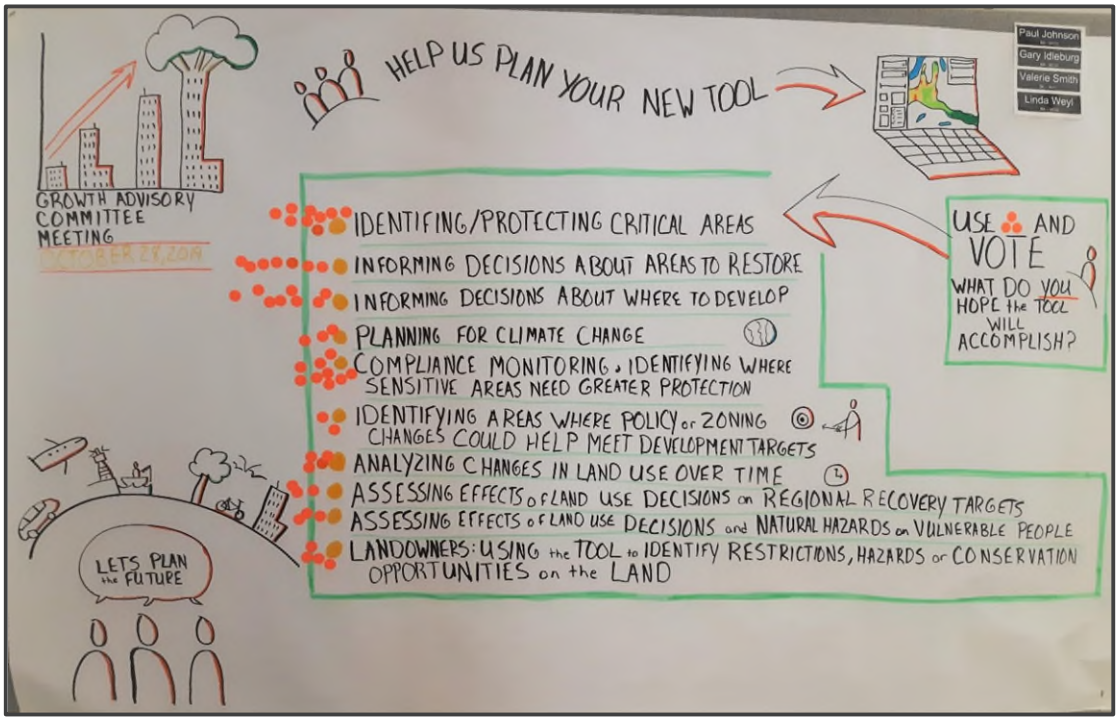

Figure 4. *Needs and priorities poster from our first advisory committee meeting on October 28, 2019.*

2.3 Conclusions about Needs and Priorities for the Tool

Our stakeholder engagement process and research has confirmed that there is high level of need for integration of tools to support local government planning processes for critical areas and other land use decisions. Based on stakeholder input, we were able to prioritize the functionality and end uses that the tool should be able to support to provide a multitude of benefits to local planners, resource agencies, and the public. The conceptual design for the tool presented in the following chapter was structured to support these uses and provide the requested functionality for data integration and analysis, including structured decision support for putting data and tools together to find the best areas on the landscape to implement changes and to evaluate alternative planning scenarios. We will continue to engage stakeholders throughout the tool development process to ensure that we deliver a useful product that meets the needs of planners and agencies.

3. CONCEPTUAL DESIGN FOR THE TOOL

The following outlines a conceptual design for how the tool can be structured to meet the priority needs described in the previous chapter. We also describe models and platforms with similar functionality that can be used to guide design for our larger, regional effort. The tools and products identified show that there are good examples we can use and build from, but they would need to be adapted or expanded for the specific region-wide planning needs of this project. For more information on the similar products mentioned in this chapter and a review of their utility for our purposes, please see Appendix B: Review of Similar and Useful Products. Some additional detail and information on key data sources is provided in Chapter 4, which describes tool architecture.

3.1 Tool Structure and Functionality

The proposed structure includes several components: 1) a web mapping application, 2) a landscape prioritization tool, 3) a scenario analysis tool, and 4) an ecosystem services modeling tool. The web mapping application will be the user interface that displays map layers and metrics based on user inputs. The landscape prioritization tool will show the best areas for development, protection, and restoration actions based on user priorities, existing infrastructure, and landscape features and condition. The scenario analysis tool will allow users to define zoning, regulatory, and restoration scenarios to calculate their effects on metrics related to land use, critical areas, and ecosystem services. The ecosystem services tool will provide function and values analysis to show which areas are most important for ecosystem services. All four components are interconnected and interrelated, so the results of each can become inputs to the others (Figure 5).

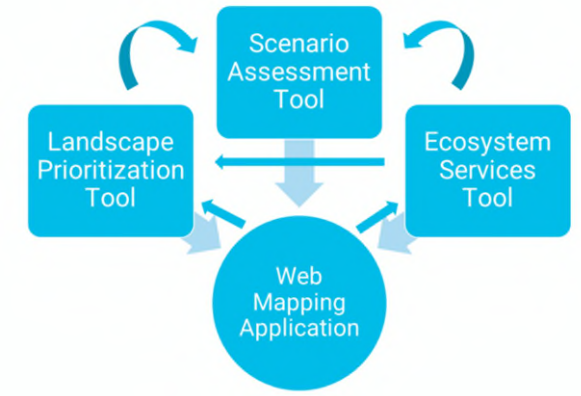

Figure 5. *Decision support framework components*

3.1.1 Web Mapping Application and User Interface

The front end of the tool will be a web mapping application with a user interface for data and decision analysis (Table 3; Figure 6). It will organize datasets in an online map interface that allows users to display and overlay layers. It will also provide an interface that allows users to share new layers and use them within the tool. For each map layer, dataset, or model included, information will be provided on data quality, coverage, and proper use. It will also identify which data sources are considered best available science (BAS). This platform will provide users with access to critical areas and land use planning data from multiple agencies and organizations in a shared location where it can be easily viewed, overlaid, and analyzed together.

Web mapping applications have become common and are easy to create and customize using existing tools such as Esri's WebApp Builder, ArcGIS Application Programming Interfaces (APIs), open source libraries such as Leaflet, or mapping and data exploration platforms like Data Basin. Tools for organizing and providing access to relevant data, and allowing users and organizations to share and find new data include Esri Portals and Hubs, and Data Basin gateways.

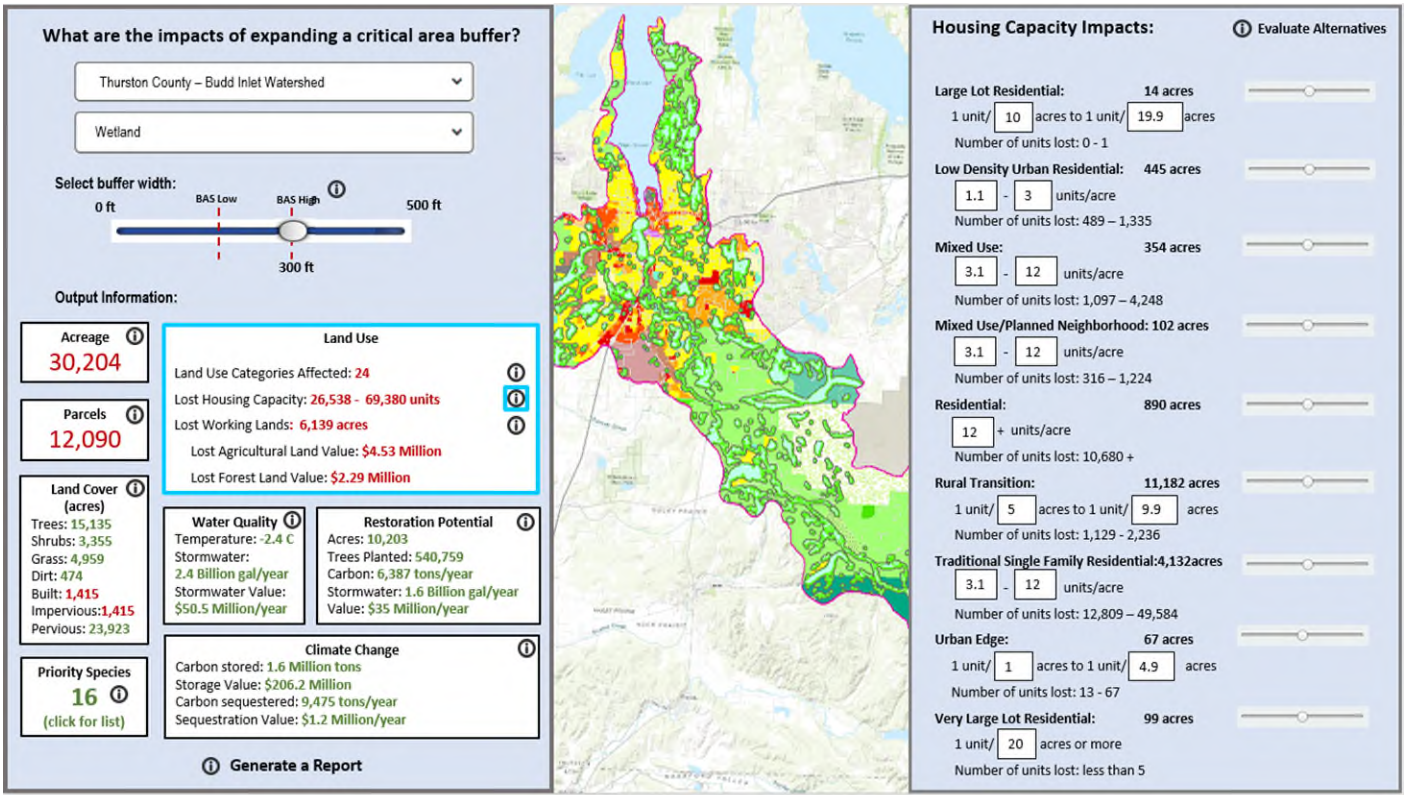

Figure 6. *Mock-up of the decision support tool user interface*

Querying, Filtering, and Measurement Tools

The map interface will allow users to query and filter data, both by attribute and by relationship to other layers. Planners will be able to use this functionality for self-guided analysis of features from layers that have certain attributes or spatial relationships to other layers, and for filtering landscape features (i.e. watersheds or parcels) based on multiple criteria (*see Table 3 for examples of use)*. Advanced querying and filtering capability is not commonly found in local government web mapping applications, and our research indicates that creating a web map with this functionality will provide significant added value for planners. Measurement tools, such as area and distance, will also be included.

Web Mapping Application Features

- Data organization & sharing platform
- Web mapping tools
- Advanced querying & filtering
- Measurement tools
- Decision support interface
- Save & export maps, scenarios, data,

All these analysis tools exist in Esri, Data Basin, and other application development platforms. We have reviewed several web mapping applications that implement filtering and querying particularly well. Peninsular Florida LLC's Florida Resource and Assistance Simple Map Viewer has slider bars and input fields that allow users to filter watersheds based on multiple criteria, like the amount of habitat available for different species or the amount of land that will be impacted by sea level rise. Trust for Public Land's Open Space Assessment Tool has a query building interface that allows users to query a parcel layer based on its relationship to multiple ecosystem service layers. Washington Department of Natural Resources' Geologic Information Portal has querying capability that uses standard Esri WebApp Builder tools.

Interface for Decision Analysis

The web mapping application will also include an interface for using the decision analysis tools for landscape prioritization, scenario assessment, and ecosystem services modeling. It will collect user inputs for each tool, such as selecting variables and parameters for the analysis and datasets to be used. It will also display the analysis results, both as quantified metrics on a dashboard and as map layers on the map (Figure 5).

We reviewed many examples of web interfaces for decision support tools, including the following:

- Model My Watershed and Pollination Mapper guide users through a process of defining land cover and conservation scenarios and calculating their effects on stormwater or crop yield using integrated models.
- SeaSketch, OceanReports, Resilient Land Mapping Tool, Open Space Assessment Tool (OSAT), and IPaC let users sketch a planned reserve, park, development project, or other area of interest and generate reports and metrics of its features and impacts based on intersection with various data layers.
- Restoration Prioritization Tool, i-Tree Landscape, and OSAT, allow users to input weighted criteria to prioritize areas for open space and restoration, and display maps of the results.
- Environmental Evaluation Modeling System (EEMS) is a logic model for landscape assessment that can be explored and modified by users online, and it is built into the RePlan Regional Conservation and Development Planning Tool, which lets users screen the landscape based on multiple criteria and then select sites for further analysis.
- Atlas of Ocean Wealth Explorer allows some user inputs for storm scenarios and links map layers with quantified ecosystem services, economic values, and statistics in a user-friendly display.

Each of these examples has features and design characteristics that we will want to consider when designing the interface for our tool. Esri's GeoPlanner platform also provides tools for integrating data and decision support functionality into a web interface that can be used collaboratively by planners (for both landscape prioritization and scenario evaluation). Our tool will likely combine some of these features and others in a customized interface suited to displaying the specific data, models, and metrics that are integrated. Design will also be guided by the specific needs of our end users.

Saving and Exporting Information

Additionally, users will be able to create, save and export maps, scenarios, reports, and data (pre- and post-processing). Many of the previously mentioned tools already provide these features in a variety of ways (Table 3). These include generating printable PDF reports with additional detail about metrics calculated, exporting shapefiles of map layers for use in desktop GIS programs, exporting data tables, exporting or printing custom maps, generating a unique URL that can be accessed in the future with all the same scenario and map settings applied, and saving results to user accounts that require sign in. Our tool will include most of these features, with user account sign in likely to be the primary method of saving scenarios for future use. For transparency and reproducibility, output reports will include a file containing all user-specified or scenario-generated thresholds, weights, buffers, and assumptions for documentation.

Table 3. *Web Mapping Application and User Interface Features*

Feature	Functionality	Example Use for Planning	Similar Product Examples
Data Organization & Sharing Platform	Easy access to land use planning data from multiple organizations, ability to share new data.	Access all the data for critical areas and land use planning in one place, learn about new datasets	Washington State Open Data Portal, Conservation Planning Atlas
Web Mapping Application	View, overlay, and analyze spatial data from multiple organizations together at local and regional scales.	Overlay critical areas data from multiple sources with other land use layers to see patterns across jurisdictional boundaries.	Various county and agency web mapping applications.
Querying & Filtering	Display or analyze subsets of features from layers that meet criteria or have a certain relationship with other layers.	1) Only show critical areas of high priority. 2) Only show land cover change within 300 feet of a critical area. 3) Only show watersheds that have > 50 acres critical areas, < 10% impervious, high watershed priority, and > 500 acres forest habitat.	Florida Resource and Assistance Simple Map Viewer, OSAT, Geologic Information Portal,
Measurement	Measure area or distance.	Measure size of critical areas, or distance from critical areas to roads.	Various county and agency web mapping applications.
Decision Support Interface	Gather user inputs for decision support tools and display results.	Input landscape prioritization criteria for land use activities. Input land use scenarios for evaluation. View metrics and calculated map layers.	Model My Watershed, Pollination Mapper, SeaSketch, OSAT, IPaC, Restoration Prioritization Tool, i-Tree Landscape, EEMS, RePlan
Save & Export Maps, Scenarios, Data, Reports	Save user-defined scenarios for future use, export maps and data pre- and post-processing, generate reports	Develop reports and maps to show results to decision makers. Save scenarios and criteria to rerun or modify them in the future. Export data layers for further analysis.	Model My Watershed, Pollination Mapper, SeaSketch, OSAT, IPaC, Restoration Prioritization Tool, Data Basin, Florida Resource and Assistance Simple Map Viewer, RePlan

3.1.2 Landscape Prioritization Tool

The landscape prioritization tool will prioritize landscape areas for development, protection, and restoration based on spatial data and weighted user criteria (Figure 7; Table 4). It will produce map layers and tables of prioritization scores that show the most and least suitable areas across the landscape for each of these land use priorities. Users will be able to select and weight variables to include in the analysis based on their jurisdictions' priorities and built in guidance related to BAS and other resource agency recommendations. Variables may include impacts to critical areas, impacts to watersheds, impacts on land use, restoration value, constraints, and other factors that a land use decision may be based on. Each variable will be linked to one or more spatial datasets or models, and users will be able to select the data source to use for each variable based on their needs and built in guidance on BAS and data quality. The tool will be clear about which

Figure 7. *Landscape prioritization tool framework*

variables are required to be considered in planning processes due to regulation, and which are optional but would result in better planning (i.e. watershed or ecosystem service-based planning). The variables and datasets that are initially included in the landscape prioritization models will be decided during the first phase of tool development based on identified needs and available data, in collaboration with end users, resource agencies, and data and modeling experts.

> *"People are talking about land use and how it plays out, but almost no one understands regulations, other local government programs that protect habitats, and how the big picture actually plays out."*
> *– County Planner*

Prioritizing Areas for Development Density

The tool will prioritize areas for development density based on the need to protect sensitive areas, avoid hazards, and consider other land use constraints. Protecting sensitive areas will include regulatory considerations for avoiding critical areas and buffers, as well as recommended considerations (i.e. minimizing impacts on watershed processes). Avoiding hazards can include various geologic hazards as well as hazards related to climate change and sea level rise. Land use considerations may include opportunities for development and existing infrastructure, as well as areas where other resource lands need to be protected (i.e. agricultural, forest, mineral, and cultural resources).

The results will include a map of the most and least suitable areas on the landscape for development density. Planners can calculate buildable land in the most suitable areas for development to see how much of their projected growth could be allocated to those areas. The results of this analysis could be used to support specific comprehensive planning decisions and processes that add density in the most appropriate areas and/or reduce density in the least appropriate areas through new development, redevelopment, and infill development. Examples include zoning code amendments, Urban Growth Area (UGA) expansions, sub-area plans, rural zoning density, and buildable lands analysis.

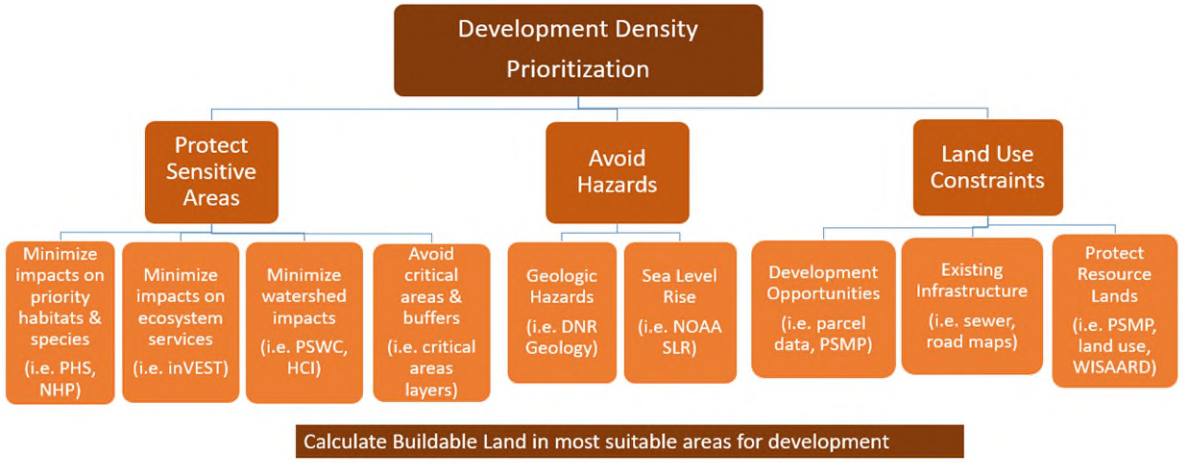

Figure 8. *Development density prioritization framework*

Prioritizing Areas for Protection

The tool will calculate prioritization of areas on the landscape for protection based on the need to protect sensitive areas, minimize impacts of regulations on land use, and protect other resource lands. Protecting sensitive areas may include regulatory and non-regulatory considerations based on BAS and resource agency recommendations, including protecting critical areas and buffers, important watersheds, areas on the landscape that are important for maintaining watershed processes, corridors for priority habitats and

species, and areas that are important for provision of ecosystem services. Minimizing impacts of regulations on land use will allow planners to explore tradeoffs in protection decisions and may include impacts on development capacity as well as use of working lands. Protecting resource lands can show where other resources need to be protected alongside critical areas (i.e. agricultural areas, forests, mineral resources, and cultural resources) and there may be win-wins or conflict between multiple goals.

> *"[The tool] could be a powerful way to get jurisdictions out of site by site planning and show the connections to the whole system." – Environmental Consultant*

The results will include a map that shows areas on the landscape that are imperative to protect. This analysis could be used to support regulatory changes for critical areas and sensitive watersheds, such as Critical Areas Ordinance (CAO) and Shoreline Master Program (SMP) updates. The protection prioritization maps could also be analyzed with land cover change maps to see where sensitive areas may be in need of more protection, as well as to assess compliance with existing regulations and/or potential benefits of proposed regulatory changes.

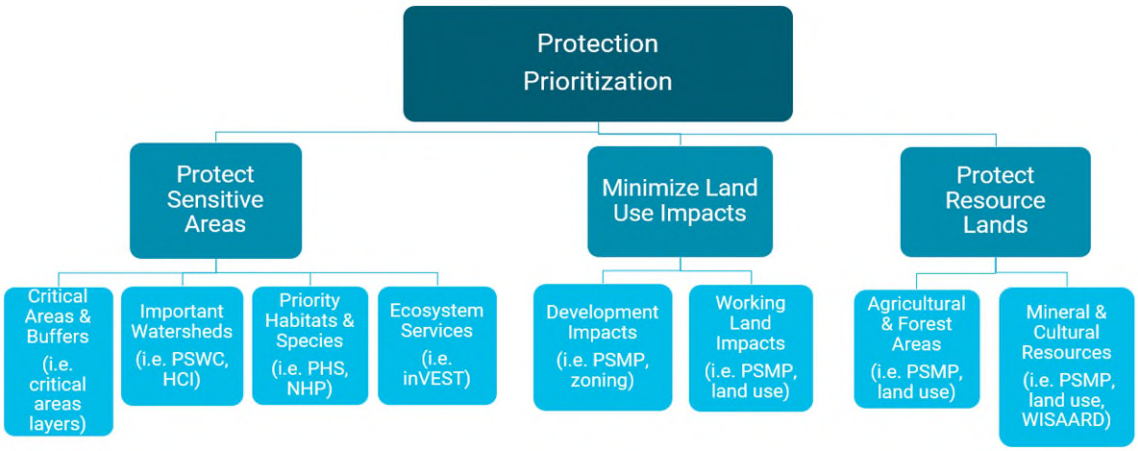

Figure 9. *Protection prioritization framework*

Prioritizing Areas for Restoration

The tool will calculate prioritization of areas on the landscape for restoration based on the need to restore the most important degraded areas, add to existing corridors, and consider constraints which may limit the feasibility of implementing restoration actions. Important degraded areas may be critical areas and buffers, as well as important watersheds, areas within watersheds that are most important for restoring watershed processes, important habitats, and areas where ecosystem services could be restored. The tool can also prioritize areas where land could be added to existing corridors for wildlife or open space. Constraints may be related to ownership and land use, as well as climate change impacts such as temperature projections and sea level rise.

> *"I think such a tool would be incredibly useful to inform local policies and plans, and project permitting (also restoration prioritization and mitigation opportunities)." – Environmental Consultant*

The results will include a map that shows the areas on the landscape that provide the highest restoration value. The tool will allow restoration value to be calculated based on a single priority goal, or by balancing multiple priorities to find the areas that would achieve the most benefit for multiple goals. The results can be used by planners when choosing

restoration or mitigation sites, as well as by funding agencies to target funds in areas that provide the most benefit for both local and regional recovery priorities. Going from a broad to a finer scale could create better alignment of local efforts with regional priorities to achieve the most benefit for Puget Sound recovery.

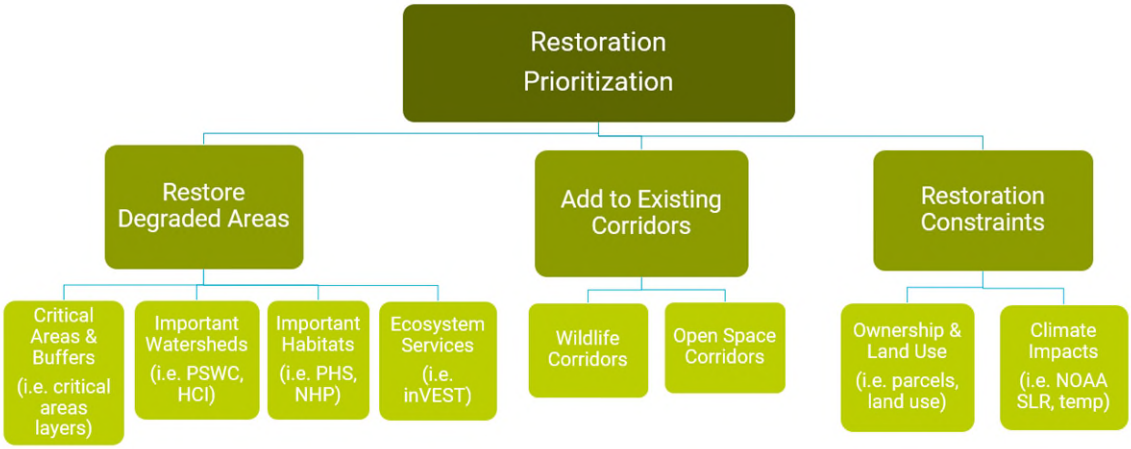

Figure 10. *Restoration prioritization framework*

Landscape Prioritization Outputs

The outputs of the landscape prioritization tool will be map layers that show the areas on the landscape that are best suited for development, protection, or restoration based on the selected criteria. Analyses can go from broad scale (i.e. watershed scale) to a finer scale (i.e. sub-watershed, neighborhood, or parcel scale as data are available. However, different datasets and models are appropriate at different scales, so the tool will need to include limitations or guidance to prevent improper use. In addition to the overall prioritization map, the tool will produce normalized maps of the most important areas on the landscape for each variable, and will clearly show the contributions of each variable to the overall prioritization results so that planners can easily explore alternative prioritizations by altering their criteria.

Landscape Prioritization Tool Features

- Show areas on landscape best suited for development, protection, and restoration
- User selected and weighted criteria
- Prioritization calculated from data layers and models
- Uncertainty analysis
- Save & export maps, data, reports
- Foundation for developing planning scenarios based on results

Planners will be able to use the outputs within the web mapping application or as a data download to overlay the results with other layers (i.e. current zoning). This will allow them to look at how well the prioritization results align with current regulations and policies, and where changes may be needed. They can also find areas with conflicts or areas where multiple goals intersect and planning can achieve win-win outcomes. Planners will be able to change the criteria weights and variables included to see how the prioritization results change, allowing them to examine the effects of emphasizing one goal over another. From there, planners can start to develop scenarios for putting prioritization results into action as policy changes or focused restoration efforts.

We have reviewed several platforms that provide this type of landscape prioritization modeling. These include the Ecosystem Management Decision Support (EMDS) system, the Environmental Evaluation

Modeling System (EEMS), and Esri's Suitability Modeler. We could use any of these models for the landscape prioritization component of our tool, and each has benefits. EMDS provides the most capability for integrating more complex modeling results alongside map layers, incorporating expert knowledge, assessing uncertainty, and integrating landscape assessments with multi criteria decision analysis. EEMS has been successfully integrated into web applications for prioritizing landscape areas for conservation and development. Esri's Suitability Modeler handles assessment of mapped data well, is readily available in WebApp Builder and GeoPlanner, and requires less technical expertise to set up for use in an application. All of these tools can organize map layers for various criteria, normalize them on a common scale that can be used to combine and compare their values, and then calculate a prioritization map based on weighted user criteria. Because these are the core functions needed for the landscape prioritization tool, any of these tools could be successfully used to build it, as was confirmed by each developer after reviewing the proposed concept (*see Appendix B: Review of Similar Products for more detail*).

Table 4. *Landscape Prioritization Tool Features*

Feature	Functionality	Example Use for Planning	Similar Product Examples
Prioritize Areas for Development	Show areas most and least suitable for development density.	Support zoning code amendments, UGA expansions, sub-area plans, rural zoning density, and buildable lands analysis	EMDS, EEMS, Esri Suitability Modeler
Prioritize Areas for Protection	Show areas most imperative to protect.	Support regulatory changes (i.e. CAO, SMP updates).	
Prioritize Areas for Restoration	Show areas with the highest restoration value.	Choose restoration or mitigation sites. Align local restoration efforts with regional recovery priorities.	
Weighted User Criteria	Allow users to assign importance of each variable in the analysis.	Explore how emphasizing one goal over another changes the prioritization results.	
Sensitivity & Uncertainty Analysis	Show contributions of each variable to the result and highlight areas of uncertainty.	Show where there is uncertainty that planning decisions should take into account.	
Analyze Results with Other Layers	Overlay landscape prioritization layers with other layers in the web map or in desktop software.	Show how prioritization results align with current policies and regulations. Show where sensitive areas need more protection.	

3.1.3 Scenario Assessment Tool

The scenario assessment tool will allow users to assess the impacts and benefits of user-defined land use scenarios (Table 5). These scenarios can be created based on the results of the landscape prioritization tool or independently, and they will include guidance based on BAS and agency recommendations. Key scenarios that will be supported include zoning and buildout scenarios, regulatory scenarios, and restoration scenarios. For zoning and buildout scenarios, planners could examine the effects of upzoning in areas suitable for development density, while downzoning in areas that should be protected. Planners are also interested in comparing the impacts of rural cluster development with the impacts of standard

five acre lots in rural areas. For regulatory scenarios, planners could assess the impacts of expanding critical area buffers or increasing protections in sensitive watershed areas. For restoration scenarios, planners could assess the impacts of restoring critical areas, wildlife corridors, or riparian tree cover.

Scenario Assessment Tool Features

- Calculate impacts and benefits of user-defined land use scenarios.
  - Zoning & buildout
  - Regulatory
  - Restoration
- Manipulation of scenarios for alternatives analysis.
- Quantified metrics, economic values, and maps of scenario changes as outputs

All scenarios will include outputs related to both the benefits (i.e. improvements in critical area function) and costs (i.e. impacts on land use) of proposed actions to aid decision makers in a cost-benefit analysis. The tool will allow planners to compare current conditions to future conditions if those actions are implemented. To do so, actions will need to be translated into spatial changes in impervious surface, vegetation cover, land use, and other model inputs. Similar products and assessments have translated zoning scenarios into land cover change by applying a standard development template to each undeveloped parcel in the area where a zoning change is desired. The Department of Ecology is working on a scenario template based on zoning maps that we may be able to use in our tool. Similarly, restoration scenarios would need to calculate benefits based on the area and location of land that can be restored.

Users will be able to easily manipulate scenarios for alternatives analysis. For example, they could evaluate the impacts of various critical area buffer sizes to compare results and support a decision, or they could evaluate the impacts of changing a zoning designation. Users will also have the ability to adjust each variable within the output to see how it affects the scenario and each other variable in real time. For

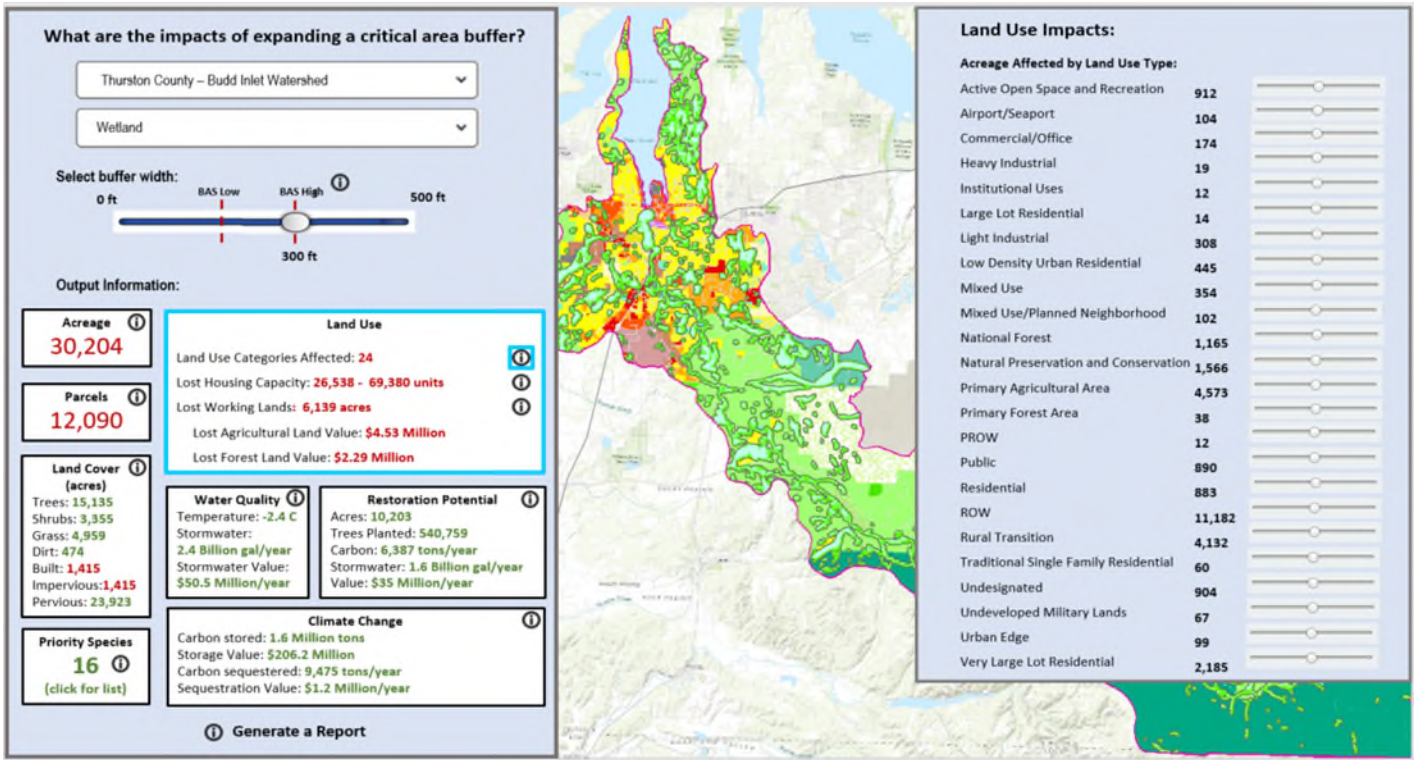

Figure 9. *Mockup of the scenario analysis tool for a simplified example of assessing a regulatory scenario for expanding critical areas buffers.*

example, if the amount of a particular land use (i.e. residential) that is lost due to a regulatory buffer scenario is unacceptable, they could input their target for that land use and see how that affects the buffer size, or they could experiment with moving land from other zoning categories to meet their needs. The Model My Watershed web-based scenario evaluation application has a similar feature that allows users to alter the distribution of land cover categories to see how changes affect modeled stormwater results.

The outputs will include quantified benefits and impacts of scenarios, including economic values where appropriate, as well as map layers of scenario changes. Planners can overlay those scenario layers with other data layers. The results will allow planners to show the benefits and costs of changing zoning, protecting critical areas, or doing restoration work (i.e. ecosystem service values). They can also calculate the cumulative effects of land use decisions. NatureServe Vista has some especially advanced cumulative effects and off-site effects models that we may consider recreating in our tool. All model assumptions will be visible to users.

Several existing platforms could be used to build the proposed concept. Envision integrates data, models, and scenario definitions, and allows users to manipulate dials and knobs for scenario analysis, making it well suited to building the proposed scenario evaluation tool. EMDS also has capabilities for scenario analysis, which is primarily achieved by translating scenarios into spatial changes in the input data layers and re-running the models; there is a built in workflow editor that can be used to automate this process. Esri's GeoPlanner is designed to allow users to input zoning plans and other land use changes and calculates metrics for each scenario's performance based on spatial data layers. The developers of all three platforms have reviewed the proposed concept and informed us that it could be built using their tools (*see Appendix B: Review of Similar Products for more detail*).

Table 5. *Scenario Assessment Tool Features*

Feature	Functionality	Example Use for Planning	Similar Product Examples
Assess zoning & buildout scenarios	Calculate the effects of changing zoning on metrics related to critical areas, ecosystem services, and land use.	Support zoning code amendments, UGA expansions, sub-area plans, rural zoning density, and buildable lands analysis. Evaluate trade-offs.	Envision EMDS Esri GeoPlanner
Assess regulatory scenarios	Calculate effects of changing regulations on metrics related to critical areas, ecosystem services, and land use.	Support regulatory changes (i.e. CAO, SMP updates). Evaluate trade-offs.	
Assess restoration scenarios	Calculate effects of restoring areas on metrics related to critical areas, ecosystem services, and land use.	Provide information on return on investment for restoration or mitigation. Evaluate trade-offs.	
Manipulation of Scenarios & Variables	Allow users to manipulate scenarios and variables in the output to explore alternatives.	Manipulate variables to see how land use or ecological needs can be met within a scenario and explore trade-offs.	

3.1.4 Ecosystem Services Modeling Tool

A key component that will be needed to support both the landscape prioritization tool and the scenario assessment tool is ecosystem services modeling. This tool will calculate the most important areas on the landscape for ecosystem services based on spatial data layers and other data inputs, and it will quantify the amount of certain ecosystem services that are provided by a specified area (i.e. carbon sequestration, habitat provision, stormwater management, hydrologic function). It can be run using current data to display results that can be viewed in the tool and included in the landscape prioritization models, and it can also be run to evaluate the impacts of proposed scenario changes on ecosystem services.

Ecosystem Services Modeling Features

- Calculate most important areas for ecosystem services
- Quantify ecosystem services provided under current conditions and proposed scenarios

We reviewed several ecosystem service models that could be integrated into the proposed concept to generate this information. inVEST Natural Capital Project tools take in land use/land cover maps and associated data as inputs and use them to generate maps of the most important areas on the landscape for various ecosystem services. The VELMA Eco-Hydrological Model can assess the impacts of land use scenarios on ecosystem services and has been successfully incorporated into an EMDS-based decision support platform by Tulalip Tribes. i-Tree has tools specific to calculating ecosystem service benefits of trees at the landscape and site scale, and for estimating the benefits of planting trees in restoration projects. The Hydrologic Condition Index (HCI) assesses the impacts of development on stream flow and downstream hydrologic processes, habitats and biota, and has been calibrated for the Puget Sound region (*see Section 4.3.3*). We plan on working with the Department of Ecology to integrate the HCI as a key component in the first phase of tool development, and will conduct further assessment of the options for integrating other ecosystem services models at that time (*see Appendix B: Review of Similar Products for more detail*).

3.2 Conclusions about Conceptual Design

The conceptual design presented in this chapter describes the key functionality that will be included in the tool, and the similar products and tools that can be used as examples or adapted to build each feature. Our design meets all of the priority needs identified in Chapter 2 and the described functionality can be used to support multiple specific planning decisions, including UGA expansions, upzoning, rural zoning density, selection of restoration/mitigation sites, and CAO updates. We will describe the process a user would go through to use the tool in support of these decisions in Chapter 6. Chapter 4 will dive deeper into the architecture of the tool and include additional information on the needed components for developing the back end and the user interface, as well as data needs and sources.

4. TOOL ARCHITECTURE AND KEY DATA

Software architecture is the fundamental structure of a software system, comprised of its elements and the relationships between them. Although the architecture of our tool will be modified and finalized based on the platform and vendor selected in the next phase, we are presenting a high level description of a possible system architecture that could be used to build the proposed tool. This chapter will describe the necessary software components and how they will interact to deliver the functionality presented in the previous chapter on conceptual design. We will require all vendors who respond to our Request for Proposals (RFP) in the next phase to describe their proposed software architecture in detail, including clear articulation of the details of how maps and models from different sources will be integrated. All solutions will need to integrate with the Esri platform using ArcGIS Enterprise systems, as this is Commerce's GIS platform of choice.

The architecture of the tool will include a web client, a web server, a map server, and hosted web services (Figure 11). The client will present a graphic user interface (GUI) for viewing and downloading data, metrics, and maps in a web browser. The web server will house the web application and scenario definitions, and it will provide decision analysis and scenario processing engine services through a REST interface (representational state transfer interface; a software architectural style used for creating web services that provide interoperability between computer systems on the internet). The map server will provide services for more complex maps. Most data will be shared with the tool via web services that are hosted on the servers of the originating agencies. The end of this chapter describes the key data sources that we have identified for initial integration into the tool, including a preliminary assessment of their usefulness and considerations for integration.

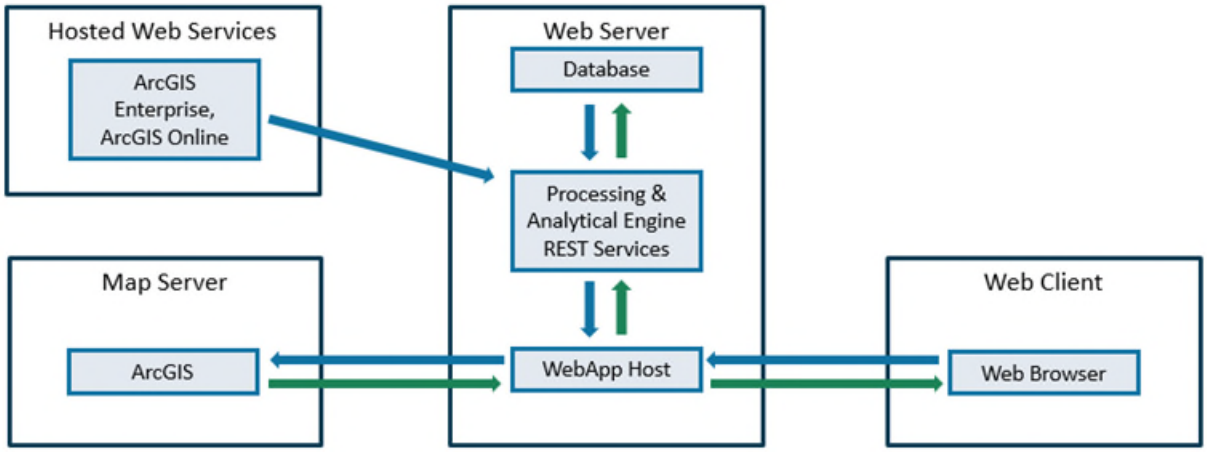

Figure 11. *Web-based spatial decision support system architecture*

4.1 Client Architecture (Front End)

The front end of the tool will be a web browser that presents a GUI to facilitate user interaction with the core functionality of the tool. It will be comprised of a web mapping application with a built in interface

for the decision support tools. These components are typically developed using HTML, Javascript, or Web Assembly (WASM), and they will need to be Esri-compatible. We may consider using existing application development tools to develop the map interface, such as Esri's WebApp Builder, ArcGIS Application Programming Interfaces (APIs), open source libraries such as Leaflet, and/or mapping and data exploration platforms like Data Basin. Significant effort will be allocated to ensuring ease of use by developing an intuitive and flexible GUI that is suited to the tool, its data, and the specific needs of our end users.

The web mapping application will organize and display all the layers included in the tool. Users will be able to select and display layers from a list. There will also be an interface for users to add their own layers to the tool (*see Section 4.2)*. Multiple layers can be selected simultaneously and overlaid. Functionality will be built in to adjust transparency of layers and swipe between layers to facilitate comparison of datasets, and to measure features and areas. Users will also be able to download layers for use in desktop programs. These features are all standard tools provided in Esri and other web mapping application development platforms.

The web mapping application will also include advanced querying and filtering capability. These features may require some custom development to extend and customize the capability of off the shelf tools available in Esri web products or other mapping platforms. Several similar mapping tools have implemented more advanced querying and filtering in a user-friendly way, including Peninsular Florida LLC's Florida Resource and Assistance Simple Map Viewer and Trust for Public Land's Open Space Assessment Tool.

The decision support interface will gather user inputs to the tools via map selections, dropdown menus, and other input fields and communicate those inputs to the server-side processing components to initiate analyses. It will also receive, interpret, and display results from the back end, with quantified data displayed in windows and spatial data displayed as map layers. Development of the interface will require some custom coding to gather and display information in a way that suits the specific needs and format of the tool and data, and is intuitive to users.

Guidance will be provided within the web application on proper use of the data and models in the tool, how to conduct analyses, and interpretation of results. There will also be guidance provided within the decision support tool interface on best available science (BAS), agency recommendations, planning requirements, and other information that can help guide the use of the tool for integrated critical areas and watershed protection. Some guidance will be built into the decision support tools' structure, and other elements may be included within pop-up boxes that users can click on for more information. Some analyses may be limited based on BAS or scale by programming bumpers and bounding ranges to prevent misuse or misinterpretation of results (*see Chapter 6*).

4.2. Server Architecture (Back End)

Server side components may be hosted on Commerce's servers or in the cloud, depending on processing needs, the platform selected, and final decisions about where the tool should be housed. The back end of the tool will consist of a model and data integration and processing engine, models, a database, and a map server. We have identified several existing platforms that could be used as the integrating and processing engine, which will run the decision support tools. These include Envision, EMDS, and Data

Basin. Alternatively, all processing could be run using Esri platforms and tools such as GeoPlanner. Envision and the Ecosystem Management Decision Support System (EMDS), in particular, have an open source, plug-in software architecture that can integrate any processing engines, models, workflows, and spatial data needed to run the decision analyses. These tools are also interoperable, with potential to use the parts of each that meet our needs best. Both tool developers are working on an exposed web service version that can connect to web applications, and both will be completed in the coming months. Platform selection will be made in the next phase based on responses to the RFP.

The models used in the tool will be designed to run using any dataset that contains the same structure, rather than being dependent on a particular version of a dataset. However, we anticipate that data from different jurisdictions often will not have the same structure. Attribute fields will need to be matched between each dataset and the attribute names the tool is programmed to recognize. A user interface will be included to facilitate mapping of any newly structured or added datasets to the format that can be read by the models. The tool will also need to be able to handle cases when data is not available, by running analyses with missing or incomplete data and notifying users about implications for uncertainty. The tool will be programmed to send a message to the user interface when data links or structure are not valid or data is unavailable, and will include a mechanism for users to update data links if they change due to updates or other factors.

> *"It organizes existing resources and can make users aware of datasets they may not otherwise consider using or know exist." – County Planner*

Due to the complexity and size of some of the spatial datasets that will be included in the tool, we will also need a map server, which will likely be an ArcGIS server. Some datasets may also need to be tiled (i.e. displayed as cached images rather than polygons), which improves the speed of loading map features as the user navigates around a map by joining individual small image files rather than loading a single large image.

4.3 Data Sharing and Governance

As much as possible, data will be brought into the tool via links to web services hosted by the originating agencies or organizations, rather than hosting it locally on our servers. We will consider using tools like Esri Portals and Hubs, and Data Basin gateways for organizing and providing access to relevant data and allowing users and organizations to share and find new data. We are also coordinating with the Office of the Chief Information Officer (OCIO) on using the state data sharing platform for some data sharing needs (particularly for data shared by state agencies). Most agencies and jurisdictions are already sharing some or all of their planning data on the state data sharing platform, ArcGIS Online, or ArcGIS Enterprise. However, jurisdictions may have some datasets that need to be uploaded and hosted locally on our servers to be used in the tool. Analysis outputs will also need to be hosted on our servers. We will need to identify and implement the appropriate data sharing agreements, with consideration for public disclosure requirements.

From our research, we anticipate that most of the data used in the tool will be open and publicly available. However, jurisdictions may sometimes wish to use more secure categories of data in the tool. To allow for this, we will include an optional sign in process through Secure Access Washington, which will allow user profiles to be assigned permissions. When a jurisdiction or agency adds data to the tool, they can assign a security level and select which users it can be shared with. Without signing in, users would only

be able to view and use public data. Within this structure, each jurisdiction or agency will be responsible for ensuring that the correct level of security is applied to datasets they add to the tool. The security features will also prevent tampering with data in the tool.

All data included in the tool should contain metadata that follows best practices. Each dataset should have information on ownership, data quality (i.e. accuracy and correctness), data usability (i.e. attributes and how they should be used), data integrity (i.e. consistency with respect to definitions and updates), data security (i.e. who can access the data), and data preservation (i.e. how data is archived or deleted). Data will need to include a service date or expiration date, and information on when the last update occurred. We will vet the data that is initially included in the tool based on these criteria and develop the needed metadata structure in coordination with the originating agencies. Metadata for data brought to the tool will be the responsibility of the organization that provides it. We will develop a data dictionary that lists each data and model element along with its key attributes to help users understand the data and models and their appropriate uses. The data dictionary will also be useful for automating the mapping and translation of data to the models, which will also need data dictionaries that describe the data types and attributes that they accept.

"This kind of information will help WSDOT and locals be on the same page about land use." – Resource Agency

Beyond vetting the initially included datasets, including them in the data dictionary, and providing guidance on appropriate use, Commerce does not intend to govern use of the tool or data. Ensuring that new or updated data is appropriately documented will be the responsibility of the agencies that add them to the tool. While we will build in some controls and guidance on use of the tools and data, the responsibility for proper use will remain with each user. Appropriate disclaimers will be included and all users should follow best practices.

4.4 Key Data and Model Components

We have done some initial research and coordination on data and models that can be used as starting points for the scenario analysis tool. These include critical areas maps used by local governments; the Department of Commerce's Puget Sound Mapping Project; the Department of Ecology's Hydrologic Condition Index (HCI) and Puget Sound Watershed Characterization (PSWC); the Department of Natural Resources' Geologic Hazards Mapping and Natural Heritage Program, as well as their other aquatic data; the Department of Fish and Wildlife's Priority Habitats and Species (PHS), High Resolution Change Detection (HRCD), and High Resolution Land Cover (HRLC); the Department of Archaeology and Historic Preservation's Washington Information System for Architectural and Archaeological Records (WISAARD), the Department of Health's Source Water Protection, the National Oceanic and Atmospheric Administration's Sea Level Rise modeling, and Stanford University's inVEST Natural Capital Project ecosystem services modeling, among others. We have done some initial coordination with these agencies on integrating their tools and provide a brief description of each component in the following sections, but we will further assess integration of these and other data sources in the next phase of tool development.

"We all need to intersect in resource management and look at the same data/picture." – Nonprofit Organization

4.4.1 Critical Areas Maps

We will bring together the available map layers from local jurisdictions and agencies to develop a cross-jurisdictional map of critical areas that can be used for scenario analysis at both local and regional scales. Each Puget Sound jurisdiction maintains maps of its critical areas, but they vary in quality and format. Most critical areas maps, especially those used by counties and larger cities, are now available in the form of GIS shapefiles, and many are hosted online via ArcGIS Online or ArcGIS Enterprise. We have spoken with several local jurisdictions that do not yet have their web services publicly accessible, but all believed they could make them accessible to Commerce for use in the tool when needed. Some smaller cities may need their data hosted with the tool or through their counties. None of the local jurisdictions we spoke with had concerns about data security for any of the key datasets needed for the tool. However, we have not yet coordinated with most jurisdictions in the region, and a substantial assessment process to determine the usability of local maps and data and develop translation capabilities for handling inconsistent attributes will be needed early on in the tool development process.

State and federal agencies also maintain maps of critical areas. Key data sources include the Department of Fish and Wildlife's Priority Habitats and Species; Department of Natural Resources' Geologic Hazards and Natural Heritage Programs, as well as their shoreline aquatic data; Department of Health's Source Water Protection; FEMA's flood hazard maps; the National Hydrography Dataset (NHD); and the National Wetlands Inventory (NWI). Several local jurisdictions have informed us that they rely heavily or entirely on these sources for their critical areas maps, and some are working with agencies to improve accuracy in their areas. All these resources are currently hosted online, but not all are currently accessible as web services. We interviewed several agencies about how to bring their data into the tool and found that most agency datasets can likely be made available to the tool as web services when needed, but doing so will require further coordination with each agency. Any data that cannot be shared as a web service would need to be loaded onto the tool server and updated periodically.

> *"We need to unify data sets used by different levels of government." – Resource Agency*

WDFW's Priority Habitats and Species

Since 1990, the Washington Department of Fish and Wildlife (WDFW) has provided maps, management recommendations, and technical assistance regarding Priority Habitats and Species (PHS). PHS maps draw data from many WDFW databases to provide points and polygons of known locations of several priority habitats and priority species. PHS identifies "priority areas" for priority species—places that warrant special consideration when land use actions are taken. PHS data is mostly publicly accessible (Category 1), but it also includes sensitive data (Category 3). Sensitive data, which is masked when publicly released, includes locations of species that are prone to harm due to human interference. PHS spatial information is available via the PHS on the Web map app: https://geodataservices.wdfw.wa.gov/hp/phs/. WDFW is currently modernizing the PHS system, and will remain in close contact with us to facilitate compatibility with the tool as they consider their path forward.

4.4.2 Commerce's Puget Sound Mapping Project

Commerce's Puget Sound Mapping Project is a consolidated and standardized map layer of each Puget Sound jurisdiction's proposed land use and housing growth that provides the ability to compare planned and actual land use trends across jurisdictions and across the region. This layer will be an important component of the decision support tool, for several reasons: 1) it will provide a single base layer for assessing impacts on land use and development capacity under regulatory and zoning scenarios, 2) it will

allow for integration of land use analysis across jurisdictional boundaries and at multiple scales from local to regional, which cannot be easily achieved when using separate datasets for each jurisdiction, and 3) it was designed to integrate with tools developed at other agencies that will be included in the proposed tool (i.e. Ecology's Puget Sound Watershed Characterization Project) by aligning data with Water Resource Inventory Analysis (WRIA) assessment units. All Puget Sound Mapping Project data is currently hosted as a single tiled web service on ArcGIS Online and can be linked to the tool. There are attributes for land use categories and subcategories, as well as housing growth and density by year. Commerce intends to update the Puget Sound Mapping Project with current data alongside development of the proposed tool.

4.4.3 Ecology's Hydrologic Condition Index and Puget Sound Watershed Characterization

The **Hydrologic Condition Index (HCI)** developed by King County and the Department of Ecology calculates an index of watershed condition that can be used to compare current condition of watersheds with future condition under alternative development and restoration scenarios. The index provides a spatially explicit way to 1) determine the least impacting places for development and the most impactful places to restore, and 2) quantify the cumulative effects of land use changes over time. HCI uses high pulse counts as a metric because it correlates with the Benthic Index of Biotic Integrity (B-IBI), but the framework can be expanded upon to plug in other distance-based metrics that measure watershed health and cumulative effects of land use decisions on hydrology, water quality, habitat, or other variables. By integrating historic land cover data and land cover change data, HCI can be used to quantify the impact of land cover changes, account for legacy land use effects, and compare current conditions with past condition. By integrating permit data, users can assess the effect of land cover changes that are not in compliance with critical areas regulations. We will also work with Ecology to build recommendations into the tool for mitigating predicted land use effects on hydrologic condition.

HCI is a simple Python script that calculates scores based on data inputs for land cover, surficial geology, and grid cells with flow routing. HCI has been used with 30 meter C-CAP land cover data and high resolution land cover data for King County, but any land cover map can be used as an input with translation between category names. Higher resolution maps produce better predictive ability, and consideration should be given to update frequency. Ecology is currently working on spatial templates for translating zoning categories into likely change in land cover, so those could potentially be used with Commerce's Puget Sound Mapping Project data and local zoning data. For the grid cells, Ecology is currently beginning a process of calibrating the model for use around Puget Sound, which will be complete by the end of 2022, and they have expressed willingness to work with our timeline to provide intermediate products needed to build the tool.

"Good information is critical to improving planning decisions" – City Planner

To build an interactive tool where planners can input their own scenarios for zoning or restoration and see how they affect watershed condition, we will need to build the HCI Python script into our web application. The script is ready and will be straightforward to integrate once the grid has been created. If we cannot immediately achieve full interactivity for scenario assessment due to the timeline of HCI grid completion or other factors, an intermediate option for including HCI is to pre-calculate results for existing conditions and some predetermined development density scenarios around Puget Sound and display them on a dashboard. Even without interactive scenario functionality, this would create significant value for comparing watersheds across the region. This can effectively provide an alternative futures assessment geographically, by allowing planners to compare results for similar watersheds that have differing land use practices.

Ecology's **Puget Sound Watershed Characterization (PSWC)** has coarse scale indices that can be integrated into our tool to prioritize landscape areas for development, restoration, and protection based on watershed characteristics. Indices include a variety of metrics for water flow, water quality, and habitat that are used to assess the importance and intactness of watersheds. Local governments have successfully used PSWC to justify changing buffer requirements to match watershed importance and to decide where to expand Urban Growth Areas (UGAs). PSWC indices are available as map layers that can be directly utilized in our tool, and Ecology will consider making them available to us as web services.

4.4.4 WDFW's High Resolution Change Detection and High Resolution Land Cover

The Washington Department of Fish and Wildlife (WDFW) is mapping High Resolution Change Detection (HRCD) and High Resolution Land Cover (HRLC). HRCD will be important for assessing where land cover has changed in critical areas (and other important areas) to improve regulations and protection. Current data spans 2006 to 2017 and is in the format of a polygon layer, in which each polygon represents an area of change over a two year period. Attributes include total change, loss of canopy cover, increase in impervious surfaces, and increase in semi-pervious surfaces. Users will need to be able to query the data in the tool based on these attributes to return a subset of the data for analysis. The process for using it in the tool would be to select an area of interest (i.e. a certain critical area type within a jurisdiction), clip the change polygon to that area, and then calculate the amount of change. The HRCD data is currently hosted as a web service. Because the data is only updated every two years, it could also be hosted with the tool and used directly if necessary.

The High Resolution Land Cover (HRLC) data currently focuses on canopy cover and visible surface water, but impervious surfaces are under development. Canopy cover plays into many important indicators, including assessment of riparian and watershed condition. The visible surface water data is also useful for riparian assessment and has less error than older NHD maps in some areas. Some issues with the impervious surfaces are still being resolved, but the current version is already better than Landsat data. HRLC data can potentially be connected with the HCI and other ecosystem services models in our tool. It is currently a polygon layer but would be converted to raster to make it easier to host in a web tool. WDFW has indicated that they may be able to make HRLC available as a web service for use in the tool.

4.4.5 DAHP's WISAARD

The Washington Department of Archaeology and Historic Preservation (DAHP) maintains the Washington Information System for Architectural and Archaeological Records Data (WISAARD), which provides access to the state's most comprehensive repository of cultural resource information. Cultural resources can include buildings, structures, sites, districts, and objects, as well as landscapes and traditional cultural places. Planners are required to consult with DAHP on the protection of cultural resources that may be impacted by development activities. Including cultural resource information alongside natural resource information is essential for integrated comprehensive planning because, like natural resources, cultural resources have economic, social, and educational benefits and are legally protected by federal, state, and local statutes. WISAARD data will be leveraged within our tool to help users identify cultural resources that should be avoided and/or would require impact mitigation. In addition to historic records, WISAARD includes a predictive model that provides recommendations based on the potential presence of cultural resources. Taken together, the WISAARD data and

> *"Everything, including these databases are too siloed, there should be a way for users to find the data for decision-making...for DAHP, cultural resources are often forgotten while we can make available useful and easy to access data." – Resource Agency*

model enable planners, landowners, developers, project proponents, and decision makers to consider the impact of land use actions on designated and protected cultural resources.

WISAARD includes both publicly accessible data (Category 1) and secure data (Category 3). Public data includes register listed historic properties, project areas, historic properties, and maritime. Secure data includes cultural resource survey boundaries, archaeology site boundaries, cemeteries boundaries, and traditional cultural properties. A data sharing Memorandum of Understanding (MOU) would be required to use any Category 3 data in the tool. All WISAARD data is hosted on DAHP's Enterprise ArcGIS portal and can be shared directly with Commerce and the tool as a web service.

4.4.6 Puget Sound Partnership's Vital Signs and Restoration Mapping

Puget Sound Partnership (PSP) has developed maps for the Vital Signs, a set of ecosystem health measures that guide the assessment of progress toward Puget Sound recovery goals. These are ecological assessment maps (as opposed to regulatory maps), and include floodplains, shoreline armoring, habitats along the shoreline, freshwater riparian, and others. Putting these maps together with other planning information will help facilitate communication between land use planners and recovery planners to help prioritize geographic areas for restoration and reduce planning conflicts. Some Vital Signs maps are already available as web services that can be pulled into the tool. As PSP modernizes, they will share the rest of the maps with us as web services.

PSP is also working on mapping project footprints for all funded restoration projects. These will be polygons with information attached for quantifying the restoration that was done (i.e. tree planting, shoreline restoration), and could be linked with ecosystem services models in our tool to help communicate information to decision makers. The map should be ready in early 2021 and can be shared as a web service for use in our tool.

4.4.7 Climate Change Maps

Sea level rise is a key climate change effect that stakeholders want to be able to assess in the tool for analyzing development and restoration scenarios. The National Oceanic and Atmospheric Administration (NOAA) has developed a Sea Level Rise Viewer and downloadable data layers that show potential coastal flooding, marsh migration, and other land cover changes for various sea level rise scenarios. We can use these map layers in our tool and we may also be able to integrate newer or more localized work on sea level rise modeling.

The other key climate change effects that stakeholders want to be able to assess in the tool are the implications of increases in temperature and changing precipitation patterns. The NorWeSt Stream Temperature interactive map shows historical stream temperature data and projected temperature increases for future scenarios in 2040 and 2080, and could be used for riparian restoration planning scenarios in our tool. Similarly, WDFW's Culverts and Climate Change web mapping application provides projections of percent change of future bankfull width and future 100-year flood discharge. Many sources exist for general predictions of temperature and precipitation changes under climate change scenarios. These models and others will be further assessed in the next phase.

4.4.8 Ecosystem Services Models

Several ecosystem services models that may be included in the tool are described in Section 3.1.4. These models and others will be further assessed in the next phase.

4.5 Conclusions about Tool Architecture and Key Data

We have identified the architecture needed for the tool, including components for back end and front end development and integration, data sharing, and key data and models. The tool architecture was developed based on existing platforms and products, and the specifics will be adjusted based on the vendor and platform selected in the next phase. We have identified products that can be used as the back end processing and integration engine and tools that can be used to build an effective GUI. We have also developed a plan for data sharing and governance.

Additionally, we identified several data sources and models that are important starting points for inclusion in our tool, and conducted some preliminary assessment and coordination on how they can be integrated. We will conduct additional assessment of the data and models in the next phase, but the information we have gathered so far indicates that the key datasets and models can be integrated into the proposed tool architecture. However, there will be a substantial effort needed to gather all the necessary data, coordinate with jurisdictions and agencies to get as much data as possible shared as web services, and develop translation capabilities to standardize inconsistent data attributes for use in the tool. Each and every dataset will require some level of work to make sure it is ready for use in the tool, and we will need to provide adequate time and budget to complete these tasks.

5. TOOL MAINTENANCE

The tool and the data and models it relies upon will need to be sustainable. There will be maintenance and updates needed for the tool itself, the models used by the tool's analytical engines, the data the tool uses from other agencies, and the data created and stored by the tool. There will be some ongoing funding needs for maintenance of the tool. These will include fees for hosting the tool, and there may be some annual licensing fees for models or engines that are included.

5.1 Tool Ownership and Hosting

Long-term funding and a committed long-term steward will be needed for repairs, maintenance, and updates to the tool. We have identified three viable options for tool ownership and housing: 1) owning the tool internally at Commerce and hosting it on the agency's existing ArcGIS servers, 2) hosting the tool on our vendor's servers, or 3) contracting with WaTech to host the tool. Further assessment of this issue is needed, but we believe hosting the tool on our vendor's servers may be the best option because it will push the maintenance of the platform onto them. The final decision on where to host the tool may depend on the vendor selected for tool development. Funding will be needed to cover up-front fees for setting up hosting of the tool and for annual maintenance costs. Some data will also need to be hosted and maintained locally. This will include saved scenarios, user data, and analysis results. It may also include some datasets that cannot be hosted by the originating jurisdictions, which will require data sharing and maintenance agreements.

5.2 Data Maintenance

For most of the data used in the tool, we intend to link to web services hosted by the originating agencies or organizations to keep internal data maintenance needs minimal (*see Chapter 4*). Each organization will be responsible for maintaining its own data, and the tool will automatically pull from the most up to date version as long as the link remains the same. However, there are likely to be some datasets that will need to be uploaded and hosted with the tool due to the limitations of individual jurisdictions or agencies in their ability to share data as web services. These data would need to be replaced with updated versions periodically as part of the ongoing maintenance needs of the tool, either by Commerce or our vendor.

Many agencies and jurisdictions already follow a schedule for updating their data and maps. We may need to find ways to ensure datasets are updated frequently enough to be useful in the tool, and that updated versions remain compatible with it, through data sharing or other agreements. Data included in the tool will need to include a service date or expiration date, and information on when the last update occurred. Saved analyses and scenarios will track the version of each dataset that was used at the time they were conducted.

5.3 Model Maintenance

The models used in the tool will be designed to run using any dataset that contains the same structure, rather than being dependent on a particular version of a dataset. In instances where links or data structure (i.e. attribute names) change between updates due to complete replacement of layers or changes in protocols, some minor maintenance may be needed to update the link or ensure proper functionality of the data within the tool. The data dictionaries described in Chapter 4 will facilitate this process and

minimize maintenance. A user interface will be included to facilitate mapping of any newly structured or added datasets to the format that can be read by the models. The tool will also need to be able to handle cases when data is not available. Several existing platforms included in our review can run analyses with missing or incomplete data. The tool will also be programmed to alert users when data links are not valid or data is unavailable, and will include a mechanism for users to update data links if they change due to updates or other factors.

The models managed and used by the tool are likely to evolve over time. Updates may be needed due to changes in data structure, as described in the previous section, or because the models themselves evolve with new concepts or improved algorithms and structures. We will need to plan for implementing these updates to the models in coordination with our vendor over the lifespan of the tool.

5.4 Tool Updates and Improvements

The tool will be a collection of analytical engine components and models with associated user interfaces. The business logic of the tool will flexibly manage the interoperability of these components. This allows for a more flexible architecture that is easier to evolve over time. It also allows a moderate number of components to be reused for a wide variety of analytical purposes.

There will need to be capacity to update and expand the tool based on what works best along the way. We will gather analytics from the users of the tool to see the most commonly asked questions, most commonly used data, and other information. This will allow us to supplement the information in the tool based on what questions cannot be asked because of data availability, take out features that people do not use, and plan future functionality additions. We plan to build a platform that can start small but leave room for expansion with other questions, use cases, data, and models over time.

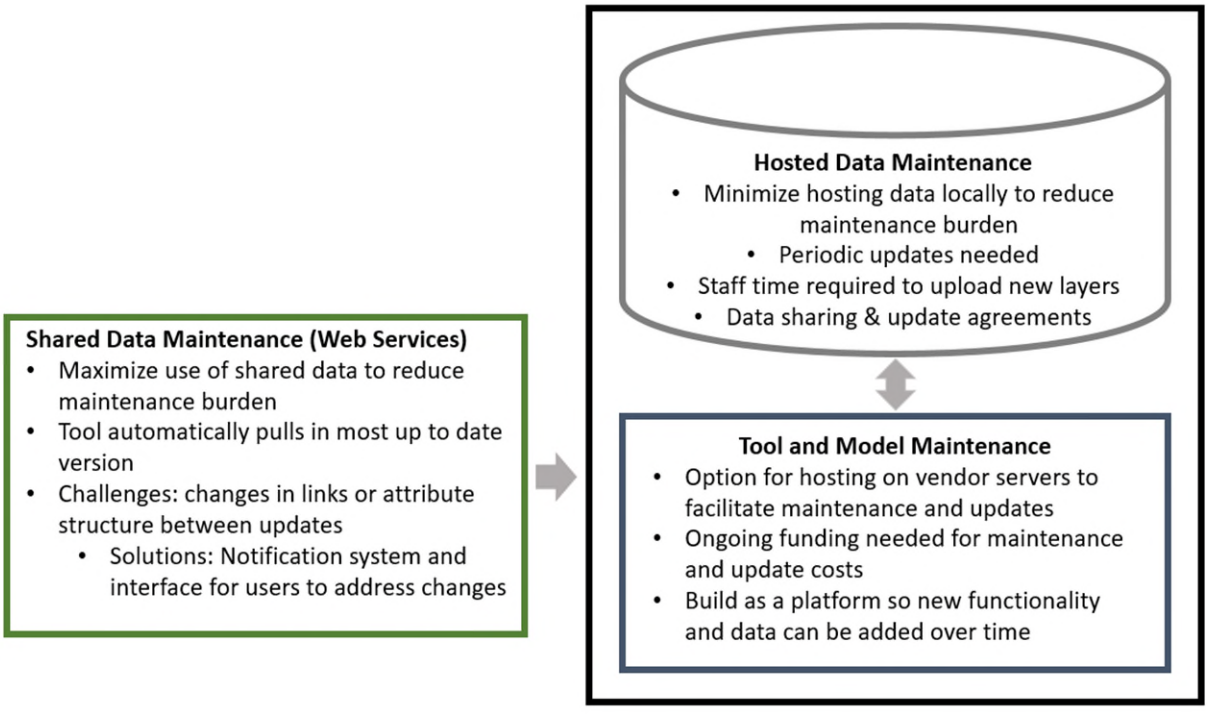

Figure 12. *Tool maintenance structure and requirements*

6. USE OF THE TOOL

We believe providing tools for local governments that make best available science (BAS) more accessible and provide increased transparency, consistency, and accountability in decision analyses can improve efficiency and defensibility in planning processes, help ensure that decisions are science-based, and facilitate planning at the watershed scale. This will ultimately result in better decisions that benefit Puget Sound recovery goals. Commerce intends to provide detailed guidance on use of the tool and data to support planning decisions, both within the tool and as supporting documents, as well as well-developed disclaimers about appropriate use of the tool. The tool will be designed so that results can be viewed in real time, allowing planners to analyze and compare alternative planning scenarios during planning meetings.

6.1 Using the Tool to Inform Priority Planning Decisions

We will work with planners to ensure that tool outputs can be correctly and consistently applied to specific planning decisions by providing a decision support framework and guidance. Specific decisions that have emerged as a high priority include 1) Urban Growth Area (UGA) expansions, 2) urban upzoning, 3) rural zoning density, 4) selection of mitigation/restoration sites, and 5) Critical Areas Ordinance (CAO) updates. The decision framework will take into account the processes planners currently go through to make these decisions, the information they need, and the recommendations of agencies that regulate or study critical areas. The following sections describe how a planner would use the tool to support these decision processes.

> *"If successful, it would allow for better education of the public and more efficient implementation of local regulations." – County Planner*

6.1.1 Informing UGA Expansions

UGA expansions occur as comprehensive plan amendments when more land is needed for urban growth. Urbanizing rural land results in significant environmental impact, and not all areas are equally appropriate for urbanization and development density due to their environmental and land use contexts. Planners told us that when jurisdictions wait to select areas for expansion until they are actually needed, developers tend to drive the process in a site by site way that does not account for these issues. A priority use for the proposed tool is to help planners evaluate and compare possible areas for UGA expansion in the long range planning stage. The tool can facilitate better coordination between counties and cities, and can help jurisdictions set aside the most appropriate land for future expansion or protection.

To go through the process of using the tool for a UGA expansion, a planner could select all the possible areas for expansion on the map; for this decision, watersheds or sub-watersheds may be appropriate. Using the landscape prioritization tool interface, they could then select the variables that they want to consider in the analysis. A simple example analysis could consider avoiding floodplains, geologically hazardous areas, and areas with projected sea level rise, as well as areas where dense development would have the most impact on wetlands, watershed processes, habitat connectivity, and agricultural lands. In addition to areas to avoid, the planner may also be interested in giving preference to areas that have the most buildable land and/or existing infrastructure. Then they can decide which of these considerations are most important and should

> *"Many local governments do not have the resources to expend on such a resource and the ones that are publicly available do not function to the needed level of service." – Resource Agency*

be given the most weight in the analysis, with guidance based on resource agency recommendations and BAS.

The tool would then assess the condition of each watershed or sub-watershed for each of those variables and generate a prioritization map that shows the range from watersheds that meet the criteria the best to those that score the worst. Scores would also be broken down to show how much each variable contributed to the results, and planners could manipulate weights to re-assess the landscape for different priority scenarios if the initial outcome does not meet their needs. The tool would also generate a map that shows the condition of each watershed for each individual variable so that the planner can visually compare results.

> *"I can see the value, and especially value added for agencies working state-wide. I can see the value of local entities viewing what other entities have already completed, how they've already tackled similar problems, etc." – Resource Agency*

Once they are satisfied with the landscape prioritization results, the planner can select the most suitable watersheds or sub-watersheds for further analysis using the scenario analysis tool. In the interface for the tool, they would set a scenario for how UGA expansion would alter the land use and land cover of that watershed or sub-watershed (i.e. where impervious surfaces would increase and vegetation would be removed due to buildout under a new zoning scenario). This would be based on buildable land after regulated areas (i.e. critical areas) and previously developed lands are removed. Then they would select the output information they want the tool to calculate. For this example, outputs could include information on impacts to hydrology, water quality, carbon sequestration, resource lands, and land cover, as well as gains in housing and development capacity and various other land uses. The planner could compare the results for different zoning scenarios for each candidate watershed to make a decision about the best place for the UGA expansion. The results would clearly show the potential costs and benefits of the proposed action and can be used to justify its implementation to decision makers and stakeholders.

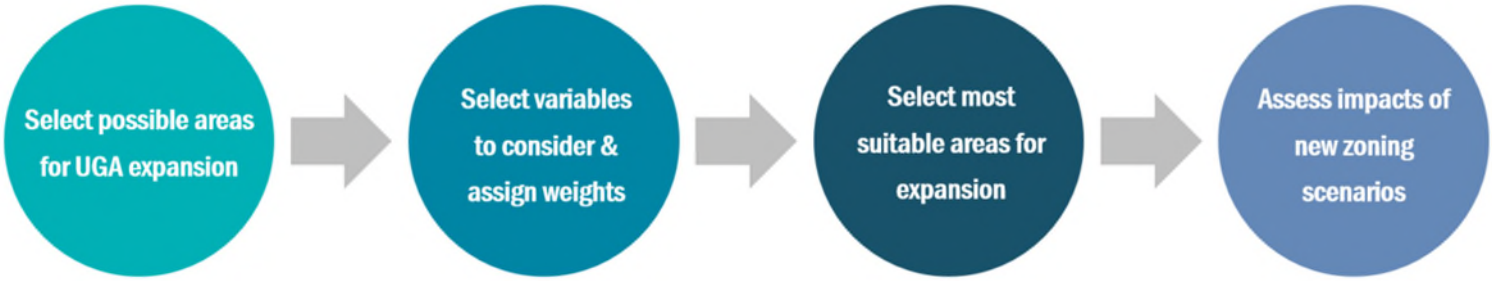

Figure 13. *Process for using the tool to assess areas for an urban growth area (UGA) expansion.*

6.1.2 Informing Urban Upzoning Decisions

Urban upzoning is another common land use decision that involves increasing development density in certain areas to accommodate population growth. Upzoning options are typically exhausted before a UGA expansion can be considered. The process of using the tool for selecting areas for upzoning would be very similar to the UGA expansion process described in the previous section, but the areas selected for densification would typically be inside the UGA instead of outside of it. Generally, this will result in fewer environmental impacts than urbanization of rural land. Upzoning analysis is also an important

component of Transfer of Development Rights (TDR) programs, which are becoming increasingly common.

6.1.3 Informing Rural Zoning Density Decisions

Rural zoning density is a priority land use decision for county planners. Development in rural areas typically has greater environmental costs than urban development because there are higher concentrations of critical areas, and a significant amount of rurally zoned land is actively farmed or forested. The per capita amount of imperviousness added and trees cleared is typically much higher for rural development, and typical rural zoning includes 5 acre lots that result in sprawling development patterns. This can be addressed by implementing cluster zoning in areas that are suitable for increased development, while downzoning in areas that need more protection. Using the tool to identify suitable areas for rural clusters would be a similar process to that described for UGA expansion, which would identify the best places increasing development density. The process for using the tool to identify areas that should be downzoned would be the opposite, since planners would be looking for the most ecologically and agriculturally sensitive areas to protect. The tool would show the amount of housing capacity lost in downzoning scenarios, which can be used to guide the amount of cluster development that is needed. Priority areas for downzoning would also be good candidates for protection under TDR programs.

"There are too many wasted resources with all the funds spent to do the same work." – City Planner

6.1.4 Informing Selection of Mitigation/Restoration Sites

Selecting the best sites for mitigation and restoration efforts is critical to effective recovery of the Puget Sound region. Restoration in different locations can generate varying amounts of benefit for watershed processes, critical areas, and habitat, and a broader view is needed to restore critical area corridors and connectivity. Local planners told us that having a map that identifies the priority areas for restoration would help them acquire the best lands for mitigation and other restoration projects.

To use the tool to find the best areas for restoration, planners would select their area of interest on the map and the units that they want to analyze (i.e. sub-watershed). Then they would select the type(s) of restoration that they need to complete (i.e. floodplain, wetland, or a particular habitat type). They would then weight criteria for 1) restoration potential in terms of improvements in watershed condition, habitat, or other ecosystem services, 2) alignment with regional recovery priorities and corridors for critical areas and open space, and 3) constraints related to land use, climate change, and costs. Guidance would be provided based on resource agency recommendations and BAS. The tool would then assess the condition of each sub-watershed for each variable and generate a prioritization map for restoration, with the same features described in the UGA expansion section.

"Our world does not end at jurisdictional boundaries." – City Planner

The user can then select one or more restoration areas on the map for further analysis using the scenario analysis tool. It will translate a proposed restoration activity into a change in land cover, then calculate the ecological benefits of completing the work (i.e. benefits for hydrology, water quality, carbon sequestration, other ecosystem services). The results can be used to justify selection of particular restoration areas to decision makers and stakeholders, and to provide information on return on investment using quantified benefits and economic valuation. Additionally, linking the scenario evaluation tool with PSP's restoration project mapping (*see Section 4.3.6*) can quantify the benefits of existing restoration projects for the recovery community.

6.1.5 Informing CAO Updates

CAO updates are conducted periodically by all jurisdictions. The proposed tool can help planners make decisions about whether updates are needed in two ways: 1) assessing land cover change in or near critical areas and quantifying the impacts of those changes to determine whether or not CAO updates are needed, and 2) evaluating scenarios for expanding critical areas buffers.

The primary data source that will be included in the tool for land cover change analysis is the Department of Fish and Wildlife's High Resolution Change Detection (HRCD). The user would select the type of land cover change to analyze (i.e. development or vegetation removal) and the distance from particular critical area type(s) they are interested in. The tool would then run a query to return the change areas that meet the criteria. The amount of change can be quantified by land use type. Using the scenario evaluation tool, the user can then quantify the impacts of that change on hydrology, critical areas, and ecosystem services to determine if it is acceptable. For jurisdictions that have permitting data, users can parse out the contribution of compliant and non-compliant land cover changes to see where improved regulations would make a difference, and where enforcement is needed.

"An integrated regional tool that assesses how well regulations are protecting critical areas would be extremely important." – City Planner

If a planner wants to explore the predicted benefits and costs of expanding critical areas buffers, they can use the scenario evaluation tool to quantify the results of different buffer scenarios. They would select the critical area type they are interested in and set a buffer width they want to explore. Then the tool would calculate the benefits of protecting that area and the impacts on land use. This would provide a cost benefit analysis that can be used to present alternatives to decision makers and stakeholders.

6.2 Target End Users

The target end users for the tool are comprehensive planners and other long-range planners. The tool will be tailored to support their needs for planning under the Growth Management Act (GMA) and Shoreline Management Act (SMA), especially those related to critical areas protection at the broad to mid-scale. However, we anticipate that the tool will also be useful for regional planning and review of plans by regulatory agencies, and some parts may be useful for permitting processes. Tool design will be user-centered, so that it can be used by planners with little or no GIS experience. Users can use the tool as a simple look up resource for critical areas information, or for more complex scenario analysis.

"[This type of tool is] especially [needed] on a larger scale for long term planning." – County Planner

6.2.1 User Differences

We anticipate differences in user priorities from different jurisdictions or organizations. Planners in more metropolitan areas and resource-minded organizations will be most likely to use the scenario planning and evaluation functions of the tool. Other jurisdictions do not have experts working on their critical areas issues, and may not use or be aware of any of the existing maps or tools. Those users will primarily want to use the tool to look up fundamental information (i.e. basic identification of critical areas). The tool will be able to answer both types of questions. It will need an easy interface for users with no GIS experience to engage with, but will need to be rigorous enough to add value for those who have more expertise. Technical jargon will be defined in dialogue boxes, guidance, and training materials for non-technical users. Data visualization will also be taken into account. For both types of planners, the tool needs to be quick and

"Especially [needed] for smaller jurisdictions with limited resources. YES." – City Planner

easy to use, with a user-friendly interface and training resources. We will involve local government advisors in testing and reviewing the interface and training materials to ensure that they meet needs.

6.2.2 Citizen Use

We intend for the tool to be usable by citizens as well as planners, as a way to facilitate public participation in decision processes and improve public knowledge and understanding of critical areas issues. However, some of our advisors have expressed concern about the potential difficulty of explaining the tool and its appropriate uses to the general public, and we recognize that the potential for public use will need careful planning for both tool design and development of training programs. With proper training and explanation of the standards and requirements that need to be followed for critical areas protection, the tool could be a very effective way to allow the public to see how hard it really is to make land use decisions that balance all the competing goals. We will carefully consider the implications of public use and strategize on how to address the risks identified. Some possibilities include limiting public use of the tool to a controlled environment during comprehensive planning meetings, building bumpers into the tool to limit use to appropriate analyses based on scale, BAS, and other factors, developing an access login to share data and use the tool, providing public training programs, or simply developing written disclaimers with well-developed terms of use conditions. We plan to include these tool features regardless of public use, so decisions about access can be made later on once stakeholders have seen how the tool works and can provide more informed advice.

> *"It's too hard for a landowner, developer, or planner to know all of the potential resources." – Resource Agency*

6.3 Considerations for Use of the Tool

Whether it is used by the public, or only by local governments, agencies, and other organizations, there is a risk of misuse, and it will be critical to ensure users understand the data included in the tool and its appropriate use. Some data is appropriate for regional questions and other data is more appropriate for parcel level questions. Many analyses will need to be kept at the appropriate scale for making watershed or sub-basin level decisions, so that they cannot be misused to justify site specific development or changes in critical area protections at the parcel level. Bumpers and bounding ranges will be programmed into the tool to prevent this type of misuse. For example, if a person wants to move a critical area buffer on their property, the tool will apply that change at a threshold where effects can be seen (i.e. the sub-watershed scale), so the person is not misled into thinking the tool can predict effects at the site level. Bumpers and bounding ranges could also ensure the values that can be explored in the tool for buffer sizes and other measures are aligned with BAS, and this could provide the additional benefit of ensuring that BAS is considered and incorporated during critical areas updates.

6.3.1 Using Non-Regulatory Information

The tool will include information that can inform regulatory decisions (i.e. maps of critical areas), as well as information based on assessments that do not have a regulatory hook but are best practices for protecting the environment (i.e. watershed processes). Non-regulatory information is useful for informing decisions at the long range, comprehensive planning stage, but not for making decisions about minimal regulatory standards. Currently, this type of information is most useful for telling a compelling story in the public process to gain support and prevent the need for an appeals board decision. We will make distinctions between regulatory and non-regulatory information in the tool. If consideration of watershed processes and similar "best practices" information is to inform regulatory decisions, new legislation may be needed. Developing a tool that shows the value of this information can help nudge planners in the

direction of best planning outside of regulation and may support future efforts by resource agencies to pursue new legislation.

6.3.2 Using Local Data

Regional planning tools are often deemed inappropriate or inapplicable by local jurisdictions because the scale of the data is too coarse or not accurate enough. To address this issue, we will include regional datasets for coverage but we will allow users to add their own data for use in the tool if they have finer scale data available. Allowing local governments to use their own data within the framework of the tool will be a way to help ensure that the tool can meet their needs. The tool will also need to provide transparency about the accuracy and confidence in the information provided.

6.4 Training and Technical Assistance Programs

To maximize the benefits of the tool and encourage local adoption and buy-in, we will establish several programs for training and technical assistance. Puget Sound wide training programs will be developed for local planners, resource agencies, and the public. A developer of similar tools suggested implementing an early adopter program, in which Commerce or agency staff would work closely with a few local planners to guide them through the process of using the tool. Then those early adopters would act as champions of the tool at conferences and events to encourage adoption by others. Another way to promote use of the tool by local governments would be to develop it in a way that provides safe harbor and assurances by documenting use of BAS. A good outreach and marketing campaign will be needed to tell decision makers and planners how the tool will make their jobs easier, and we will need to solicit and respond to feedback from end users throughout the development process.

7. TOOL DEVELOPMENT PROCESS

We have completed the preliminary concept development and feasibility research for the tool and we are ready to move on to the first phase of tool development. The first phase will include development of detailed workflows and tool architecture, data compilation and assessment, and buildout and testing of a beta version of the tool that brings together data and provides limited scenario analysis functionality. Following successful completion of the first phase, we will pursue full build-out of the tool in the second phase, develop a plan for ongoing support and maintenance, and develop a training and marketing program to encourage use of the tool by local governments. The final product will be a fully functional web-based spatial decision support system capable of handling all priority use cases, and to which additional scenario analysis functionality can be added in future updates.

7.1 Preliminary Phase: Concept Development and Feasibility Research (*complete*)

We received funding for a preliminary phase researching the feasibility of developing an integrated spatial decision support tool for critical areas and land use planning, of which this prospectus is the final product. This work focused on defining the concept for the tool and showing that its development is achievable and needed. With this funding, we accomplished the following:

1) Assessed the needs of end users to prioritize potential uses for the tool, based upon input from more than 100 individuals, including more than 60 local government planners.
2) Assembled a 50-member advisory committee comprised of agencies and local governments, modelers, GIS experts, developers of similar tools and data, and policy and planning experts.
3) Identified and addressed potential barriers to tool development
4) Developed a conceptual design for how the tool will be structured to meet priority needs and achieve the key functionality needed.
5) Assessed more than 40 similar products for potential incorporation into the proposed tool and/or usefulness as an example for developing the proposed tool. From this effort, we identified and interviewed five tool developers whose products could be used to build the proposed tool, all of whom reviewed our conceptual design and affirmed that it could be built using their platforms.
6) Published a Request for Information (RFI) to identify additional contractors who have the experience and expertise to develop the proposed tool.
7) Developed a project management plan with organizational structure needs for the next phase of the project.

From the information we gathered during the preliminary phase, we are confident that there is a high level of need and support for the proposed tool, our proposed design is achievable and can be built utilizing at least four existing platforms, and there are at least 15 experienced contractors interested in building the tool. The results of this phase fully support the decision to move on to the next phase and pursue funding for tool development.

7.2 Phase 1: Years 1 and 2

The first phase of tool development will include: 1) contracting with vendor(s) to complete the full scoping and framing of the tool that was begun during the preliminary phase, 2) compiling and assessing the needed data, 3) building out the landscape prioritization and scenario analysis functionality of the tool for a limited number of variables and at least two use cases, 4) developing a web mapping application and user interface, and 5) testing the preliminary tool with our advisory committee.

7.2.1 Select Vendor(s)

The first step will be to publish a Request for Proposals (RFP) to select vendor(s) experienced in spatial and decision model integration to 1) develop workflows and plan the tool's architecture, 2) develop the back end of the tool, and 3) design and develop a user interface that connects to the back end engines and models. Depending on qualifications and responses, we may select one or multiple vendors to complete these tasks.

Phase 1: Key Deliverables (Years 1 and 2)

- RFP and vendor contract(s)
- Detailed workflows and requirements for tool structure, data, and models to support all five priority uses
- Regional web map of critical areas and other key planning layers with querying and filtering tools
- Updated regional land use layer
- Data dictionary and metadata
- Beta tool that supports limited scenario analysis for two or more specific planning decisions
- Tool hosting setup
- Beta testing documentation and improvements

7.2.2 Develop Workflows

We will work with the selected contractor to develop full workflows that line out the details of the tool's structure, including data and modeling needs and how each model will be linked to achieve the proposed concept for the priority use cases identified. Priority use cases to be developed in the first full version of the tool are described in Chapter 6, and include decisions about upzoning, Urban Growth Area (UGA) expansion, rural zoning density, selection of mitigation/restoration sites, and changing critical areas regulations. These specific decisions will be supported by processes for 1) identifying critical areas and other ecologically important areas, and assessing options for protecting those areas via regulatory scenarios (i.e. expanding critical areas buffers), 2) informing development density decisions (i.e. upzoning or UGA expansion) based on ecological and land use considerations, and evaluating the effects of buildout under alternative zoning scenarios, 3) informing restoration decisions based on ecological and land use considerations, and calculating the benefits of implementing restoration scenarios, and 4) identifying where sensitive areas need more protection and monitoring for compliance with regulations.

Workflows for building a tool to support each use case will be lined out prior to beginning tool development with input from subject matter experts on the needed requirements, data, and analysis criteria. Plans will also include tool architecture for data sharing, security, functionality, and quality control. We will work with the state Office of the Chief Information Officer (OCIO) and state partners to develop requirements and design for these features.

7.2.3 Compile and Assess Data and Models

Concurrent with the workflow development and tool architecture planning, we will begin to compile the models and datasets needed for critical areas planning from resource agencies, local governments, and other organizations. These will include the available critical areas layers used and shared by each local jurisdiction, as well as regional critical areas layers produced by state and federal agencies. We will also

gather supporting datasets at the regional level for other key land use planning elements, including land cover, land use, zoning and development, infrastructure, watershed function, ecosystem services, and other resource lands. Key data sources for some of these features are described in Chapter 4. These data layers will be displayed on a web map.

Once the workflows for the landscape prioritization and scenario analysis functionality (and its data needs) have been defined, we will assemble and assess the available models and datasets for their ability to be integrated into these components of the tool. This will include obtaining information on each model or data source's quality, coverage, limitations, upkeep, challenges, barriers, benefits, scale, security, and accessibility. During the preliminary phase, we identified several models and data sources that will be included in the assessment and may be good candidates for inclusion as starting points for the scenario analysis tool (*see Chapter 4*). From this assessment, we will prioritize the individual models for integration and choose two or more use cases with good data coverage for initial buildout of the tool.

We anticipate that local critical areas maps will require the most work to prepare for use in the scenario tool due to the large number of individual jurisdictions and inconsistent data structure and attributes between maps. If needed, the first version of the scenario tool may focus on regional data, with local data included for a limited number of jurisdictions that have good data available and can be used as an example.

7.2.4 Develop the Back End of the Beta Tool

Once all of the workflows have been developed and data sources and models to be integrated have been identified and assessed, we will build out the back end of the tool for the two or more initial use cases that were selected, using the data sources and models that were deemed best suited for integration. The initial integration models will be built so that additional data sources and analysis variables can be added during full build-out of the tool in the next phase.

7.2.5 Develop the Front End of the Beta Tool

We will work with a group of end users to specify requirements for the user interface. We will develop the front end based on these requirements. A significant amount of front end design and development will need to occur concurrent with back end development to support its iterative design and implementation, and the user interface will be finalized after completion and testing of the back end. The completed front end will include a web map that displays all the compiled data layers needed for critical areas planning and allows them to be overlaid and queried, and it will provide an interface for the scenario analysis tools that were built out in this phase. The front end will be designed so that additional scenario analysis capabilities can be added during full build-out of the tool in the next phase. We will set up hosting of the tool to make it available online.

7.2.6 Criteria for Progressing to the Next Phase

Criteria for moving on to the next phase include successfully developing and hosting a beta-ready web-based spatial decision support tool that organizes and displays critical areas planning data and can handle at least two scenario analysis use cases. Decisions about which data and scenarios will be included in the beta version will be made during the workflow development process, but a likely outcome of this phase would be a preliminary tool that 1) organizes and displays critical areas planning data layers across jurisdictional boundaries and provides querying and filtering capability, 2) a landscape prioritization interface that prioritizes areas for development density based on at least three key variables, which may

include impacts on critical areas, impacts on watershed functions, impacts on ecosystem services, impacts on resource lands, development capacity, and existing infrastructure, and 3) a scenario analysis tool that calculates the results of buildout under alternative zoning scenarios on the same key variables. The result would be a preliminary tool that provides value for informing decisions such as upzoning, downzoning, or UGA expansion based on the effects of those decisions on a limited set of ecological and land use variables. We will work with our advisory committee and a group of end users to test the preliminary tool and make recommendations for improvements and additional variables that should be implemented during full build-out in the next phase. Based on the results of this phase, we will re-assess the feasibility and timeline of full tool build-out and develop an action plan for completing the next phase of the project.

7.2.7 Puget Sound Mapping Project Update

Concurrent with the other activities in this phase, we intend to update Commerce's Puget Sound Mapping Project, which compares planned versus actual development throughout the Puget Sound region (*see Chapter 4*). This will provide a single regional base layer for assessing impacts on land use and development capacity under the regulatory and zoning scenarios that can be explored using the tool. It also allows for integration of land use analysis across jurisdictional boundaries and at multiple scales from local to regional, a task that is not easily accomplished using non-standardized zoning layers from individual jurisdictions.

7.3 Phase 2: Years 3 and 4

In the second phase of tool development, we plan to continue working with our vendor(s) to 1) refine and add additional maps and functionality to the beta tool that was built in the first phase, 2) develop a fully built out tool that can handle all the priority use cases identified, 3) produce a fully functioning decision support interface for the public, 4) develop plans for maintaining and managing the tool moving forward, and 5) implement a training and outreach program for assisting others in using the tool.

7.3.1 Improve and Expand the Beta Tool

The beta tool developed in the first phase will be improved based on beta testing results and recommendations from our test group. Any maps and variables that were not initially included but are still desired to support those initial use cases will be added. We will also build out the rest of the workflows that were developed during the first phase for other use cases that were not yet implemented. When full back end development is complete, the user interface will be modified to accommodate the additional functionality. The full tool will be hosted and tested with our advisory committee and a group of end users. When the needed modifications have been made, the tool will be made publicly available online.

Phase 2: Key Deliverables (Years 3 and 4)

- Additional data and models added to scenario analysis beta tool
- Beta tool expanded to support all five priority planning decisions
- Additional layers added to web map
- Updated data dictionary and metadata
- Full tool hosted and accessible
- Testing documentation and improvements
- Maintenance plans
- Training materials and programs

7.3.2 Develop Plans for Maintenance

During this phase, we will develop plans and a program for maintaining and managing the tool into the future. The tool will need to continue to be hosted and made available to local governments and the public. We will need to have a plan in place for funding ongoing costs associated with tool hosting and

maintenance, as well as possible licensing fees for tool components. We will also need to have an agreement with our vendor in place for maintenance of the tool and data links, as well as future updates to add new data and functionality. Additional maintenance considerations are described in Chapter 5.

Concurrent with tool development, we will develop training materials and tutorials for end users. This will include developing a training program and early adopter program to encourage buy-in and use of the tool by local governments. When tool development is complete, we will implement these programs and launch a marketing and outreach campaign to inform planners about the new tool and how it will add value for their work. We will also develop guidance on proper use of the tool, in collaboration with our partner agencies and advisory committee. Additional information on our plans for guiding use of the tool can be found in Chapter 6.

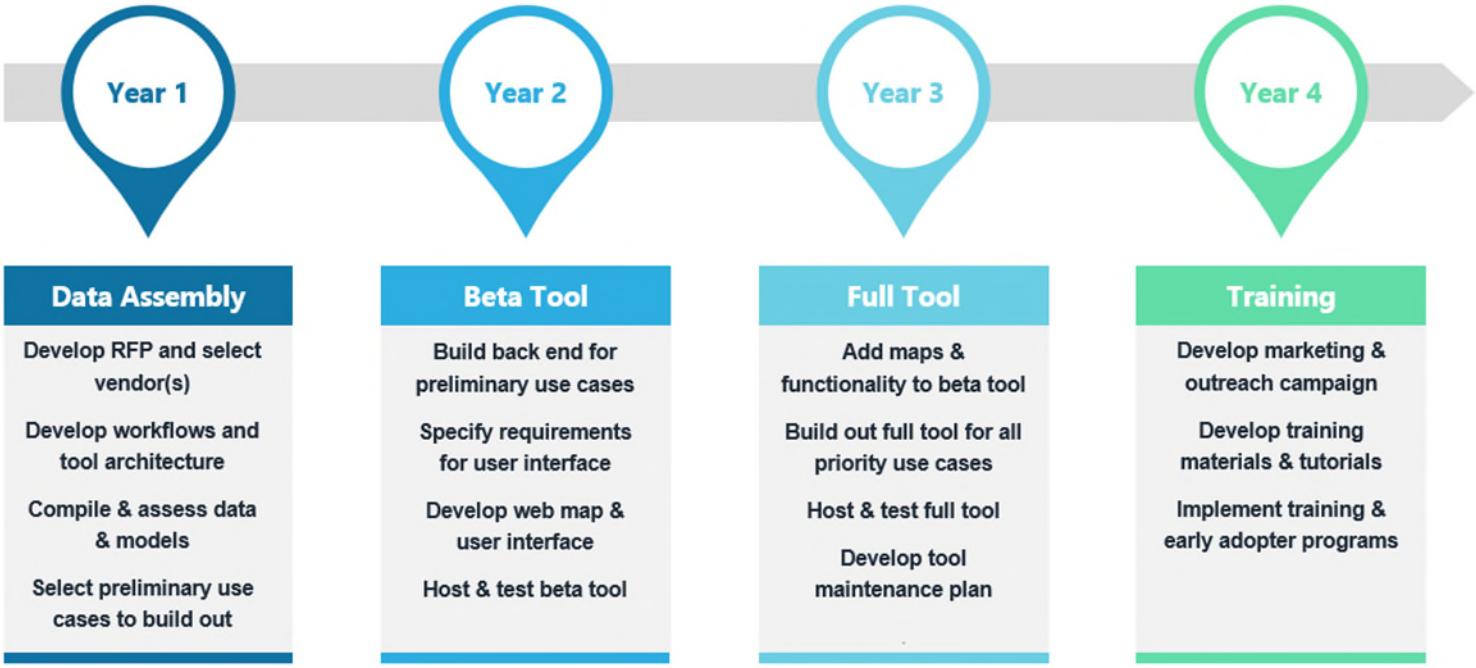

***Figure 14**. Timeline for the tool development process.*

7.4 Final Product

The final product will be a web-based spatial decision support system that integrates the maps needed for critical areas planning, delivers all of the scenario analysis functionality outlined in Chapters 3 and 4, can support all of the specific planning decisions described in Chapter 6, and can provide answers to all of the priority planning questions outlined in Chapter 2, to the extent that each of these components is feasible given the available data and model constraints. Commerce will work with a vendor to host and maintain the tool indefinitely as a resource for local governments to achieve more integrated planning under the Growth Management Act. Proposals may be developed for future phases to integrate additional models and functionality to answer other planning questions that were identified as important to end users but did not make the cut for inclusion in the first version of the tool.

8. BUSINESS ARCHITECTURE

We have identified the management team structure needed to implement this project and ensure quality control. It will include: a) one or two contractors for tool design and development, b) one contractor experienced in geospatial technology and spatial decision support tools to serve as project manager, c) Commerce project owners and advisors, d) partnering agencies and local jurisdictions, e) a stakeholder/advisory committee, and f) a consultant experienced in helping local jurisdictions with their planning processes to provide guidance on meeting local needs. We may also be required to work closely with the Office of the Chief Information Officer (OCIO) due to the size and length of the project. The roles of each element are described in the following sections.

8.1 Tool Design and Development Vendor(s)

We will hire a contractor for tool design and development. We have assessed contractor interest, experience and expertise through a Request for Information (RFI) process and interviews with tool developers. From our research, we are confident that there is a sizable pool of at least 15 interested vendors with the needed qualifications to design and develop the tool. We found that most vendors have the qualifications to develop the entire system, likely eliminating the need to hire separate vendors for front end and back end development. In the event that we do contract these components out separately, an additional integrating consultant and oversight process would be needed.

8.2 Project Management and Data Consultant

We will hire a consultant experienced in geospatial technology and spatial decision support tools for the bulk of the project management, coordination, and data assembly and governance tasks. They will be responsible for coordination with stakeholders and vendors, as well as all deliverables related to data governance. Commerce has a convenience contract that provides access to a pool of contractor resumes. Commerce's project team will review resumes and interview candidates to select a contractor for this role.

8.3 Commerce Project Owners and Advisors

Commerce's project team will consist of Growth Management Services (GMS) and Information Services (IS) staff. The project team will ensure quality control and that the vision, goals and objectives of the project remain aligned to create a product that is useful for local jurisdictions. The project team will coordinate to develop a Request for Proposals (RFP) and select contractors for tool development and project management. Once the contractors have been selected, the project team will guide and assist with development of the tool. GMS staff will provide expertise in watershed and land use planning, and will leverage the agency's relationships with local planners to gather the needed information and data from local jurisdictions. IS staff will be responsible for advising on technological considerations and ensuring that tool architecture and development meets state and agency IT standards. Growth Management Services staff will also update the Puget Sound Mapping Project (a key tool component described in Section 4.3.2) alongside development of the tool. Following tool development, Growth Management Services staff will provide technical assistance and training programs to local governments.

8.4 Partnering Agencies and Local Jurisdictions

Partnering agencies and local jurisdictions will have ownership of some project deliverables alongside Commerce's project team. They will ensure that the tool aligns with the values and science of their agencies or jurisdictions, and that their existing tools and data are integrated and used appropriately. Partners will be tasked with providing the information needed to integrate their tools, resources, and recommendations. They will also provide the information needed to align the tool with their processes. Representatives from the partner group will meet regularly with Commerce's project team and our consultant team to guide development of the tool.

***Figure 15**. Business architecture & project governance structure*

8.5 Stakeholder and Advisory Committee

We will maintain a volunteer stakeholder advisory committee to guide the development of the tool. We have already assembled a 50 member advisory committee of local government planners, state and federal resource agencies, non-profit organizations, environmental consultants, and other organizations interested in land use planning. We have also assembled a contact list of other stakeholders who have provided input for scoping the tool. Advisors and other stakeholders will continue to contribute their time and expertise to 1) help identify and assess data and models for inclusion, 2) help align tool workflows with planning processes and requirements, 3) help develop requirements for a user interface, 4) participate in testing the tool and make recommendations for improvements, and 5) help promote the completed tool to others. We will continue to hold advisory committee meetings at important points in the tool development process to discuss topics such as data and requirements gathering, model development, interface design, and tool testing and improvement.

8.6 Local Planning Advisor Consultant

Due to anticipated time and capacity constraints of local governments to advise us throughout the tool development process, we plan to hire an additional consultant experienced in helping local jurisdictions with their planning processes to serve as an advisor. They will attend planning meetings, provide input, and review and test products to ensure that the tool meets the needs of local planners. We have identified multiple consulting firms that assist local governments with this type of work.

8.7 OCIO Oversight

Because of the size and length of the project, we may need oversight from the Office of the Chief Information Officer (OCIO) throughout the tool development process. We will need to submit the project through the IT Project Assessment Tool (ITPA) for a determination on oversight requirements from the OCIO based on project risks.

8.8 Governance Structure

We will have a tiered governance structure to help make major project decisions that are important to stakeholders, such as tool requirements and changes to scope. The structure will include advisory committee discussions at the lowest level, partner meetings and discussions at the mid level, and Commerce project owner decisions at the executive level. We anticipate that most concerns can be resolved at lowest level through discussions with our advisory committee, which includes partners and key representatives from impacted stakeholders. The next level of escalation would be discussions with representatives from our smaller group of partner agencies only. If agreement cannot be found, Commerce project owners will maintain executive decision making authority.

9. ADDRESSING POTENTIAL BARRIERS AND RISKS FOR THE TOOL

Based on our research and input from our advisory committee and other stakeholders, we understand the barriers and risks associated with developing the proposed tool and have developed solutions and workarounds for avoiding, mitigating, or meeting these challenges as they arise. There are unique challenges to consider for scoping the tool, data and model inclusion, use of the tool, tool development, funding, and maintenance. We will address these risks and barriers in the following sections, and most of them are also addressed in the previous chapters. After assessing the risks and barriers and considering the possible solutions, we do not believe there are any challenges that are likely to prevent us from developing an end product is viable, resilient, and sustainable into the future.

9.1 Scoping the Tool

Defining an achievable and tangible scope for the tool has been the first challenge, and will continue to be a challenge as we move into the final scoping tasks in the next phase. We have consulted with 135 planners and scientists affiliated with 64 different organizations to learn about their needs and priorities. We successfully determined what local planners want to get out of the tool, which planning decisions they need it to support, and what specific questions it should answer. While a range of questions and needs are important to planners, several specific uses and needs rose to the top as the highest priorities for most end users. We will focus on those uses and needs for the first phases of tool development, but will build the tool as a platform to which we can add functionality to support additional uses at a later point in time. We have determined from interviews with tool developers and information received from vendors that the proposed concept is achievable and can be readily built using at least four existing platforms.

> *"Start with the low hanging fruit. Do the analysis that is somewhat easy to do first so that people can see the value of the tool. Perhaps where the data is already available but no one ever tied it together to show trends. Then tackle the analysis and data collection that might be more complicated."– County Planner*

9.1.1 Too Much Information without Guidance

Planners and other stakeholders expressed the need for a decision framework to guide the use of information at the appropriate scales. Without a decision framework, there is a risk of developing a collection of too much information that local governments will have a hard time sorting through and applying correctly. Our conceptual design includes a decision support framework that addresses this risk.

9.1.2 Taking on Too Much Right Away

Due to the nature of comprehensive land use planning under the Growth Management Act (GMA), our proposed concept is still broad, and there is still a risk of trying to take on too much right away. To address this risk, we decided to scope development of the tool in phases. The first phase will produce a beta scenario analysis tool that supports two specific, high priority planning decisions, and may only incorporate local data for a small geographic area to test functionality. Advisors have suggested starting with easier analyses where data are available but have not yet been connected, to show the value of the tool. The first phase will involve further scoping under the guidance of decision support and modeling experts to make final decisions about which specific planning decisions will be easiest to support in the beta tool based on the data sources and models available. This final scoping phase will 1) line out the

details of which models and datasets are of sufficient quality to meet planning needs and answer the specific questions planners selected as priorities, 2) assess how difficult they will be to integrate, and 3) develop workflows for how each model and dataset will be linked within the proposed concept. During this process, we will continue to consult with planners on the information and accuracy they need. A benefit of designing the tool using a platform-based approach is that models and datasets can be easily modified or swapped out as better sources of information are developed, mitigating risks associated with not incorporating all the best pieces of information right away.

"To truly encompass a jurisdiction's needs under the GMA, the scope will need to be broadened beyond just critical areas. - City Planner

9.1.3 Changing Priorities

Even though all the appropriate stakeholders have been consulted, there is a risk that some priorities for the tool could change during development. However, the priority uses we are pursuing for the tool are key elements needed for comprehensive planning, critical areas protection, growth management, and Puget Sound recovery, so we believe that tools to support these planning decisions will continue to be needed. One area where we expect priorities to change is in increasing importance of climate change planning as more jurisdictions integrate these considerations into their comprehensive plans. We will address this by building climate change considerations and data into the tool within the top priority uses, and we will leave room to add tools and data to answer additional climate-related questions in a later phase of development. If changes to scope are needed, we will have a tiered governance structure (*described in Chapter 8*), to help make decisions. We anticipate that most concerns can be resolved at the lowest level through discussions with our advisory committee, which includes key representatives from impacted stakeholders, or through discussions with our smaller group of partner agencies. If agreement cannot be found at the lower levels, Commerce project owners will maintain executive decision making authority over scope of the tool.

"Compile GMA planning goals. For each goal ask what questions would we need to answer to know whether or not the goal is being achieved. Build the model around those questions." - City Planner

9.1.4 Project Team Changes

There is a risk of staffing and project team changes within Commerce during development of the tool. We need to ensure that the project can continue if key team members are no longer involved. We will address this by thoroughly documenting the vision for the project and all key scoping decisions so that development can be guided by others in the future if necessary. This prospectus thoroughly documents the initial vision for the project, and this vision will need to be updated and expanded upon in documentation produced during the next phases. We will build multiple tiers of control into the project management plan by requiring intermediary deliverables, utilizing two project managers, and maintaining close coordination with the funding agency. Any necessary rehiring would be handled through an amendment to the contract.

9.1.5 Partner Priorities and Values

In addition to the needs of local planners, we will need to incorporate the values, priorities, and science of our partners into the tool. We will work with our resource agency, local government, and other partners throughout the tool development process to ensure that their data, models, and recommendations are incorporated and used correctly. We will task resource agencies responsible for critical areas information with providing information on their data, models, best available science (BAS), and recommendations that

should be used in local decision making. We will ensure that the questions they want planners to consider when making specific land use decisions are included in the decision framework.

Table 7. *Solutions to Barriers and Risks for Scoping the Tool*

Barrier, Risk or Challenge	Solutions
Engaging appropriate range of stakeholders.	Engaged 135 stakeholders from 64 organizations and received a robust response from local planners. Continue stakeholder engagement and outreach during the final scoping phase.
Differences in needs and wants between stakeholders, and potential for taking on too much right away.	Assessed stakeholder needs and chose specific high priority planning decisions to focus on during first phases. Implement a governance structure to manage decisions about scope.
Missing important questions.	Build the tool to answer highest priority questions for planners and agencies. Build the tool as a platform so that additional data and functionality can be added over time to support needs that were missed initially.
Shifting priorities during tool development, and scope creep.	Priorities are key planning elements which will continue to be needed. Build the tool as a platform so additional data and functionality can be added over time to support new priorities. Implement a governance structure to manage decisions about changes in scope. Account for the possibility of re-scoping if necessary after the first phase.
Project team changes.	Thorough documentation of vision and all scoping decisions, to be updated frequently during tool development. Multiple tiers of control via intermediary deliverables, two project managers, and close coordination with the funding agency. Rehiring would be handled through an amendment to the contract.
Developing a collection of too much information that is difficult for local governments to sort through and apply.	Proposed design includes a decision support framework to guide planners through decision processes at appropriate scales. Data and models included in the tool will be accompanied by guidance on proper use.
Incorporating values, priorities and science of partners.	Work with partners throughout tool development to ensure that their data, models, and recommendations are incorporated and used correctly.
Scoping a well-defined, tangible, and achievable initial product.	Developers have confirmed our conceptual design is achievable. Develop the tool in phases that are well-defined and focused on specific planning decisions and data.

9.2 Data and Model Inclusion

Analysis is only as good as the data basis. The most significant data and model challenges for developing the tool will be related to data accuracy, availability, scale, coverage, model assumptions and validation, varying definitions in data sources, providing good metadata, understanding relationships well enough to link data and models, and minimizing errors and uncertainty in tool outputs. Additional data challenges related to interoperability, structure, and security that will need to be addressed through tool development are discussed in Section 9.3.

> *"Have experts of each layer help guide the needs of that data." – Non-Profit Resource Organization*

9.2.1 Data Accuracy

Forty six percent of stakeholders who responded to our end user survey said that data not being accurate enough was one of their biggest challenges when using

decision support tools. Although developing more accurate new datasets is beyond the scope of this integration project, we plan to include functionality for end users to easily swap out data sources in the decision support tools if they have more accurate data that can be used. For example, if the tool only includes regional data layers in a particular area and there are concerns about accuracy, local planners can supplement that information with local data where available, and the tool can prioritize the most accurate data to use for each location in the analysis. In this way, the most accurate data available can always be used and users will not be limited by the accuracy of the datasets that we initially build into the tool. As jurisdictions and agencies update and improve the accuracy of their datasets and layers, those more accurate datasets can be added to the tool for use.

9.2.2 Missing Information

There is a risk of not having all the necessary data, or finding out during tool development that we do not have all the data we think we have. Thirty four percent of stakeholders who responded to our end user survey said not having enough data to make the decision was one of their biggest challenges with using decision support tools. We have already conducted some review of data sources and models, and we believe that sufficient data to answer all the key questions for the tool are readily available, using a combination of regional and local sources. We will dive deeper into the data and models during the next phase as we work with an experienced contractor to develop workflows for linking them in the decision support tools. Through this process, data needs and availability will be assessed prior to tool development and any questions that we find cannot be answered using the available data can be eliminated or saved for later. There are some known gaps in datasets that would be desired components of the tool, such as city and county jurisdictions' regulations and restrictions with regard to critical area and shoreline setbacks. Including this information would require additional code research and development of datasets that is beyond the current scope of this project, so it would likely need to be added at a later point in time.

> *"Ensure layers are cited and dated and have robust metadata. Use intuitive naming conventions. Be clear about the data limitations. Provide contact information for the developers of the data for further questions." – City Planner*

There is a risk of getting 99 percent of the way there and realizing something critical was missed, and having to go to an outside source to get that one piece of information. This will need to be addressed through careful planning and research before and during tool development, as well as by developing the tool as a platform to which additional data and linkages can be added later. We will work closely with local planners throughout tool planning and development to ensure that all the information needed to make specific decisions is included in the tool. The project and budget will include analysis of data and integration throughout tool development and for ongoing updates and maintenance.

9.2.3 Scale of Data and Models

Some datasets are appropriate for regional questions while others are appropriate for parcel level questions. Appropriateness for questions at different scales will be a key criterion assessed for each dataset and model that is considered for inclusion in the tool. The tool will be designed to primarily support questions at the watershed and sub-watershed scale, so datasets that can be used at this scale will be prioritized. However, there will also be some data that can support parcel level analysis. The decision support tools will be designed to match up questions with datasets at the appropriate scale. The decision support framework for some landscape prioritization decisions will be designed to move from a

broader scale down to a finer scale, using the appropriate data at each step. Information and guidance on the scale of each dataset and its appropriate use will be provided for users.

9.2.4 Unequal Data Coverage

Data coverage will not be equal across the region, and uncertainty in unmapped areas will need to be communicated. For example, natural hazards may be identified in some locations, but that does not necessarily mean that all other places do not have hazards. The tool will need to identify where there is certainty of knowledge and where there is less certainty. Uncertainty could be shown by greying out unmapped areas and flagging areas where information should be collected, or through dialog or pop up information for specific locations. This would allow users to understand where data is not yet available and may encourage the collection of additional information.

"BAS info would need to be well vetted and transparent as to how it was determined 'BAS'." – Local Planner

9.2.5 Model Assumptions

With any modeling exercise, there will be challenges with differences between models and reality. For CAOs, there is a range in how well local governments are implementing protections. There may be differences between what is protected in the code and what is actually occurring on the ground, whether that is due to exceptions, variances, illegal building or clearing in critical areas, or other factors. Some of these activities may be permitted and others may not. If models are based on CAOs as they are written, there is a risk that some areas might be shown as a protected buffer in the tool when there may still be land use activities occurring in that buffer. Whether the models reflect reality or code will need to be defined, as will other model assumptions. We will work with planners and scientists to make the most appropriate assumptions where needed. Assumptions around the relationships between, for example, expanding buffers and water quality, hydrology or other response metrics which are realized outside of the actual buffer will need to be validated or documented in order for the scenarios to have value for decision-making. The tool itself will need to properly differentiate between science and policy.

"We have locally generated information that is more accurate than non-locally generated information." - City Planner

9.2.6 Data Definitions

For datasets that are defined by varying policies or definitions, we need to make sure users know which definition is used. For example, definitions of impervious can vary by jurisdiction and by code; even within the same jurisdiction, the definition under the zoning ordinance may be different from the stormwater definition. It needs to be clear which definition is being used and where it came from. This can be done through metadata and more explicitly in the guidance for each dataset in the tool. Users will have the option to upload their own datasets if they want to use a different definition.

9.2.7 Data Updates and Metadata

We need to make sure the tool uses the best and most up to date data available. This can be partially achieved through data sharing methods where datasets are maintained and updated by the originating agencies and organizations according to their own update schedules. However, we will need to ensure that those agencies continue to maintain and update their data, and that it remains compatible with the tool through data sharing and other agreements. We can also allow users of the tool to share and use their own datasets if they have a better or more up to date data source for their jurisdiction. All layers in the tool will be named intuitively, cited and dated, and have robust metadata, as well as contact information for the developers of the data for further questions.

"A regional tool would only be useful if it is building on good data or provides better data." - City Planner

9.2.8 Linking Data and Models

There is a risk of not fully understanding the interactions between datasets and response variables. Thirty eight percent of survey respondents who had experience developing decision support tools experienced significant challenges with linking multiple models and datasets together to analyze scenarios. There are many confounding factors that may make it difficult to understand the relationships between inputs and outputs needed to run models. Another survey respondent with experience developing decision support tools said that even when they had the resources to get the needed data and build a model, they have not had the resources to thoroughly validate the model. Some models, for example the Hydrologic Condition Index, have already been validated for use in the Puget Sound. These models present a good place to start for integration into our tool. We will need to ensure that resources are allocated for validating any new models.

9.2.9 Error and Uncertainty

No tool is ever going to be perfect. As with most scientific models, there is a risk of Type II error (or a false negative conclusion showing that there is no effect or change when there really is). There is also a risk of Type I error (or a false positive conclusion showing a change or effect when there really is none). The tool and its models should build in mechanisms to minimize the risk of errors and show when they might occur where possible. The tool will need to be transparent about its limitations, and the limitations of all datasets included.

Table 8. *Solutions to Barriers and Risks for Data and Model Inclusion*

Barrier, Risk or Challenge	Solutions
Data not accurate enough.	Allow end users to add and use more accurate data where available. Tool can prioritize the most accurate available data to use in analysis.
Necessary data unavailable.	Preliminary review of data and models indicates sufficient data to answer all key questions are readily available. Deeper dive into assessing the data and models will occur during the next phase.
Not including an important piece of data.	Careful planning and research before and during tool development. Develop the tool so additional data sources and linkages can be added in later.
Datasets are appropriate at different scales.	Align questions with datasets at the appropriate scale. Provide information and guidance on the scale of each dataset and its appropriate use.
Unequal data coverage.	Mark areas of uncertainty on the map.
Errors, uncertainty, and limitations.	Build in mechanisms to minimize the risk of errors and show when they might occur. Transparency about tool, model, and data limitations.
Differences between models and reality.	Work with planners and scientists to make the most appropriate assumptions. Validate and/or document all model assumptions.
Varying definitions in datasets.	Show which definition is being used in metadata and guidance for each dataset. Allow users to upload their own datasets if they want to use a different definition.
Using the best and most up to date data.	Use data sharing methods to allow originating agencies to keep their own data updated. Allow users to share/upload their own data to the tool.
Not fully understanding interactions between datasets and response variables.	Use existing validated models and allocate resources to validate new models.

9.3 Developing the Tool

Tool development will present several challenges. These include securing sufficient funding, ensuring database and tool interoperability, providing sufficient processing power to run the tool efficiently, data security, accommodating changes in technology, and finding a contractor with the needed experience and expertise to build the tool.

9.3.1 Securing Funding

Successful development of the tool will depend primarily on securing sufficient funding. We have currently only secured the first year of funding to begin to scope and design the tool, and there is a risk that funding will not continue. Tool development will be expensive, and the total cost for full buildout will exceed the original amount requested in our NTA. We have produced a new cost estimate of the cost based on the key features to be included and information provided by developers of similar products. We have also provided a phased approach to developing the tool that does not rely on immediate funding for full buildout. Seeing the utility of new developments at each phase could encourage funders to provide money for additions. However, starting with smaller pieces and maintaining uncertainty about future funding might reduce interest in the project from potential contractors. We may need to pursue additional funding sources, potentially through NTAs and from the legislature.

Using Existing Software Platforms to Reduce Costs

Finding the right software packages and co-opting them for our purposes will help keep development costs down and prevent us from trying to reinvent the wheel. We have identified and reviewed several software packages for decision support tools that have already been developed with millions of dollars of investment. At least four of these platforms can be readily used to build our tool (*see Appendix B: Review of Similar Products for more detail)*. Using one (or a combination of) these platforms will allow us to take advantage of investments made by others and work that has already been done.

9.3.2 Database and Tool Interoperability

Another software challenge is database and tool interoperability. There may be challenges with data integration and getting maps, models, and datasets to connect with each other effectively. We plan to take advantage of existing platforms that have developed software architecture for model and data integration. Maps and datasets will need to conform to a standard structure that is recognized by the tool. There will be challenges due to inconsistency in structure and attributes between jurisdictions and among different levels of government. Each dataset will require some level of work to translate its attributes and structure for use in the tool. We will need to include adequate time and budget for handling these data tasks. The tool will provide a process for users to match up new datasets and their attributes with the needed format. Needed pre-processing of data can be automated, but automation should not be programmed until the workflow is proven. The attributes of data and models that will be included will be further assessed in the next phase. We will include interoperability requirements in our RFP, and all solutions will be required to integrate with Esri platforms. All software used in the tool will need to be compatible with state standards and standard technology at the state (i.e. Esri and SQL Server).

9.3.3 Processing Power

We will need to secure enough processing power to operate the tool efficiently. The amount of processing power needed will depend on the resource intensity of the calculations, modeling, and displays in the tool; the amount of lag time that is deemed acceptable by planners; and the number of users that will

need to be able to use the tool at once. If we determine that additional processing power is needed, it can be obtained by using cloud computing services (i.e. AWS or Azure), or through services offered by Esri. These options would come with some extra costs that would be added onto the second phase of tool development.

9.3.4 Data Sharing and Hosting

The primary challenge with bringing data into the tool will be coordination with the originating agencies and jurisdictions. We have done initial coordination on integrating the key datasets, as described in Chapter 4. Some datasets will require work on the part of the originating organizations to make sure they are ready and accessible for the tool as web services, but agencies and jurisdictions we interviewed believed they could make data available in that format when needed. Data that cannot be brought into the tool as web services due to technical limitations at the originating organizations will need to be hosted with the tool on Commerce's or our vendor's servers, which will have implications for ongoing maintenance needs.

9.3.5 Data Security

Permissions for using data vary by agency and may be inconsistent between jurisdictions. If we only use open data, it can be viewable for all users. However, some users will likely want to use more confidential categories of data, and accommodating this need will require a security component that only grants access to secure datasets to certain users. We plan to address this by incorporating a login system with user profiles that can be assigned permissions for data access and sharing. The originating agencies will be responsible for ensuring that the correct level of security is applied to any datasets they bring to the tool. The tool will need to be able to handle cases where certain datasets are not available to all users by conducting analyses with incomplete information or using alternate datasets. Several existing platforms have successfully implemented these features.

9.3.6 Changes in Technology

Another consideration is that technology could change within the 3 to 4 years that it will take to develop and implement the tool. Commerce's Information Technology (IT) office will continue to be involved in the project as a business partner, we are coordinating with the Office of the Chief Information Officer (OCIO) and state GIS coordinator, and we will soon have a dedicated agency GIS coordinator who can provide assistance and help us keep up with any new advancements. We will build flexibility into the tool to allow us to take advantage of new tools and IT developments.

9.3.7 Finding an Experienced Contractor

Finally, there is a risk of not being able to find a contractor with the experience and expertise to develop the tool. We have addressed this risk through research, interviews with tool developers, and publishing a Request for Information (RFI) to identify suitable contractors and ensure that a sufficient applicant pool exists. We received a robust response and have determined that at least 15 experienced vendors are interested in working with us on this project. We have reviewed responses in coordination with our IT office, and are confident that the respondent pool contains the needed experience and expertise to successfully develop the tool. In addition to relevant experience and capabilities, we will include organizational health of vendors in our criteria for vendor selection in the next phase.

Table 9. *Solutions to Barriers and Risks for Developing the Tool*

Barrier, Risk or Challenge	Solutions
Securing sufficient funding.	Phased development approach. Pursue additional funding sources. Adapt existing software platforms to reduce costs.
Trying to reinvent the wheel.	Co-opt existing software packages to take advantage of previous investments by others.
Database interoperability.	Include interoperability requirements. Require solutions to integrate with Esri platforms and other state standards. Develop a standard structure for maps and datasets and a process for users to match up new datasets and their attributes with the needed format. Automate pre-processing of data.
Processing power.	Obtain additional processing power through cloud computing services (i.e. AWS or Azure) or services offered by Esri, if needed.
Data security.	Incorporate a login system with user profiles that can be assigned permissions for data access and sharing. Build tool so it can handle cases where certain datasets are not available to all users.
IT advancements.	Coordinate with IT stakeholders to keep up with advances in technology. Build flexibility into the tool to take advantage of new developments.
Finding a suitable contractor.	Addressed through research, interviews with tool developers, and publishing an RFI. Response indicates that a sufficient and experienced applicant pool is available.

9.4 Maintaining and Updating the Tool

The tool and the data it relies upon will need to be sustainable. We have identified the needed mechanisms and structures for data maintenance, tool maintenance and stewardship, and future updates and additions.

9.4.1 Data Maintenance

For data maintenance, linking the tool to datasets hosted by agencies and jurisdictions as web services through the state open data sharing platform and ArcGIS Online or ArcGIS Enterprise (rather than uploading data to the tool and hosting it ourselves) will allow originating organizations to update and maintain much of their own data. Most jurisdictions and agencies are already sharing some or all of their spatial planning data online, and many already follow a schedule for updating their data and maps. We may need to find ways to ensure datasets are updated frequently enough to be useful in the tool, and that updated versions remain compatible with it, through data sharing or other agreements. Establishing standards for data-sharing participants to follow could eliminate many issues with interoperability and maintenance. Data included in the tool will need to include a service date or expiration date, and information on when the last update occurred. Saved analyses and scenarios will track the version of each dataset that was used at the time they were conducted.

Even if most data can be shared with the tool as web services, there will likely be some datasets that we need to upload and host with the tool. These datasets will need to be replaced periodically as updated versions are provided by the originating agencies. This work will be included as part of the ongoing

maintenance needs and costs associated with the tool. We will need to implement the appropriate data sharing agreements.

We have considered succession planning and how to solve problems with broken links and turnover with agencies that produce the data. Keeping data links up to date was the biggest challenge encountered by 50 percent of users and maintainers of other tools who responded to our end user survey. The tool will need to be able to handle cases when data is not available. Several existing platforms included in our review can run analyses with missing or incomplete data. The tool will also be programmed to alert users when data links are not valid or data is unavailable, and will include a mechanism for users to update data links themselves if they change due to updates or other factors.

9.4.2 Tool Maintenance

Even if most of the data can be self-maintained, the platform will need an owner who can update the tool itself, and there is a risk that there will be no owner or maintainer after the tool is developed. Long-term funding and a committed long-term steward will be needed for repairs, maintenance, and updates to the tool. We have identified three viable options for tool ownership and housing: 1) owning the tool internally at Commerce and hosting it on our servers, 2) hosting the tool on our vendor's servers, or 3) contracting with WaTech to host the tool. Further assessment of this issue is needed, but we believe hosting the tool on our vendor's servers may be the best option because it will push the maintenance of the platform onto them. However, this would potentially establish a long-term commitment to that particular vendor, so careful consideration will need to be given to vendor selection. To address risks associated with long-term viability of vendors, we will include criteria related to organizational health of vendors in our selection process and specify requirements for access to the source code should the vendor cease to exist. Another hosting option that has been used by other agencies is to host the tool on vendor servers at first and migrate it to agency servers later on as agency capacity for maintenance increases. Funding will be needed to cover up-front fees for setting up hosting of the tool and for annual maintenance costs associated with updates to the tool or data, as well as any necessary licenses for software components.

9.4.3 Future Updates and Additions

There will need to be capacity to update and expand the tool based on what works and what does not work along the way. Machine learning or artificial intelligence (AI) could be used to gather analytics from the users of the tool to see the most commonly asked questions, most commonly used data, and other information. This would allow us to supplement the information in the tool based on what questions cannot be asked because of data availability, and take out the things that people do not use. Advisors believe it would be best to start small but leave room for all of the other functionality to be added in later. However, concern has also been expressed about the potential to take on too much technical debt. We intend to develop the tool in phases, with a fully functional tool produced in the first phase that is useful for making specific decisions and can be expanded upon over time.

Table 10. *Solutions to Barriers and Risks for Maintaining and Updating the Tool*

Barrier, Risk or Challenge	Solutions
Keeping data up to date.	Link the tool to datasets hosted by agencies and jurisdictions as web services to allow them to update and maintain their own data. Agreements to ensure datasets are updated frequently enough and remain compatible. Include a service date or expiration date, and information on when the last update occurred. Track data versions used in saved analyses and scenarios.
Broken or outdated data links.	Build functionality to handle cases when data is not available (i.e. capability to run analyses with missing or incomplete data). Alert users when data links are not valid or data is unavailable. Include a mechanism for users to update data links.
Finding a long-term owner and steward for the tool.	Identified three viable options for housing and maintaining the tool. Secure long-term funding for maintenance.
Long-term vendor viability.	Include criteria related to organizational health of vendors in selection process. Specify requirements for access to the source code should the vendor cease to exist.
Tool updates and improvements.	Gather analytics on tool use to improve the tool. Leave room for features to be added later.

9.5 Use of the Tool

Challenges related to use of the tool include providing structure that can be easily applied to decision making, accommodating user differences between jurisdictions, addressing risks related to citizen use of the tool, preventing misuse, and promoting local adoption and buy in.

9.5.1 Applying Outputs to Decisions

We have defined the target end users and their needs for the tool as a business case, and we have assessed how using the tool will result in better decisions. A challenge expressed by one stakeholder who had experience with decision support tools was that tool outputs cannot always be applied to the decision that needs to be made. We will work with planners to address this by providing a decision support framework and guidance for end users to ensure that it can applied correctly and consistently to specific decisions. This will take into account the processes planners currently go through to make these decisions, the information they need, and the recommendations of agencies that regulate or study critical areas.

There will always be a risk that profit-driven decisions may prevail over resource conservation-driven decisions despite development of the tool. Commerce can provide guidance on use of the tool, but responsibility for enforcement of compliance with the GMA and use of BAS will remain with the Growth Management Hearings Board. However, we believe that providing tools for local governments that make BAS more accessible and provide increased transparency, consistency, and accountability in decision analyses can help mitigate this risk.

9.5.2 User Differences

Even among local planners, there are likely to be user differences. Planners in metropolitan areas and resource-minded organizations may be most likely to use the scenario analysis functions of the tool. Other

planners will need very fundamental information on what critical areas are and where they are located, since some jurisdictions do not have experts working on their critical areas planning and do not use or know about the available maps and tools. Those users will need the tool as a look-up resource. The tool will need to include an easy interface for users who have no GIS experience, but will still need to be rigorous enough to add value for those who have more expertise. Data visualization will also need to be taken into account. For both types of planners, the tool needs to be quick and easy to use. Thirty four percent of stakeholders who responded to our end user survey said that difficulty of use and lack of training were some of their biggest challenges with other decision support tools. Planners told us they will not use a tool if it takes too long or is too difficult to use. This issue will need to be addressed through developing a user-friendly interface and training resources; we will have advisors from local governments involved in testing and reviewing these components.

A related risk is that not all potential users of the tool will understand technical jargon. Consideration will need to be given to how best to simplify the tool to make it accessible, without simplifying it too much. We plan to address this through dialogue boxes with definitions and guidance that can be viewed within the tool, as well as by developing training materials. A Puget Sound wide training program will also be developed for the tool, both for the public and for local governments.

9.5.3 Citizen Use

The potential for citizen use of the tool could be complicated, and some of our advisors have expressed concern about explaining the tool and its appropriate uses to the public. We have received a range of opinions from advisors on whether or not this tool should be made available to the public, and what controls on access and use should be built in. If access is restricted, there is a risk that lack of transparency might heighten distrust of government, and that a lack of public knowledge and understanding of critical areas issues will ultimately work against protection goals. With proper training and explanation of the standards and requirements that need to be followed for critical areas protection, the tool could be a very effective way to allow the public to see how hard it really is to make land use decisions that balance all the competing goals. More thought is needed to carefully consider the implications of public use and strategize on how to address the risks identified. Some possibilities include limiting public use of the tool to a controlled environment during comprehensive planning meetings; building bumpers into the tool to limit use to appropriate analyses based on scale, BAS, and other factors; blurring or shading out answers when the scale changes; developing an access login to share data and use the tool; providing public training programs; or simply developing written disclaimers with well-developed terms of use conditions, as are seen in most agency web maps and tools. We plan to include these tool features regardless of public use, so decisions about access can be made later on once stakeholders have seen how the tool works and can provide more informed advice.

9.5.4 Misuse

Whether it is used by the public, or only by local governments, agencies, and other organizations, there is a risk of misuse. Forty two percent of stakeholders who responded to our end user survey said that users not understanding how to interpret or use the data was one of their biggest challenges with decision support tools. Advisors expressed concern that planners do not always understand all the data they are provided or how it should or should not be used. Some data is appropriate for regional questions and other data is more appropriate for parcel level questions. It will be critical to ensure users understand the data included in the tool and its appropriate use. Many analyses will need to be kept at the appropriate

scale for making watershed or sub-basin level decisions, so that they cannot be misused to justify site specific development or changes in critical area protections at the parcel level. Bumpers and bounding ranges can be programmed into the tool to prevent this type of misuse. For example, if a user wants to move a critical area buffer on their property, the tool will apply that change at a threshold where effects can be seen (i.e. the sub-watershed scale).

Alignment with Best Available Science

Depending on how the tool is designed, there is a risk that it could be used to justify decisions that do not align with BAS; for example, rationalizing buffers that are narrower than BAS dictates. Bumpers and bounding ranges could ensure the values that can be explored in the tool for buffer sizes and other measures are consistent on BAS. If implemented in this way, this could provide the additional benefit of ensuring that BAS is considered and incorporated during critical areas updates. If the tool itself becomes BAS, there is a risk that the Growth Management Hearings Board will not see it that way, so they will need to be involved in and informed about the tool development process as well.

9.5.5 Local Adoption and Buy-In

In order for tool development to be worthwhile, it will need to be used and relied upon by local governments to inform GMA and SMA decisions, but it may be challenging to get everyone to agree to support and use the tool. Thirty eight percent of stakeholders who responded to our end user survey said lack of organizational support for using tools to make decisions was one of their biggest challenges, 14 percent had issues with lack of buy-in from target users, and 34 percent experienced difficulty with other people not liking or believing the results. A few advisors expressed concern that some local governments may not want or trust a tool coming from the state level with federal funding. We found that the vast majority of survey respondents were very receptive to the idea of the tool; however, a few did express this sentiment and one planning director expressed concern that the tool could reduce local control over implementation of the GMA and SMA.

Outreach, Early Adopter, or Safe Harbor Programs

A developer of similar tools suggested implementing an early adopter program, in which Commerce or agency staff would work closely with a few local planners to guide them through the process of using the tool. Then those early adopters would act as champions of the tool at conferences and events to encourage adoption by others. Another way to promote use of the tool by local governments would be to develop it in a way that provides safe harbor and assurances in exchange for using the tool. Good outreach will be needed to tell decision makers how the tool will make their jobs easier and we will need to solicit and respond to feedback from end users throughout the development process.

Legislative Requirements

The tool will include information that can inform regulatory decisions (i.e. maps of critical areas), as well as information based on assessments that do not have a regulatory hook but are best practices for protecting the environment (i.e. watershed processes). Non-regulatory information is useful for informing decisions at the long range, comprehensive planning stage, but not for making decisions about minimal regulatory standards. Currently, this type of information is most useful for telling a compelling story in the public process to gain support and prevent the need for an appeals board decision. We will make distinctions between regulatory and non-regulatory information in the tool. If consideration of watershed processes and similar “best practices” information is to inform regulatory decisions, new legislation may be needed. Developing a tool that shows the value of this information can help nudge planners in the

direction of best planning outside of regulation and may support future efforts by resource agencies to pursue new legislation.

Allowing Use of Local Data

Another challenge related to local buy-in is that many previously developed agency planning tools have been deemed inappropriate or inapplicable by local jurisdictions because the scale of the data is too coarse or not accurate enough. Allowing local governments to use their own data within the framework of the tool will help ensure that the tool can meet local needs and that planners are able to use familiar local data that they trust. The Department of Ecology incorporated local data for wetlands and streams into their Puget Sound Watershed Characterization and found that this was effective in improving local receptivity to the tool, even if the data did not change results much. The tool will also need to provide transparency about the accuracy and confidence in information provided.

Table 11. *Solutions to Barriers and Risks for Use of the Tool*

Barrier, Risk or Challenge	Solutions
Difficulty applying tool outputs to decisions.	Work with planners to provide a decision support framework and guidance for applying the tool to specific decisions, taking into account decision processes, information needs, and recommendations from agencies.
Profit-driven decisions prevail over GMA and BAS-driven decisions despite tool development.	Providing tools that make BAS more accessible and provide increased transparency, consistency, and accountability in decision analyses can help mitigate this risk. Responsibility for enforcement of compliance with the GMA and use of BAS will remain with the Growth Management Hearings Board.
User differences between small and large jurisdictions.	Make the tool useful as a look-up resource as well as for scenario analysis. Easy interface for inexperienced users but rigorous enough for more experienced users. Good data visualization.
Too difficult or time consuming for planners to use.	Make tool quick and easy to use by developing a user-friendly interface and training resources, with testing and review by planners.
Public use/difficulty explaining use to the public.	Possibilities include: limiting public use to controlled planning meetings; restricting access by developing a login; building bumpers to limit use to appropriate analyses based on scale, BAS, and other factors; public training programs; or written disclaimers with terms of use conditions.
Misuse of the tool and misinterpretation of results.	Guidance and training to ensure users understand the data included in the tool and its appropriate use. Keep analyses at appropriate scales by programming bumpers and bounding ranges that apply scenario changes at a threshold where effects can be seen.
Not all potential users understand technical jargon.	Dialogue boxes with definitions and guidance that can be viewed within the tool, training materials, training program.
Using the tool to justify decisions that do not align with BAS.	Provide information on BAS. Program bumpers and bounding ranges to ensure that scenarios explored in the tool are consistent on BAS.
Using the tool as BAS.	Coordination with scientific subject matter experts and the Growth Management Hearings Board throughout tool development.
Lack of local adoption and buy in.	Allow local governments to use their own data in the tool. Transparency about accuracy and confidence. Early adopter program and/or program for safe harbor and assurances. Outreach to decision makers. Solicit and respond to feedback.

9.6 Conclusions about Barriers and Risks

We believe that our proposed solutions adequately address all the barriers and risks that have been identified through our research and discussions with stakeholders, advisors, tool developers, and end users. We will include the solutions for mitigating and addressing barriers and risks in our project plan and as tool requirements in our RFP for vendor selection. Our research of similar products and vendors has already shown that all tool development requirements associated with mitigating these barriers and risks can be implemented by vendors using their existing platforms. After careful consideration of the risks, barriers, and solutions, we believe that the remaining risks are acceptable and there are no barriers that will prevent us from developing a tool that is useful and sustainable.

10. PARTNERS AND ENDORSEMENTS

We have established collaborative relationships with all of the key agency model owners and multiple local jurisdictions. They have all agreed to serve on the advisory committee and help guide the development of the tool. Additionally, a number of agencies have expressed interest in partnering with us on the project. We plan to formally forge these partnerships after partners have had time to review the prospectus and see the full plans for the tool and project structure.

We also received strong interest and support for the tool from many end users and agencies. When we asked stakeholders whether they believe this tool is needed and why, response was overwhelmingly positive. Some responses from stakeholders included the following:

- "A tool like this sounds like it would be helpful for informing long-range projects and plans like PSRC's Vision 2050 and county comprehensive plans. Often there is a sense of where growth should occur theoretically, but having a richer, more integrated dataset would help identify where land use designations make the most sense on the ground."
- "I think such a tool would be incredibly useful to inform local policies and plans, and project permitting (also restoration prioritization and mitigation opportunities)."
- "Yes, especially on a larger scale for long term planning."
- "The tools we have show where land uses are…but do not have any analysis associated."
- "Yes, too much planning is done using poor quality information or is based on the "these four other jurisdictions did it so it must be right" method. We've got lots of science and data but it needs to be useful to the practitioners and decision makers"
- "This tool, with any or all of the potential aspects described, would help the region and the state to make decisions more cohesively. The joining of resources will also facilitate state-wide consistency and has the potential to increase the utilization of data to make decisions."
- "I can't imagine a single planner that wouldn't be extremely excited about this project. It is possibly the most important tool to develop. It would save individual jurisdictions enormous amounts of time and money."
- "I previously was skeptical about this tool. Would it be too clunky with as much data and alternative scenarios as it would support? But after switching jurisdictions, it's clear that mapping services can be inconsistent and a central repository would benefit all."
- "It organizes existing resources and can make users aware of datasets they may not otherwise consider using or know exist."
- "Yes, there are too many wasted resources with all the funds spent to do the same work."
- "Yes! [A tool that] allows all considerations to be analyzed/queried at the same time, on the same platform, with current data, is essentially THE tool needed for accurate, insightful, and quick planning analysis"
- "Especially [needed] for smaller jurisdictions with limited resources. YES."
- "Yes, many local governments do not have the resources to expend on such a resource and the ones that are publicly available do not function to the needed level of service."
- "I can see the value, and especially value added for agencies working state-wide. I can see the value of local entities viewing what other entities have already completed, how they've already tackled similar problems, etc."

- "An integrated regional tool that assesses how well the critical areas regulations are protecting critical areas would be extremely important."
- "Very much so…Our planning and permitting is still very much oriented to site by site review which cannot solve environmental problems that have their roots at the broad scale."
- "Yes, it's too hard for a landowner, developer, or planner to know all of the potential resources."
- "Yes, our world does not end at jurisdictional boundaries."
- "If it has more accurate and up to date data for critical areas it would be particularly useful."
- "Yes – if successful, it would allow for better education of the public and more efficient implementation of local regulations."
- "Yes! Because we all need to intersect in resource management and look at the same data/picture."
- "Yes. Good information is critical to improving planning decisions"
- "We need to unify data sets used by different levels of government."
- "Yes, everything, including these databases are too siloed, there should be a way for users to find the data for decision-making...for DAHP, cultural resources are always forgotten while we can make available useful and easy to access data."
- "Yes, for region planners and for local planners. This kind of information will help WSDOT and locals be on the same page about land use."
- "Having a regional tool would allow us to compare apples to apples so we can figure out how to provide assistance that's most useful for each jurisdiction."
- "Yes. It's currently herding cats!"
- "It would improve decision making to have this information in an easy to use tool."
- "Yes because local problems can be a product of top down influences."
- "Yes, I spend too much time gathering data from disparate sources, [this tool would] increase productivity and data reliability."
- "Yes, data aggregation and integration is incredibly useful and any data to analyze trends and predict future planning can greatly improve planning decisions."
- "Yes. There are many "silos" of approaches, data, and perspectives. Climate change impacts are currently resulting in significant changes to a variety of phenomenon that are linked (e.g., flooding and real estate)."
- "I see it as beneficial in assessing things on a regional scale like regional targets, sea-level rise, climate change."

These endorsements demonstrate that the proposed tool has strong support among a range of jurisdictions and agencies. They illustrate a variety of the reasons why developing this tool is so important for improving planning processes and decisions.

11. PROSPECTUS OUTCOMES

We have developed a conceptual design for a decision support tool for critical areas and land use planning based on needs and priorities of local governments and resource agencies. Through our work researching and developing this prospectus, we established that 1) there is significant demand for the proposed tool from more than 100 stakeholders, 2) there are at least four existing platforms that we can build upon for tool development, and many more examples that can be used as a guide, and 3) there are at least 15 skilled contractors that can be readily utilized to build the tool. The technology and data needed to build the tool are readily available and we have developed solutions to mitigate and address risks and barriers. The biggest remaining risk is securing adequate funding for tool development and long-term maintenance, and we have taken steps to reduce this risk through phased development, utilization of existing platforms, and hosting decisions. We have carefully considered the need for and benefits of the tool alongside the remaining risks and barriers, and concluded that tool development is both worthwhile and achievable. Providing this tool for local planners would improve decision making by allowing better integration of critical areas planning with other comprehensive planning elements, improving access to and use of best available science (BAS), and allowing planners to show their work and justify decisions for stakeholders and reviewers. It would improve efficiency and defensibility in local planning processes, saving individual jurisdictions time and money.