
Bear Creek Watershed Management Study



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King County

Department of Natural Resources and Parks
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Bear Creek Watershed Management Study

A watershed-scale stormwater management study with instream, riparian, and wetland habitat elements in compliance with NPDES Phase I permit requirements

Prepared for:

This study is required for compliance with NPDES Permit conditions S5.C.5.c (Phase 1) and S5.C.4.g (Phase 2). Submitted on behalf of King County, Snohomish County, City of Redmond, City of Woodinville, and Washington State Department of Transportation

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King County Water and Land Resources Division

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EXECUTIVE SUMMARY

Development of this Bear Creek Watershed Management Study (the Study) meets the requirements of King County's 2012-2018 National Pollutant Discharge Elimination System (NPDES) Phase I Municipal Stormwater Permit. The Study represents a multi-jurisdictional approach to resolving one of the last and most challenging environmental issues in the Puget Sound basin – stormwater. Stormwater running off of developed lands can carry toxic chemicals, harmful pathogens, and habitat-smothering sediments. Habitat loss and degradation through development, such as decreased stream shading from trees and large changes in streamflow, are negatively impactful on salmon and other aquatic life.

King County, Snohomish County, the City of Redmond, the City of Woodinville, and the Washington State Department of Transportation have collaborated to complete this Study. The Study provides a comprehensive analysis of the current condition of the Bear Creek watershed and identifies a suite of stormwater management strategies that would result in hydrologic and water quality conditions that fully support “existing uses,” and “designated uses” throughout the stream system, with a particular focus on Low Impact Development (LID) best management practice (BMP) strategies.

This Study provides a long-term analysis for the restoration of the Bear Creek watershed, including a ten year strategy, budget, and specific projects that can be undertaken. Doing so would constitute a critical step in the hard work of retrofitting outdated stormwater infrastructure and restoring water quality and habitat in the Bear Creek watershed.

Purpose and Context

This Study was developed in accordance with Special Condition S5.C.5.c of King County's 2012-2018 NPDES Phase I Municipal Stormwater Permit (the Permit). King County was the lead agency for developing the Study, in partnership with Snohomish County, the City of Woodinville, the City of Redmond, and the Washington State Department of Transportation.

King County selected the Bear Creek watershed for this Study because the majority of the watershed is in unincorporated King County and it was identified by the Washington Department of Ecology (Ecology), the agency that issued the Permit, as a targeted watershed for stormwater retrofit planning due to its high ecological integrity. While there are restoration needs and concerns, the watershed contains important habitat for salmon recovery, and has generally good water quality.

The Permit-defined objective of the Study is to identify stormwater management strategies that would result in hydrologic and water quality conditions that fully support “existing uses,” and “designated uses” throughout the stream system. These uses are defined in Washington Administrative Code (WAC) 173-201A and include core summer salmonid habitat, salmon spawning, rearing and migration; and recreational, water supply, and miscellaneous uses. While the 2012-2018 NPDES Permit requires development of the stormwater strategies, there is no requirement that the findings be implemented.

The Study evaluated a number of stormwater management strategies to assess what would be needed to improve instream flow metrics and water quality parameters. The strategies include installation of stormwater facilities and low impact development (LID) best management practices (BMPs) throughout the watershed; and tree planting (to meet state water quality standards for temperature) along degraded stream corridors.

The Study identifies strategies for preservation and improvement of instream habitat, wetlands, and riparian areas. This aspect of this study exceeds the analysis required by the Permit and was not completed by other NPDES Phase I municipal permittees that were required to conduct a watershed study. King County and partners expanded the Study to include a focus on habitat conditions to address the integrated nature of aquatic resources across a watershed, specifically the linkage of fish and habitat to water quality.

In line with the Study's aspirational objectives – to fully restore the water quality and simultaneously address habitat – a suite of strategies are presented that are estimated to need a long time period (many decades) to implement. In light of the scale of the effort to address degraded conditions throughout the watershed, the Study identifies – and recommends – a set of near term actions for getting started over the next 10 years.

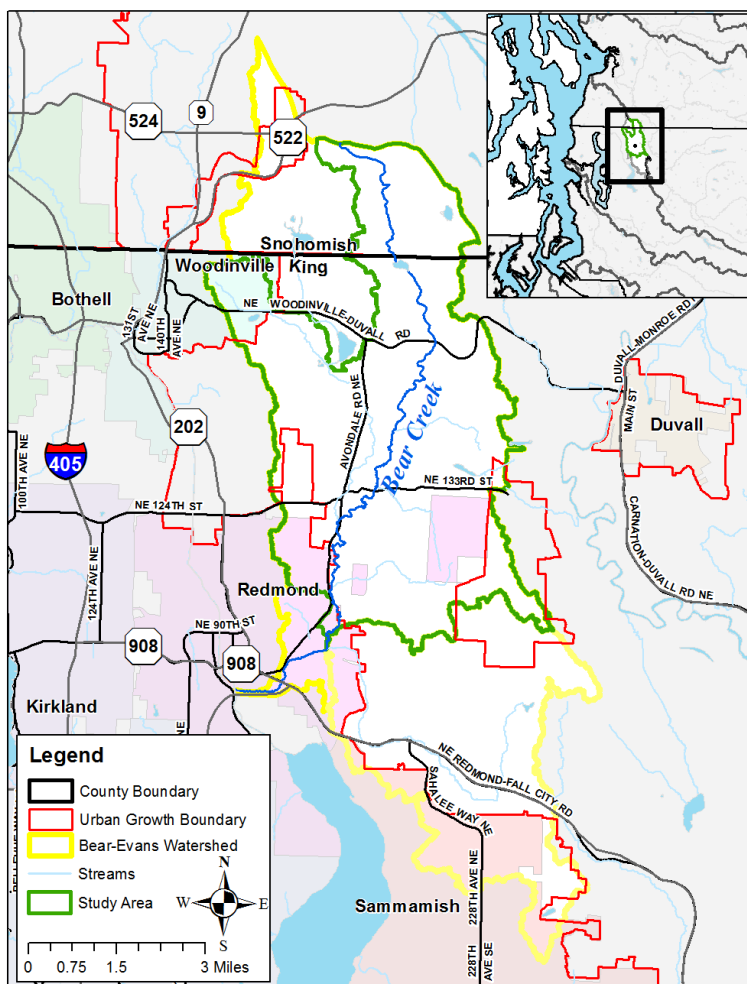
The proposed near-term recommendations actions are not required by the Permit, but they offer a road map to begin restoring the ecological health of the Bear Creek watershed. While the proposed actions are significant, it is clear that new information and unforeseen changes will affect what projects that would be constructed in future decades. The early steps would begin the process toward restoration, and in so doing, generate information to refine and improve the effectiveness of the long-term strategy.

Background and Existing Conditions

The Study area covers about 26 square miles of the Bear Creek watershed. The majority of the study area is within unincorporated King County, with smaller portions in the City of Woodinville, the City of Redmond, and unincorporated Snohomish County. Bear Creek currently supports a wide range of salmonids including Chinook, sockeye, coho, kokanee, steelhead, and coastal cutthroat. Moreover, Bear Creek has been identified as one of two high priority habitats to restore for Chinook salmon recovery (known as “Tier 1” habitat) by the Water Resource Inventory Area 8 (WRIA 8) Salmon Conservation Plan, covering the Greater Lake Washington Watershed.

Bear Creek's water quality, while generally good, is challenged with high levels of fecal coliform bacteria, elevated water temperatures, and low dissolved oxygen levels. Ecology has developed Total Maximum Daily Loads for temperature and bacteria in Bear Creek. Native vegetation along the stream corridor has been degraded over time and historic wetlands have been altered or filled in for other uses. Instream habitat, critical for salmon and other aquatic life, is lacking in quantity, quality and variety. Bear Creek's overall aquatic health based on observed Benthic Index of Biotic Integrity (B-IBI) scores is categorized as “Fair.”

The majority of land in the watershed is privately owned and has already been developed to some extent. Most areas not developed are within the City of Redmond Watershed (protected for water supply purposes) or are defined as critical areas by King County code. A small number of undeveloped parcels outside of these protected areas remain. Most of the development in the watershed occurred prior to current requirements for modern stormwater controls. Some stormwater facilities to manage runoff (such as ponds) have been built in the past, but most were based on older design standards that do not adequately protect aquatic resources. Land use projections based on population trends and current zoning suggest increasingly dense developments within the urban areas of the watershed in the future, with incremental increases in development levels in rural areas.



Complementary Actions in the Watershed

There is already a lot of investment by public agencies towards maintaining and improving the quality of the Bear Creek watershed. These investments include, but are not limited to, King County land conservation and acquisition efforts, WRIA 8 salmon habitat recovery projects, road drainage improvements, stormwater retrofits, pollution source control, and Redmond's Watershed Restoration Plan. The Study reviewed several of the major planned actions over the next 10 years and over \$40 million may be expected to be invested in the Bear Creek watershed that will improve water and habitat quality. Additional investments are expected from projects and programs not reviewed as part of this Study.

Assessing Actions to Achieve the Permit Targets and Standards

The Study identified a suite of strategies that if implemented would result in achieving the instream flow metrics and water quality targets as defined in the Permit. The strategies include installation of stormwater facilities built to current standards (ponds, gravity injection wells, etc.) and low impact development (LID) best management practices (rain

gardens, permeable pavement, drywells) throughout the watershed to address flow metrics and water quality. The strategies also include a source control effort to reduce fecal bacteria loadings and tree planting to reduce stream temperatures along degraded stream corridors. Incentive programs are recommended to promote these strategies on private lands. The Study results suggest that the majority of hard surfaces (roads, driveways, houses, parking lots, etc.) in the watershed would require treatment with LID BMPs and/or traditional stormwater facilities. While the identified strategies reflect the best available science, the effectiveness of many of these actions is not yet fully understood. As a consequence, the Study suggests a long-term timeframe and calls for adaptive management. The identified long term actions (and any associated costs) are therefore highly uncertain — new approaches and technologies are likely to modify what is ultimately needed.

The Study identifies comprehensive strategies for conservation and improvement of instream habitat, wetlands, and riparian areas. While the Permit considers the identification and analysis of these strategies discretionary, such strategies directly address the stream's aquatic life uses. They were deliberately included in the scope of the project from the outset, and supported through public workshops held during the plan's preparation.

Despite the challenges of fully implementing a comprehensive watershed management plan, King County and its partners recognize the need and opportunity to move beyond planning and take a critical first step. To that end, the Study recommends near-term actions that will begin to restore the watershed and generate momentum for ongoing improvements.

Near-Term Recommendations

The Study recommends a set of near term actions – over the next ten years – to improve water quality in select catchments (small, sub basins within the Bear Creek Watershed) and begin to restore habitat throughout the Bear Creek watershed. While many factors, including jurisdictional priorities, limited funding, and other ongoing activities will affect the degree to which recommendations are implemented, they reflect a path toward restoring the basin. Focusing intense stormwater efforts in smaller geographic areas increases the likelihood of achieving measurable instream improvements earlier, compared to more diffused efforts throughout the watershed. Besides demonstrating results, focused implementation can provide timely, useful feedback on the strategies employed so that they can be modified, as needed, to ensure effectiveness.

Key recommendations over the next 10 years include:

- Aggressively seeking funding (e.g. grants) to implement high priority actions;
- Constructing the recommended stormwater management facilities and LID BMPs on public land in the high priority catchments;

- Providing incentives for LID BMP construction on private residential properties in the high priority catchments; and
- Restoring 50 percent of degraded wetlands and riparian corridors, installing 10 percent of the high priority instream habitat projects, and providing incentives to plant trees along stream corridors throughout the watershed.

Additional activities recommended over the next 10 years include:

- Developing an in-lieu fee program that allows those proposing development activities the option to pay for stormwater mitigation in the watershed when it is infeasible to provide mitigation on a development site;
- Completing a study that analyzes the feasibility of a flow-control credit transfer program in unincorporated King County;
- Implementing a monitoring program to track strategy effectiveness, to be used in adaptively managing the plan;
- Completing a study that identifies and prioritizes fish barriers in the Bear Creek stream system;
- Implementing a public outreach and education campaign to support plan implementation by residents; and
- Completing a program review at completion of the ten year period, to inform next steps.

If implemented, the estimated costs to perform the recommended near term actions over the ten year period is \$81 million (presumably shared among the watershed partners). The analysis completed in the Study estimates the near-term capital construction cost for stormwater facilities in the priority catchments to be \$51 million. The near-term capital cost for habitat improvement projects is estimated to be \$26 million. Program costs including recommended studies and monitoring are estimated at \$4 million. The remainder of the estimated 10-year cost would cover a wide range of operation and maintenance activities for stormwater facilities in the watershed.

The extent to which funds are available to implement the near-term recommendations is unknowable at this time. Funding is dependent upon factors such as grant availability, the ability to leverage existing programs, and the ability to raise additional funds through rate setting and budgeting processes. It is expected that existing complementary efforts in the watershed will lower the additional amount of funding sought.

The Importance of Ongoing Public Support, Commitment, and Involvement

Public involvement, support, and cooperation will be crucial to the success of water quality and habitat restoration efforts in the Bear Creek watershed. Not only is public support

required for many of the agency strategies identified in the Study, some strategies like stream corridor planting and construction of new LID BMPs are projected to occur on private lands. Reducing pollutants to the stream that result from common activities depend on changed practices and behaviors by watershed residents. The Study identified the long term challenge, and identified steps that can be taken to get started. But the kind of public commitment that is necessary for achieving the goals of the Study can only result from a sustained, cooperative effort based on an understanding the stream's value to the greater community, and a commitment to its stewardship.

ABBREVIATIONS AND ACRONYMS

ASGWC	Areas Susceptible to Groundwater Contamination
B-IBI	Benthic Index of Biotic Integrity
BMP	Best Management Practice
CAO	Critical Areas Ordinance
CSP	Conservation Stewardship Program
CWM	Cooperative Watershed Management
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
EDT	Ecosystem Diagnosis Treatment
EPA	Environmental Protection Agency
ESRP	Estuary and Salmon Restoration Program
FCBMP	Flow-control Best Management Practice
GROSS	Grants of Regional or Statewide Significance
HOA	Home Owners Association
HSPF	Hydrological Simulation Program—FORTRAN
LCI	Land Conservation Initiative
LID	Low Impact Development
LWCF	Land and Conservation Water Fund
MAMP	Monitoring and Assessment Management Plan
NFWF	National Fish and Wildlife Foundations
NPDES	National Pollutant Discharge Elimination System
PBRs	Public Benefit Open Space Rating System
RCO	Recreation and Conservation Office
RCPP	Regional Conservation Partnership Program
REET	Real Estate Excise Tax
SUSTAIN	System for Urban Stormwater Treatment and Analysis Integration
SWM	Surface Water Management
STS	Science and Technical Services Section
SWDM	King County Surface Water Design Manual
SWS	Stormwater Services Section
TMDL	Total Maximum Daily Load
TSS	total suspended solids
UGA	Urban Growth Area

U.S.	United States
WAC	Washington Administrative Code
WHPA	Wellhead Protection Area
WLRD	King County Water and Land Resources Division
WPZ	Wellhead Protection Zones
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation

1.0 INTRODUCTION

This Bear Creek Watershed Management Study (the Study) was developed in accordance with Special Condition S5.C.5.c of the 2013-2018 National Pollutant Discharge Elimination System (NPDES) Phase I Municipal Stormwater Permit (the Permit). King County is a Phase I permittee, and the Permit was issued by the Washington State Department of Ecology. King County was the lead agency for developing the Study, with participation, as required by applicable NPDES permits, Snohomish County (Phase I S5.C.5.c.vi), the City of Woodinville (Phase II S5.C.4.g.iv), the City of Redmond (Phase II S5.C.4.g.iv), and the Washington State Department of Transportation (WSDOT) (S5.A.4.a).

The Permit-defined objective of watershed-scale stormwater planning is to identify a stormwater management strategy or strategies that would result in hydrologic and water quality conditions that fully support “existing uses,” and “designated uses” throughout the stream system. These uses are defined in Washington Administrative Code (WAC) 173-201A and include core summer salmonid habitat, salmon spawning, rearing and migration; and recreational, water supply, and miscellaneous uses. While the Permit requires the development of watershed strategies, it does not require implementation of the strategies.

As required by the Permit, stormwater management strategies evaluated include potential future structural retrofit projects and changes to development-related codes, rules, and standards. These strategies target improvements to instream flow metrics and water quality parameters. The structural strategies considered include installation of Best Management Practices (BMPs) and Low Impact Development (LID) techniques. Tree planting was considered along degraded stream corridors to reduce stream temperatures.

The Study also includes analysis of several efforts and identified strategies considered discretionary by the Permit. These efforts include an evaluation of strategies to preserve or improve other factors that influence maintenance of the existing and designated uses of the stream system. Evaluation and prioritization of projects that preserve or improve instream habitat, wetlands, and riparian areas was performed. These projects directly support the objective of improving designated aquatic life uses in the stream system.

King County assessed existing hydrologic, biologic, water quality, and habitat conditions in the study area to support strategy recommendations. Existing stream flow metrics, Benthic Index of Biotic Integrity (B-IBI) scores, concentrations of dissolved copper and zinc, temperature, and fecal coliforms were quantified and then utilized to develop and calibrate a continuous runoff model. This calibrated model was used to evaluate the effectiveness and estimated costs of proposed mitigation strategies under future land use conditions.¹

The Study includes an implementation schedule and cost estimates of the identified structural and programmatic strategies that are expected to result in the achievement of

¹ Future land use conditions were based on the full build-out of the most recent Comprehensive Plans (as of 2016) from King and Snohomish counties and the cities of Redmond and Woodinville.

the Study goals. The strategies and individual projects outlined in the Study are based on the best available current information. Adaptive management of the Study is recommended on a decadal timescale. Modifications to recommended strategies, projects, and schedule are anticipated as more information becomes available over time.

1.1 Permit and Project Background

The NPDES program was established by US Congress in 1972 as part of the Clean Water Act. The Clean Water Act allows the United States Environmental Protection Agency (EPA) to delegate NPDES permitting to individual states that meet specified requirements. The Washington State Department of Ecology (Ecology) issues municipal stormwater NPDES permits to municipalities, cities, counties, and special purpose districts in Washington State. The municipal stormwater permits require permittees to undertake efforts to reduce stormwater pollution by implementing best management practices (BMPs), which refer to a wide variety of pollution prevention systems or efforts.

King County's current NPDES Phase I Municipal Stormwater Permit was issued by Ecology, effective August 1, 2013 through July 31, 2018, and was modified January 16, 2015. Section S5.C.5.c of the Permit requires King County to conduct a watershed-scale stormwater management planning effort. King County selected the Bear Creek watershed because the majority of the watershed is in unincorporated King County and it was identified by Ecology as a targeted watershed for stormwater retrofit planning due to its high integrity (Figure 1) (King County, 2015). The selection meets the Permit defined criteria for watershed selection and has been approved by Ecology².

For this effort, the selected watershed (the study area) is defined as including Bear Creek and lands that drain to Bear Creek, with the following exclusions:

- The Evans Creek basin (a tributary to Bear Creek)
- The reach of Bear Creek downstream of the confluence to Evans Creek, along with small direct drainages and tributaries to this reach of Bear Creek
- Cottage Lake and the area that drains to Cottage Lake.³

About 2.4 square miles of the study area are in the City of Redmond, 1.1 square miles are in the City of Woodinville, 1.9 acres are owned by WSDOT, 3.7 square miles are in unincorporated Snohomish County, and 18.9 square miles are in unincorporated King County. The majority of the unincorporated King County area is designated rural except for about 1.9 square miles within the urban growth boundary (UGA) (Figure 1). Woodinville and Redmond are within the UGA. About 39 percent of the study area, including some unincorporated rural area, have existing densities greater than one house per 2.5 acres.

² Scope of Work approved January 13, 2016 by Ecology (<https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/BCP-SOW-approval-2016-01-16.pdf>)

³ Drainages upstream of Cottage Lake are not included in the project area because Cottage Lake serves to substantially mitigate the effects of land use change upstream of the lake. Thus, selection of potential mitigation sites would be most effective downstream of Cottage Lake when focusing on Cottage Lake Creek.

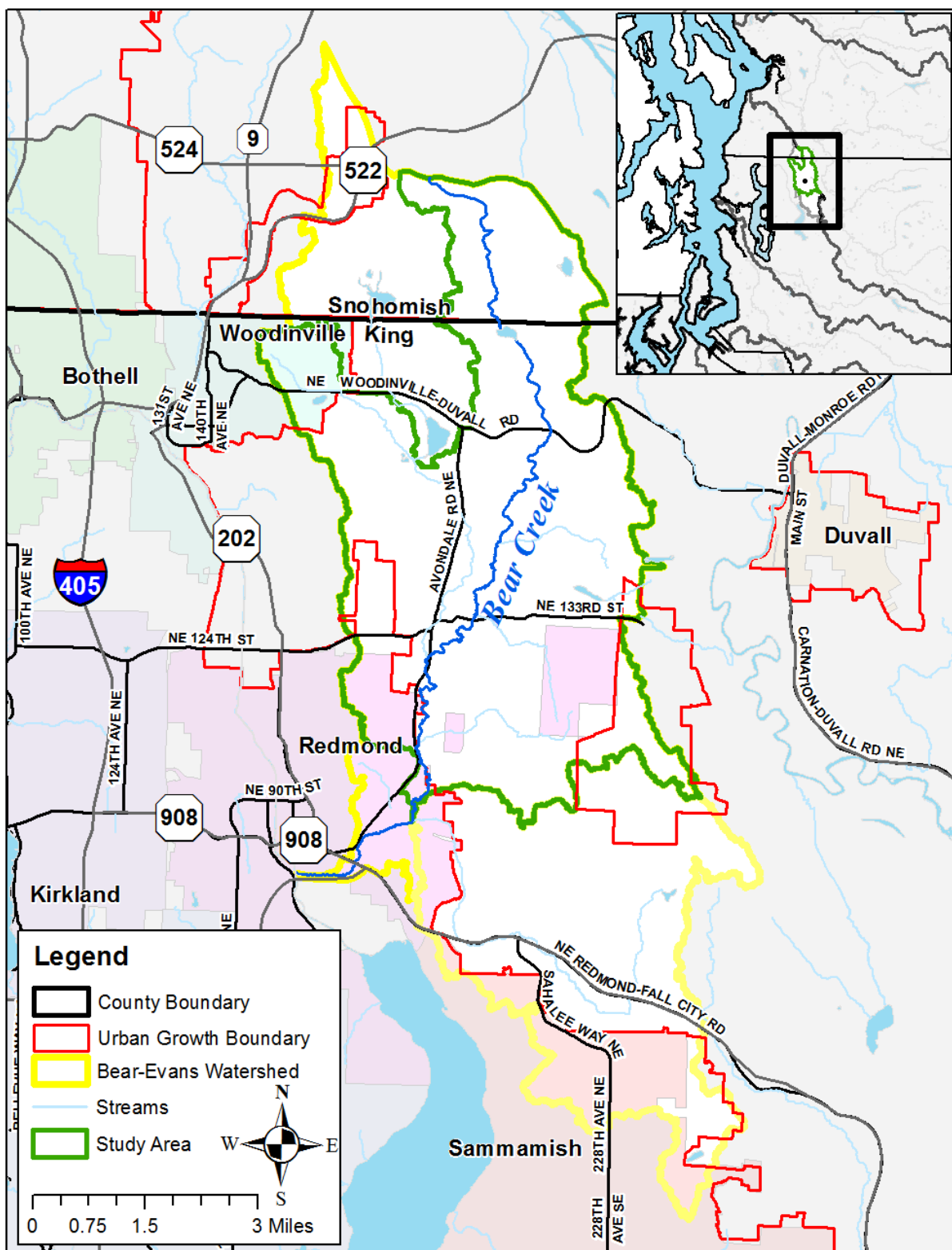


Figure 1. Greater Bear Creek watershed, including Cottage Lake and Evans Creek drainage.

Substantial development has already occurred and more is expected in the Bear Creek study area. The study area currently is home to an estimated population of about 27,000 people. Land use, based on satellite imagery from 2011, is composed largely of a mixture of light urban, medium urban, deciduous/mixed forest, and grass. Future land use was estimated using current comprehensive land use plans, and the zoning regulations contained within them. Current land use regulations set limits for the amount of impervious surfaces allowed for a given density. Projected future land use assumes these limits will be reached reflecting the substantial growth pressures anticipated in this basin.

Bear Creek water quality monitoring data indicate that the creek does not meet water quality standards for several parameters. High levels of fecal coliform bacteria, elevated water temperatures, and low dissolved oxygen levels have been all documented. B-IBI scores, an indicator of overall stream health, are in the “Fair” range. Bear Creek supports a wide range of salmonids, including Chinook⁴, sockeye, coho, kokanee, steelhead, and coastal cutthroat.⁵ The Bear Creek watershed was identified by Ecology as a targeted watershed for stormwater retrofit planning⁶, with a watershed integrity index of 9 (based on a scale of 1 (low integrity) to 9 (high integrity)). An integrity index of 9 characterizes the basin as a high value resource and high potential to be restored. Ecology has also identified the mainstem of Bear Creek as requiring special protection vis-à-vis water temperature for native char, salmon, and trout spawning and incubation (Ecology, 2011a). Completing and implementing a watershed management strategy for Bear Creek would help preserve and restore these aquatic resources.

In September 2017, Snohomish County completed a stormwater management plan for the Little Bear Creek watershed within Snohomish County. The Little Bear Creek watershed is adjacent to the western boundary of the Bear Creek watershed. Snohomish County’s project was performed to meet the same Phase 1 NPDES municipal stormwater permit requirements applicable to King County. Snohomish County concluded that water quality standards could be met through a combination of development under existing stormwater regulations coupled with a significant Snohomish County capital program of low impact development BMPs, stormwater treatment and flow control BMPs, riparian planting, and continuation and potential expansion of program activities that target the reduction of fecal coliform bacteria. An important finding was that anticipated new development and redevelopment after full build-out in the Little Bear Creek study area resulted in improvements to B-IBI and temperature under current Snohomish County stormwater regulations.

⁴ Listed as threatened species under the Endangered Species Act

⁵ Kerwin, J., 2001. Salmon and Steelhead Habitat Limiting Factors Report for the Cedar - Sammamish Basin (Water Resource Inventory Area 8). Washington Conservation Commission. Olympia, WA

⁶ Assessed by Ecology in support of National Estuary Program Watershed Protection & Restoration Grant Program 2015

(http://www.ecy.wa.gov/puget_sound/docs/grants/2015TargetWatershedsStormwaterRetrofit.pdf)

1.2 Known Concerns in the Bear Creek Watershed

Through the analysis of existing and newly collected data, the Bear Creek technical team identified concerns, i.e., the problems preventing Bear Creek from fully supporting its existing and designated uses. Table 1 details the identified water quality and habitat quality problems in the Bear Creek study area.

Table 1. Identified water and habitat quality concerns in the Bear Creek study area.

Problem	Rationale	TMDL ^a Exists	Reference(s)
Water Quality			
Temperature and Dissolved Oxygen (DO)	Temperatures are too warm and DO too low to meet state water quality standards which support the designated salmonid use.	Yes	King County, 2017a,b; Ecology, 2011b
Fecal Coliform	Fecal coliform levels frequently exceed the state water quality standard.	Yes	King County, 2017a,b; Ecology, 2011b
Metal Toxicants	Dissolved metals, specifically copper and zinc, found in stormwater runoff may cause surface water to exceed state standards. Cold and Mackey Creeks had exceedances of the state water quality standard for copper.	No	King County, 2017a; Hobbs, et al. 2015; King County, 2017h
Habitat			
Riparian Corridor Degradation	Riparian corridors have been altered and degrading as development has occurred. Riparian forests provide important water quality (including stream shading) and habitat benefits.	Not applicable	King County, 2017c
Wetland Loss and Degradation	Wetlands have been altered and degrading as development has occurred. Wetlands provide important water quality, hydrologic, and habitat benefits.	Not applicable	King County, 2017d
Stream Flow Regime	Many parts of Bear Creek exhibit characteristics of a flashy stream system.	Not applicable	King County, 2017e,h
Instream Habitat and Fish Barriers	Instream habitat in Bear Creek has been identified as generally lacking in quantity, quality, and variety. Salmon and other aquatic life require a variety of habitat types. Additionally, fish passage barriers prevent movement in tributaries.	Not applicable	King County, 2017e
Biology			

Problem	Rationale	TMDL ^a Exists	Reference(s)
B-IBI	The average qualitative B-IBI score in the study area is considered “Fair.” The “flashiness” of a stream has been linked to “Poor” macroinvertebrate health as measured by B-IBI.	Not applicable	King County, 2017e,h DeGasperi et al., 2009

a. Total Maximum Daily Load

1.3 Bear Creek 1990 Basin Plan

The Bear Creek Basin Plan was originally published in 1990. Elements of the basin plan were adopted by the King County Council in 1992 and 1995. The basin plan assessed the condition of the Bear-Evans Creek drainage basin and predicted future changes based on development patterns. The basin plan recommended ways to protect valuable stream, wetland and fishery habitat and reduce flooding, erosion and sedimentation. Regulations resulting from the basin plan included clearing restrictions, enhanced stream buffers, and advanced stormwater flow control. The basin plan may be responsible for the relative high quality of Bear Creek relative to other developed streams in the region. Unfortunately, there was not a comprehensive effort to track the implementation of the basin plan or to assess the effectiveness of the actions.

The work completed for this Watershed Management Study examines existing conditions and identifies updated regulations, programs, and specific capital projects that are expected to result in Bear Creek supporting existing and designated uses. This Study has a narrower focus on the Bear Creek watershed, evaluation upstream of the Evans Creek confluence and not including Cottage Lake and its drainage.

1.4 Related Complementary Efforts

There are several other major efforts underway that will improve water and habitat quality in the Bear Creek watershed. The Study reviewed several of the major planned actions over the next 10 years and over \$40 million may be expected to be invested in the Bear Creek watershed that will improve water and habitat quality. Additional investments are expected from projects and programs not reviewed as part of this Study.

1.4.1 Monticello Creek Watershed Restoration Plan

The City of Redmond developed the Monticello Creek Watershed Restoration Plan in 2016 and 2017. Monticello Creek is a tributary to Bear Creek. The Monticello Creek Watershed Restoration Plan identifies potential stormwater retrofit and instream projects that will improve flow, water quality, and habitat of the creek. The City of Redmond plans to complete design, then secure additional grant funding to install the three highest priority projects beginning in 2020. The City of Redmond expects to complete restoration efforts in the Monticello Creek watershed by 2025. The City of Redmond plans to undertake

intensive monitoring of the stream's response to restoration. Over the next 10 years, Redmond plans to spend \$8 million for restoring Monticello Creek.

1.4.2 King County Land Conservation

King County and its advisory group has identified and prioritized conservation and preservation of 65,000 acres of critical natural lands and green spaces countywide. At the current level of investment, this objective is projected to be achieved in 70 years. King County Executive Dow Constantine has proposed an initiative to “finish the job of protecting our great places forever.” The Land Conservation Initiative (LCI) sets forth the goal of conserving and preserving the remaining high conservation value lands throughout King County within the next 30 years.

In planning the LCI, King County staff and partners have identified 220 parcels totaling more than 900 acres of high conservation value land in the Bear Creek watershed, with an estimated cost of acquisition of approximately \$61 million for a mix of fee title and conservation easements. If the LCI results in full funding for land conservation, in the next ten years King County and partners may be able to permanently protect 75 parcels totaling 300 acres at an estimated cost of \$20 million. In all cases, acquisitions under the LCI would be voluntary on the part of the landowners.

1.4.3 WRIA 8 Chinook Salmon Conservation Plan

The WRIA 8 Chinook Salmon Conservation Plan recommends actions to restore and protect habitat that Chinook salmon need to survive in the Lake Washington / Cedar/ Sammamish Watershed, including Bear Creek.⁷ Between 2006 and 2015, over 85 projects have been completed, and another 90 projects (including 11 in the study area) are being implemented or advancing toward implementation. Between 2006 and 2015, WRIA 8 has guided the investment of nearly \$11.3 million in state and federal funding and over \$13.4 million in local funding to salmon habitat projects.

Over the next ten years, implementation of the WRIA 8 Plan's recommendations for restoration on Bear Creek and Cottage Lake Creek could cost in the range of \$8.5 to \$12.9 million. Many of the acquisitions identified in the LCI (see Section 1.4.2 above) are also WRIA priorities and are identified in the WRIA 8 Plan. In many cases, it is anticipated that restoration will follow acquisition; however, the restoration cost estimated above does not account for future restoration of lands that may be acquired through the LCI. Restoration projects on those acquired lands are not expected to occur within the next 10 years.

1.4.4 King County Stormwater Facility Management

King County Stormwater Services estimates it may spend approximately \$2.8 million in capital dollars for asset management of stormwater facilities within the Bear Creek watershed over the next 10 years. This assumes the current level of service funding

⁷ <http://www.govlink.org/watersheds/8/planning/chinook-conservation-plan.aspx>

allocation of capital dollars to asset management of all stormwater facilities within the County prorated to the estimated proportion of stormwater facilities within the Bear Creek watershed. This estimate does not include the cost of retrofitting these stormwater facilities to meet a higher performance standard necessary to achieve Bear Creek flow control and treatment goals. The current allocation of capital dollars to Stormwater Services for retrofitting existing facilities and constructing new ones is approximately \$970,000 for the biennium. This amounts to about \$4.85 million over the next 10 years assuming the funding stays at status quo. A large proportion of this funding could be allocated to the Bear Creek watershed given that very little of it is currently committed to specific projects outside of the watershed beyond this biennium.

1.4.5 King County Roads Services

The Bear Creek study area contains approximately 120 miles of unincorporated King County roadway. This is eight percent of the roadway inventory in unincorporated King County. King County Road Services Division plans to perform \$100,000 per year on maintenance, which may benefit water quality such as catch basin cleaning and street sweeping. The Roads Services Division also anticipates the investment of \$1 million over the 10 years towards improvement to drainage systems, which would have a habitat and/or water quality benefits. Therefore, over the 10 year time period, \$2 million may be invested in the study area. These estimates do not project potential emergent projects that may occur over the next 10 years, such as bridge replacements, slides, and other emergency type work.

1.4.6 Bear–Evans Multi-Parameter TMDL

The Bear–Evans Multi-Parameter TMDL covers the entire Bear Creek watershed, including both the Evans Creek and Cottage Lake sub-watersheds (Ecology, 2011b). The water quality concerns identified for improvement are temperature, dissolved oxygen, and fecal coliform bacteria. As part of the TMDL study, Ecology identified the pollution problems and specified how much pollutant loading needs to be reduced to achieve clean water. As a follow-up to the TMDL study, Ecology worked with the local community to prepare a Water Quality Implementation Plan detailing the specific actions needed to improve water quality in the basin. The plan describes management roles, activities, and schedules for partners. EPA approved the TMDLs in August and September 2008.

TMDL implementation is currently underway. Ecology and other watershed stakeholders are working on projects that are consistent with the Water Quality Implementation Plan. As part of its fecal coliform TMDL implementation plan, King County expects to spend approximately \$2 million on source control in Bear Creek over the next 10 years.

1.4.7 King County Noxious Weed Control Program

The Noxious Weed Control Program works throughout King County to prevent and reduce the economic, environmental, and social impacts of noxious weeds in King County, Washington. The program's focus is to provide education and technical assistance to landowners and public agencies to help everyone find the best control options for noxious

weeds on each site and to reduce the overall impact of noxious weeds throughout the county. Japanese knotweed, Himalayan blackberry, and reed canary grass are among the common noxious weeds found in the study area. Technical support from the Noxious Weed Control Program will be crucial in the management and restoration of Bear Creek.

1.4.8 Climate Change Impacts Study

Recent research has indicated that climate change may result in an increase of the frequency and intensity of extreme precipitation events (Warner et al., 2015). Design standards in existing stormwater manuals are based on historic rainfall patterns and may not provide sufficient protection for local water bodies as extreme precipitation events become more frequent and intense. King County has partnered with the University of Washington Climate Impacts Groups to evaluate outputs from multiple global climate models. These model outputs will be used to obtain rainfall data at the proper scale to analyze local stormwater impacts in King County under several climate change scenarios. The analysis will be used to develop recommendations to modify the King County Stormwater Design Manual to account for changes in precipitation patterns.

1.5 Related Regulations and Code

King County, Snohomish County, City of Redmond, City Woodinville, and Washington State have established land use code and regulations to protect water and habitat quality in their jurisdictions, including the Bear Creek watershed. The most substantial regulations are the surface water management requirements, Critical Areas Ordinance, Growth Management Act, Shoreline Management Act, clearing and grading requirements, and the State Environmental Protection Act.

1.5.1 Surface Water Management Requirements

As development of the landscape occurs and changes the quantity and quality of surface and storm water runoff, great care must be taken to minimize the impacts of these changes to natural resources, public safety, and property. This necessitates the provision of surface and storm water management systems that not only mitigate such impacts but must comply with the NPDES General Municipal Stormwater Permit issued by the Washington State Department of Ecology pursuant to the Clean Water Act. Permitted jurisdictions have adopted Ecology's Stormwater Management Manual or its equivalent. Current stormwater regulations that apply to Bear Creek watershed require that new development be mitigated in a manner that matches forested conditions by installing ponds, vaults, and flow control best management practices.

1.5.2 Critical Areas Ordinances

Critical areas are lands with natural hazards or lands that support certain unique, fragile, or valuable resource areas. Lands designated by King County as critical include areas at high risk for erosion, landslides, earthquakes, or flooding; coal mines; or wetlands or lands adjoining streams, rivers, and other water bodies. The regulations protect critical areas as

well as their buffers in order to protect public health and safety, and to promote environmental health in the region.

1.5.3 Growth Management Act

The Growth Management Act (GMA) is a series of state statutes, first adopted in 1990, that requires fast-growing cities and counties to develop a comprehensive plan to manage their population growth. A key mechanism in the comprehensive plans is placement of limitations on the amount of impervious surfaces allowed on an individual parcel tied to the size of the parcel. It is primarily codified under Chapter 36.70A RCW, although it has been amended and added to in several other parts of the RCW.

1.5.4 Clearing and Grading Requirements

Clearing and grading are activities associated with developing property for various commercial and residential uses. Clearing has to do with removing vegetation or other organic material and grading involves reshaping the ground surface. Clearing or grading proposals may need to be reviewed and a permit may be required before moving land in order to ensure the activity will not negatively impact the environment or existing structures.

1.5.5 Shoreline Management Act

In 1972, Washington State Voters approved the Shoreline Management Act by public referendum. The Shoreline Management Act has three broad policy goals: (1) Protect shoreline natural resources, (2) Promote public access, and (3) Encourage water-dependent uses. The Shoreline Management Act recognizes that "the shorelines of the state are among the most valuable and fragile of its natural resources." In order to protect this fragile resource, the Shoreline Act requires counties and cities to develop plans and adopt regulations to "prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." Shorelines of the state in the Bear Creek watershed include Bear Creek upstream to its confluence with Struve Creek, Cottage Lake Creek's lower 1.3 miles, and Seidel Creek's lowest mile, and Cottage Lake plus its adjacent wetlands. Areas regulated under the Shoreline Act include 200 feet from ordinary high water mark (OHWM).

1.5.6 State Environmental Protection Act

The State Environmental Policy Act (SEPA) process identifies and analyzes environmental impacts from governmental decisions. These decisions may be related to issuing permits for private projects, constructing public facilities, or adopting regulations, policies, or plans. SEPA review helps agency decision-makers, applicants, and the public understand how a proposal will affect the environment. SEPA can be used to modify or deny a proposal to avoid, reduce, or compensate for probable impacts.

1.6 Study Development

The Study was produced by the Bear Creek team within the King County Water and Land Resources Division (WLRD) with considerable input from watershed jurisdictional partners, stakeholders, and external partners.

1.6.1 Watershed Partners

The watershed partners (the Partners) consist of representatives from each of the local governments located within the study area (Table 2). The Coordination Plan developed by King County, Snohomish County, City of Redmond, City of Woodinville, and the Washington State Department of Transportation, requires that, if requested by a non-lead Permittee, King County will include additional information, dissenting opinions, conclusions, and/or alternative approaches submitted to King County by non-lead Permittees as appendices. Snohomish County has requested to submit an appendix and is attached as Appendix I.

Table 2. Watershed partners.

Jurisdiction	Representative	Title
City of Redmond	Andy Rheaume	Senior Planner
City of Woodinville	Asha D'Souza	Assistant Public Works Director
	Tom Hansen (Retired)	Public Works Director (Former)
King County	Curt Crawford	Stormwater Services Manager
Snohomish County	Bill Leif	Environmental Programs Compliance Specialist
Washington State DOT	Dick Gersib (Retired)	Watershed Program Manager
	Elsa Pond	Statewide Erosion Control and Total Maximum Daily Load (TMDL) Lead

1.6.2 Technical Team

The technical team included staff from the Science and Technical Services (STS) and Stormwater Services (SWS) Sections within King County WLRD. Individual team members and their roles are detailed in Table 3.

Table 3. Technical team members and respective association and roles.

Team Member	Title	Primary Role(s)
Jeff Burkey	Hydrologist	Project Manager, watershed and stormwater modeling
David Batts	Water Quality Scientist	Stormwater facilities, regulation assessment
Sevin Bilir	Hydrogeologist	Public and stakeholder engagement
Steven Brady	Ecologist	B-IBI and flow assessment
Timothy Clark	Limnologist	Implementation and watershed study. Water quality assessment and project prioritization

Team Member	Title	Primary Role(s)
Jessica Engel	Project Manager	Funding strategy
Eric Ferguson	Hydrogeologist	Water quality assessment
Claire Jonson	Stormwater Engineer	Watershed Study
Josh Kubo	Ecologist	Salmonid habitat use assessment and project prioritization
Scott Miller	Stormwater Engineer	Watershed Modeling
Mark Preszler	Mapping & Information Management Coordinator	Mapping stormwater facilities
Jim Simmonds	Supervisor	Project oversight
Jen Vanderhoof	Ecologist	Riparian and wetland assessment and project prioritization
Mark Wilgus	Stormwater Engineer	Stormwater facilities, regulation assessment

1.6.3 External Participants Input

The Partners actively sought input from watershed residents, local groups and organizations, state and federal agencies, and tribal nations throughout the development of the Study. External input was sought to inform the Study and ensure that a multitude of perspectives were considered. Public engagement events and distribution are summarized in *Appendix E: Public Engagement Summary*.

The following public engagement events were held:

- Technical Workshop #1: November 4, 2015
- Public Meeting #1: February 25, 2016
- Public Meeting #2: October 13, 2016
- Technical Webinars: November 15 and December 12, 2016
- Technical Workshop #2: March 29, 2017
- Public Meeting #3: March 7, 2018

A summary of external partners that attended the Study engagement events are included in Table 4.

Table 4. External partners included in Study workshops.

Organization Type	External Partner Group
Non-governmental organizations	Futurewise
	Sno-King Watershed Council

Organization Type	External Partner Group
	Water Tenders
	Trout Unlimited
	Wild Fish Conservancy
	Washington Environmental Council
Tribal Nations	Muckleshoot Indian Tribe Fisheries Division
State Agency	Washington State Department of Ecology (Ecology)
	Washington State Department of Fish and Wildlife
	Washington State Department of Natural Resources
	Washington State Conservation Commission
Private Residents	Persons residing in study area and surrounding region

1.6.4 Reports Supporting the Watershed Management Study

Table 5 lists and summarizes the eight reports published by King County that support the final Bear Creek Watershed Management Study.

Table 5. Technical reports supporting the Study.

Report	Summary
Existing Water Quality Conditions (King County, 2017a)	Characterization of existing water quality conditions in the basin was based on sampling of storm events and base flow conditions between March 2015 and January 2016. In agreement with historic data for Bear Creek (King County, 2017b), temperature, dissolved oxygen, and fecal coliform bacteria were identified as water quality concerns due to exceedances of the state water quality standards. Adding to these concerns, this study identified exceedance of the state numeric criteria for copper in Mackey and Cold creeks during wet-weather flow.
Analysis of Long-term trends in Bear Creek Water Quality (King County, 2017b)	Water quality has improved in terms of some parameters and worsened for others. Fecal coliform and nutrient concentrations have decreased over the past three decades. Long-term trends in temperature and dissolved oxygen have indicated that conditions have worsened over the past four decades.
Assessment of Bear Creek Watershed Riparian Areas (King County, 2017c)	Riparian areas are important because of their role in the watershed's hydrology and ecology. Mature native trees provide shade to streams, which help prevent increased temperatures. Change analysis shows ~22% less riparian tree cover in the study area than in 1972.

Report	Summary
Assessment of Bear Creek Watershed Wetlands (King County, 2017d)	Wetlands are important because of their role in the watershed's hydrology and ecology. There are approximately 330 mapped wetlands in watershed and likely many more unmapped wetlands. 20% of mapped wetlands were visibly altered since 1981-1990.
Bear Creek Watershed Juvenile Salmon Habitat Use (King County, 2017e)	Results from this study indicate that a variety of habitat types are needed to support the freshwater life stages of juvenile Chinook and coho salmon in the Bear Creek watershed. Juvenile salmonid habitat use and distribution appears to shift between different habitat types at different times of the year. Prior assessments of existing habitat conditions indicate degraded instream habitats in the Bear Creek watershed. Multiple factors affect Bear Creek habitat, including altered hydrology, the loss of channel complexity and connectivity, degradation of riparian areas, loss of large wood, and increased sedimentation.
Benthic Macro-invertebrate Status and Trends in the Bear Creek Study Area (King County, 2017f)	This report evaluates B-IBI scores in the context of land cover and stream flashiness in the Bear Creek study area. B-IBI scores showed a relatively strong correlation with land cover but showed weaker and more variable relationships with stream flashiness. B-IBI scores were also highly variable across sites, but relatively stable within a site over time. Thus, the capacity for B-IBI to respond to restoration efforts may be limited and/or require relatively long periods of time.
Stormwater Regulations History and Existing Stormwater Infrastructure in the Bear Creek Watershed (King County, 2017g)	The report summarizes current and past stormwater regulations and stormwater infrastructure development in the study area.
Watershed Model Development for Bear Creek Stormwater Retrofit Planning Project (King County, 2018)	This report details the development and calibration of the Hydrological Simulation Program—Fortran (HSPF) and S ystem for U rban S tormwater T reatment and A nalysis I ntegration N (SUSTAIN) models used to select stormwater BMPs for the Bear Creek study area.

1.7 Purpose and Structure of Watershed Management Study

The purpose of this document is to describe stormwater management strategies that would result in hydrologic and water quality conditions that fully support designated and existing uses throughout the project area.

The Study includes the following components:

- watershed goals and management objectives, and model metrics and targets (Chapter 2)
- summary of existing watershed conditions (Chapter 3)
- stormwater strategy development and prioritization (Chapter 4)

- instream habitat strategy development and prioritization (Chapter 5)
- wetland strategy development and prioritization (Chapter 6)
- riparian corridor strategy development and prioritization (Chapter 7)
- non-structural (programmatic) strategies not specific or unique to stormwater, instream habitat, wetlands, or riparian corridors (Chapter 8)
- potential implementation framework (Chapter 9)
- adaptive management and measuring progress and success (Chapter 10)
- potential schedule, budget, and funding strategy for implementation (Chapters 11 and 12)
- recommended next steps (Chapter 13)

Details on the prioritization of projects for stormwater, instream habitat, wetland habitat, and riparian corridor habitat are presented in Appendices A, B, C, and D. A summary of the public engagement activities as part of the development of the Study is presented in Appendix E. The identified stormwater strategies for the entire watershed are presented in Appendix F. The potential schedule and budget for mid- and long-term strategy implementation is presented in Appendix G. A crosswalk detailing how the Permit requirements are met is presented in Appendix H.

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2.0 WATERSHED GOALS, OBJECTIVES, METRICS, AND TARGETS

This chapter defines the goals and management objectives for the Bear Creek study area, and details the metrics and targets that were used in the modeling assessment to determine strategy effectiveness.

2.1 Watershed Goals and Management Objectives

The goals and management objectives developed by the technical team and Partners are aimed at restoration of the stream to designated and existing uses (Table 6). The objectives include those with associated indicators specifically required to be assessed by the Permit (B-IBI, flow, and water quality) and others considered discretionary that nonetheless directly support the aim of restored uses and successful implementation.

Table 6. Watershed goals, management objectives, and indicators.

Goal	Management Objective(s)	Potential Indicator(s)	Permit Required Assessment?
Improve and maintain watershed functions in Bear Creek, including water quality, habitat, and hydrology	Minimize impacts of stormwater runoff on stream hydrology to promote stable stream morphology, protect habitat, and support biota	B-IBI Flow metrics	Yes
	Provide for healthy habitat through protecting, restoring, and maintaining riparian buffers, wetlands, and instream habitat.	Area of riparian forest planted Wood volume and number of pieces added to stream channel (including “key pieces”) Wetland inventory Tree cover	No
	Restore quantity, quality, variety, and connectivity of instream habitat.	Acres of floodplain reconnected Wood volume and number of pieces added to stream channel (including “key pieces”) Temperature - Number, location and area of thermal refugia created/restored	No

Goal	Management Objective(s)	Potential Indicator(s)	Permit Required Assessment?
	Minimize impacts to stream water quality from stormwater runoff.	Meet state freshwater quality standards (Temperature, dissolved metals, Turbidity/ Total suspended solids)	Yes
Protect human health, safety, and property	Minimize human gastrointestinal health risk associated with recreational exposure	Meet state fecal coliform standard	Yes
	Minimize human health risk associated with drinking water	Meet state drinking water quality standards	No
	Minimize flooding to protect property and human health and safety.	Flooding damage	No
Involve external partners in the protection, maintenance, and restoration of Bear Creek	Encourage the public to participate in watershed stewardship.	Public attendance at public meetings and workshops Volunteers on public work days	No
	Coordinate with partner jurisdictions on watershed management and restoration efforts	Meetings between regional partners Joint projects/ programs	No

2.2 Watershed Model Metrics and Targets

A set of calibrated hydrologic models (HSPF) were used to project the values of selected water quality and flow metrics under various scenarios. Water quality and flow conditions from monitored streams were extrapolated to streams not monitored based on land use. The outputs of these models were used to evaluate the effectiveness of the identified structural strategies. Scenarios modeled include:

- current conditions,
- fully-forested conditions,
- future conditions built out to current zoning, and
- future conditions with reduced impervious build-out.

Potential stormwater management scenarios were developed using SUSTAIN model optimization. SUSTAIN is a decision support system to facilitate selection and placement of stormwater Best Management Practices (BMPs) and Low Impact Development (LID) techniques in urban watersheds (King County, 2017f). In addition, SUSTAIN allows for analysis of cost-effectiveness. Details of scenarios, modeling input, and assumptions can be found in the *Watershed Model Development for Bear Creek Stormwater Retrofit Planning Project report* (King County, 2018).

The effectiveness of the developed mitigation scenarios was gauged on the degree to which identified targets for the flow, B-IBI, and water quality were achieved. Selecting mitigation strategies that achieve targets for multiple metrics provides additional confidence that the goal of restored uses will be achieved. Table 7 defines each of the model metrics and the associated target.

Flow, temperature, dissolved copper, dissolved zinc, total suspended solids (TSS), and fecal coliform were modeled using HSPF. B-IBI was estimated based on relationships with the High Pulse Count flow metric (i.e., the annual number of flow events exceeding twice the average streamflow). Turbidity was estimated based on its relationship with TSS in study area streams.

Numeric water quality standards from WAC 173-201A were used as targets for the temperature, dissolved copper and zinc, fecal coliform, and turbidity metrics. The B-IBI target score of 60 (on the 0-100 scale) corresponds with a stream health rating considered “Good” (Karr et al., 1986; Morely, 2000; King County, 2014).

The potential ecological benefits of habitat projects were not modeled with one exception: temperature changes resulting from proposed riparian plantings. It is likely that habitat and riparian restoration will positively impact nearby B-IBI scores, however, currently no research has been done that has established science-based correlations that allow for predictive modeling.

Table 7. Metrics and targets used in the watershed model.

Model Metric		Description	Estimation Method	Target
B-IBI		B-IBI is a multimetric index based on benthic macroinvertebrate assemblage that quantifies the ecological conditions of streams in the Pacific Northwest.	Estimated based on relationship with stream High Pulse Count and was supported based on results from King County (2017f)	Score of 60 or greater (Good to Excellent) (based on 0-100 scale)
Flow Metrics		Four metrics of stream flashiness were calculated: • high pulse count (HPC), • high pulse duration (HPD), • high pulse range (HPR), and • TQ mean	Modeled using HSPF	Meet flow metric thresholds associated with Good to Excellent B-IBI scores (see above)
Water Quality	Temperature	Aquatic organisms, including salmonids, are sensitive to high water temperatures.	Modeled using HSPF	Meet WAC Water Quality Standards: • For May 16 to Sept. 14: 7-DADMax ≤16 °C • For Sept. 15 to May 15: 7-DADMax ≤13 °C

Model Metric	Description	Estimation Method	Target
Dissolved Copper	Copper, at elevated levels, poses toxicity to aquatic organisms.	Modeled using HSPF	Meet WAC Water Quality Standards: Hardness-dependent, e.g,
			Hardness (mg/L) Chronic (µg/L) Acute (µg/L)
			25 3.5 4.6
			37.5 4.9 6.8
Dissolved Zinc	Zinc, at elevated levels, poses toxicity to aquatic organisms.	Modeled using HSPF	Meet WAC Water Quality Standards: Hardness-dependent, e.g,
			Hardness (mg/L) Chronic (µg/L) Acute (µg/L)
			25 32.3 35.4
			37.5 45.5 49.9
Fecal Coliform	Fecal coliforms are indicator bacteria for human health risk related to fecal contamination.	Modeled using HSPF	Meet WAC Water Quality Standards: • Geometric Mean <50 • 90 th Percentile <100
Turbidity	Water turbidity negatively impacts aquatic organisms by burying habitat via sedimentation, affecting sight-feeding animals, and may provide attachment places for other pollutants.	Turbidity was estimated based on relationship with modeled (HSPF) TSS values. (King County, 2017a)	Meet WAC Water Quality Standards: • If background ≤50: <5 NTU above background • If background >50: <110% of background

Note: 7-DADMax: seven-day moving average of daily maximum temperature

2.3 General Methods to Generate Priority Strategies

The Permit requires that King County identify a stormwater management strategy or strategies that would result in hydrologic and water quality conditions that fully support “existing uses,” and “designated uses.” The habitat improvement strategies identified for instream habitats, riparian corridors (non-shading), and wetlands were an optional addition. Identification of stormwater, instream habitat, wetlands, and riparian corridors strategies was made based a variety of data, including:

- existing and modeled future land use, water quality data, and hydrologic data,
- existing stormwater facilities,
- planned habitat projects,
- existing instream habitat, wetland, and riparian corridor conditions, and
- parcel data (property ownership [public vs. private] and assessed value).

Relevant elements of the aforementioned data were used to develop strategies that are expected to achieve watershed goals and objectives (Table 6). The data were also used to

prioritize projects and/or geographic areas for implementation. These prioritizations were used to develop the schedule and budget (Chapter 11).

The Study evaluated both structural and non-structural strategies. Structural strategies are defined as constructed stormwater BMPs and habitat restoration projects. Non-structural (programmatic) strategies encompass programs, actions, and code or policy changes that affect runoff, pollution generation and treatment, and the health of instream, riparian, and wetland habitats. Other examples of non-structural strategies include increased maintenance of storm drainage systems, inspection of septic systems, and education/outreach to watershed residents.

The structural and non-structural (programmatic) strategies for stormwater, instream habitat, wetlands, and riparian corridors are discussed in chapters 4, 5, 6, and 7, which also describe the data sources and prioritization methods. Chapter 8 details non-structural strategies that are not specific or unique to one subject area.

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3.0 EXISTING CONDITIONS

This chapter summarizes the existing land use, water quality, hydrologic, stormwater facility, instream habitat, wetland, and riparian corridor conditions in the Bear Creek study area.

3.1 Land Use

Land use in the Bear Creek study area, based on satellite imagery from 2011,⁸ is composed of a mixture of low and open-space (non-building, pervious) development (48 percent), medium intensity development (4 percent), forest (40 percent), and wetlands (5 percent) (Figure 2). Grassland, pasture, cultivated crops, barren, and shrubland each make up 1 percent of the study area or less. Approximately 12 percent of the study area is impervious (Figure 3). Development is most concentrated in the City of Redmond, City of Woodinville, several unincorporated Snohomish County neighborhoods, and several unincorporated King County neighborhoods.

⁸ 2011 Nation Land Cover Database land use represented the most recent available data during the time of analysis.

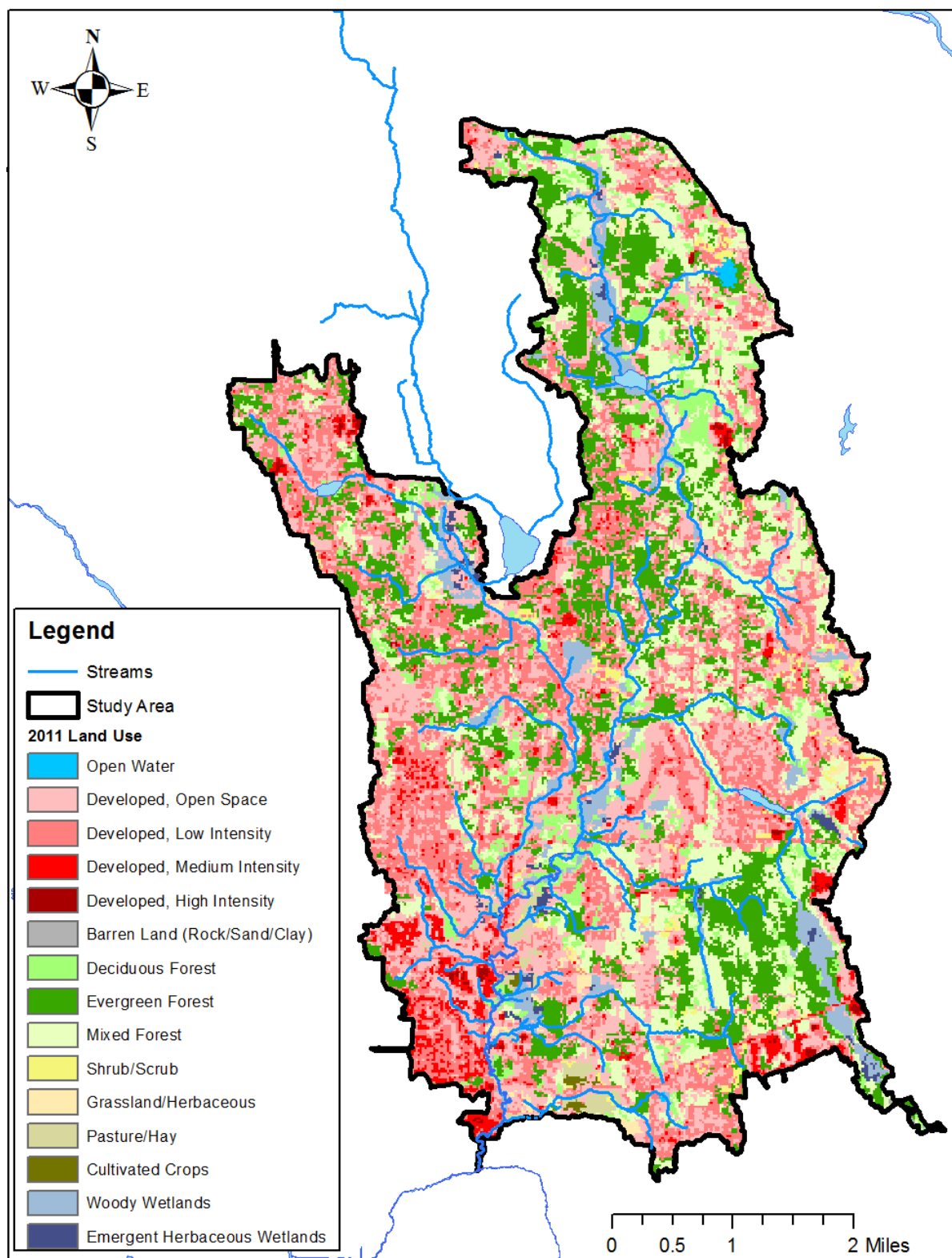


Figure 2. Bear Creek study area 2011 land use and land cover. National Land Cover Database – 98-foot resolution.

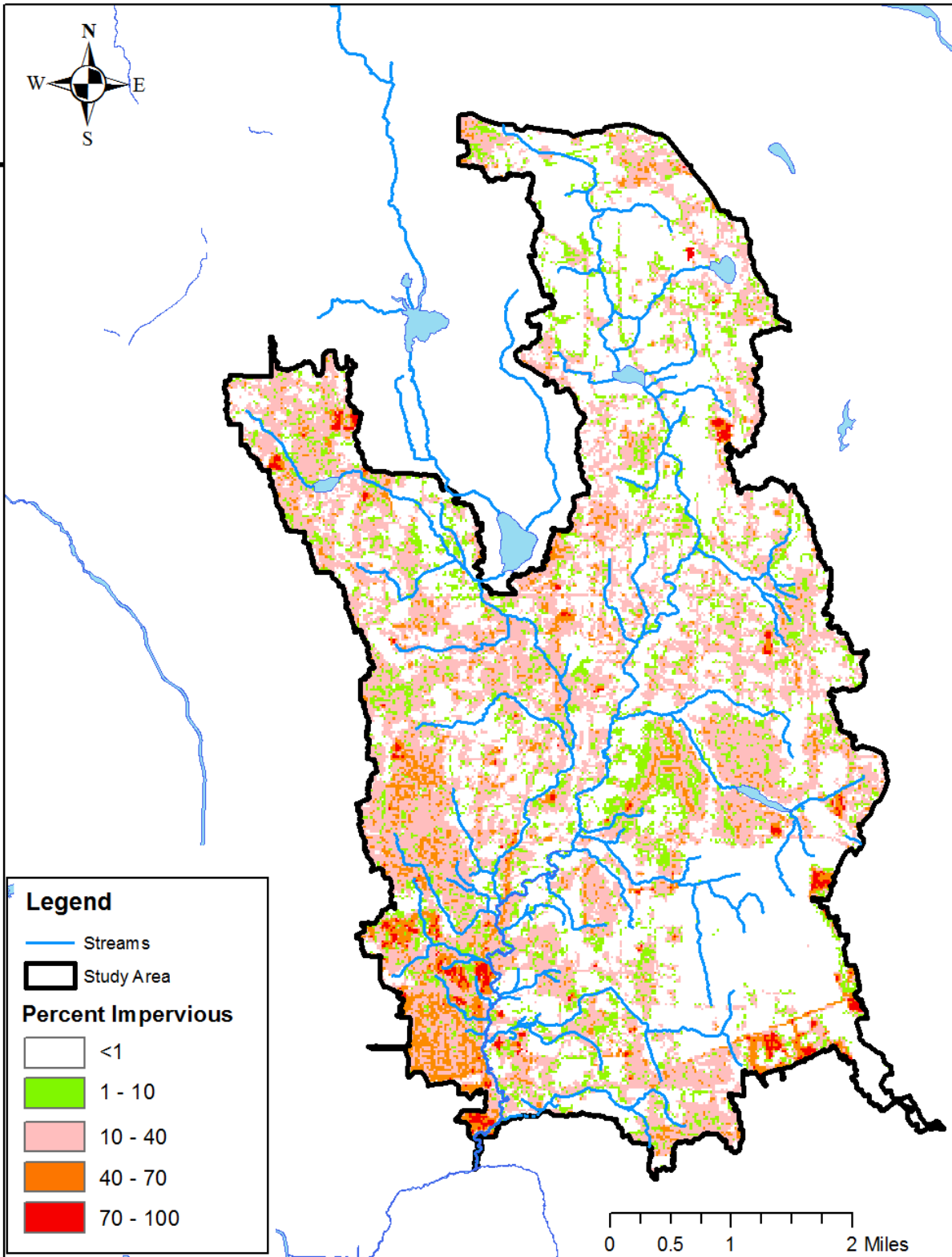


Figure 3. Bear Creek study area 2011 impervious areas. National Land Cover Database – 2011 Percent Developed Impervious Surface - 98-foot resolution.

3.2 Water Quality

Characterization of existing water quality conditions in the basin was based on sampling of storm events and base flow conditions between March 2015 and January 2016 (King County 2017b). The primary goals of the sampling effort were to characterize existing water quality during storm and baseflow events throughout the year to support calibration of a watershed model. In the model, conditions were extrapolated to non-monitored catchments based on land use. Thirteen sites were sampled during six baseflow and six storm events. Continuous flow and temperature gages were used to calculate instantaneous loading and temperature water quality standard exceedances. Historic water quality monitoring data from King County's Routine Streams Monitoring Program (1970s through 2015) were reviewed as well (King County 2017a).

The study identified temperature, dissolved oxygen, and fecal coliform as water quality concerns due to exceedances of the state water quality standards consistent with historic data for Bear Creek. Adding to these concerns, this study identified exceedance of the state criteria for dissolved copper in Mackey and Cold creeks during wet-weather.

Genetic analysis of water samples indicated the presence of human gut-associated bacteria in wet-weather samples from Lower Bear Creek, Mackey Creek, and South Seidel Creek. The relatively high levels of the genetic marker in Lower Bear Creek provides evidence of the presence of human feces, while the relatively low levels found in Mackey and South Seidel creeks are less compelling. Potential human fecal bacteria sources include illicit sewage connections, failing septic systems, leaking sewer pipes, homeless encampments without access to sanitary facilities, or human feces otherwise not deposited in a functioning sanitary system.

The study identified Monticello Creek as a major pathway of suspended solids during wet-weather flow. Monticello Creek's instantaneous loads were similar to Middle Bear Creek and greater than Cottage Lake Creek, which make up most of flow entering Lower Bear Creek. Suspended solid loading from stormwater conveyance systems, bank erosion, and non-gaged tributaries were identified as additional important pathways to Lower Bear Creek.

Ecology has identified Bear Creek and several of its tributaries as impaired for temperature, dissolved oxygen, and fecal coliform bacteria. As noted in Chapter 1, Ecology developed the Bear-Evans Multi-Parameter TMDL for temperature, dissolved oxygen, and fecal coliform. Echo Lake, Lake Leota, and Paradise Lake are also listed as impaired due to elevated phosphorus levels.

3.3 Hydrology/B-IBI

The Puget Lowland B-IBI was developed in the 1990s as an integrative measure of the biological health of wadeable streams in the Pacific Northwest. B-IBI is an index composed of 10 metrics that characterize aquatic macroinvertebrate communities by measuring taxa richness, relative abundance, and other ecological characteristics of stream

macroinvertebrates. In 2014, the B-IBI was recalibrated from a range of 10-50 to 0-100. The recalibration improved the B-IBI as a strong indicator of conditions and its ability to detect changes in condition (King County, 2014). The 0-100 B-IBI scale was used in the analysis supporting this Study, where a score of 80 to 100 represents excellent condition, 60 to 80 is good, 40 to 60 is fair, 20 to 40 is poor, 0 to 20 is very poor.

B-IBI conditions and trends were assessed within the Bear Creek study area as part of the planning effort (King County, 2017f). The average B-IBI condition in the Bear Creek study area is fair. Ecology has identified Bear Creek and Cottage Lake Creek as impaired in terms of low B-IBI scores. B-IBI was negatively correlated with both urban cover and road density in the surrounding landscape. These landscape features are important drivers of stream flashiness, which is negatively correlated with B-IBI scores. Within the study area, both the amount of impervious surface and stream flashiness have increased over time (King County, 2017f).

B-IBI is highly variable throughout the study area, and more generally, throughout the region. A range of B-IBI scores have been found in streams that appear healthy (i.e., characterized by low watershed imperviousness and stream flashiness). This is consistent with the regional pattern in B-IBI scores, wherein a small fraction of streams in undeveloped areas can have low scores, while a small fraction of streams in urbanized areas can have high scores. This variability does not indicate that the B-IBI is uninformative. Knowledge on the relationships of watershed land use and stream B-IBI conditions is imperfect and evolving.

3.4 Stormwater Facilities

The Bear Creek project team reviewed the history of stormwater regulations and existing stormwater infrastructure in the Bear Creek study area (King County, 2017g). The review accomplished the following:

- tabulated an inventory of existing ponds and vaults in the Bear Creek Basin;
- determined which version of the King County Surface Water Design Manual (SWDM) each stormwater facility was designed to meet;
- summed the current stormwater detention storage in the basin provided by those facilities; and
- projected the total stormwater detention storage that would be required for the basin's developed surfaces based on current (2016) requirements. The projection was calculated by multiplying developed surfaces (impervious, grass, and pasture) in the basin by derived detention storage ratios.

Figure 4 presents the percentage of the 173 inventoried ponds and vaults in Bear Creek Study Area by SWDM date. Table 8 below summarizes key differences between the dated versions of the SWDM.

Key findings from this study effort include:

- More than half of the existing inventory was built to pre-1990 standards, and about three-quarters of the existing inventory was built to the 1990 or earlier standards.
- Approximately 179 acre-feet of detention storage is provided within the basin's existing detention ponds and vaults. The current detention storage amount is roughly 10 percent of the estimated 1,598 acre-feet that would be needed to meet King County's current default flow control standard for all developed surfaces in the basin.
- 52 percent of the existing pond facilities and vaults inventoried were developed prior to 1990 SWDM standards where formal water quality treatment was first required. This suggests a significant deficit in water quality treatment of developed surfaces in the basin.
- There are very few flow control BMPs in the basin. Only 3.5 percent of the inventoried facilities were built to 2009 SWDM standards under which flow control BMPs were first designed to protect the hydrologic function of small streams. Flow control BMPs are likely critically important to address flashiness in Bear Creek and its tributaries, to cool receiving waters via infiltration of stormwater from developed surfaces, and to recharge groundwater.

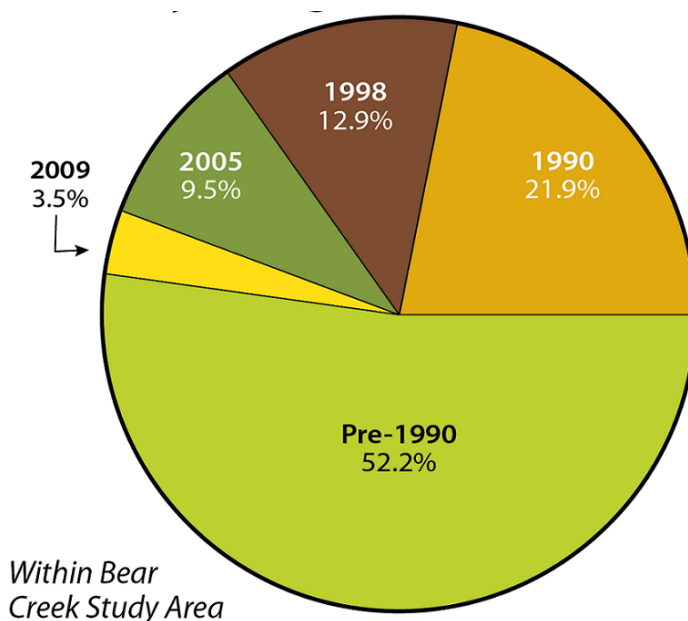


Figure 4. Percent of existing stormwater ponds and vaults by Surface Water Design Manual year.

Table 8. Overview of SWDM requirements for stormwater facilities and BMPs.

Design Manual Year	Flow Control Standard	Water Quality
Pre-1990	Aimed to prevent flooding.	No water quality treatment required.
1990	Improved modeling methods (results in larger facilities)	Added water quality treatment requirements.
1998	Improved to prevent erosion relative to existing conditions (results in larger facilities than 1990 SWDM)	
2005 and 2009	- Improved to require historic (forested) conditions (results in larger facilities than 1998 SWDM) - Best Management Practices (BMPs) and Low Impact Development (LID) techniques incentivized and required at maximum levels	
2016	Requires maximizing the use of FCBMPs	

3.5 Instream Habitat and Salmon Use

The Bear Creek watershed is an important salmonid bearing system in the greater Sammamish River geographic area. The various streams, lakes, and wetlands in the watershed support several salmonid species including Chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), coho (*O. kisutch*), kokanee (*O. nerka*), coastal cutthroat (*O. clarki*), and steelhead (*O. mykiss*). Among the salmon species observed in the Bear Creek watershed, sockeye, coho, and Chinook are most numerous. Salmon spawn and rear throughout reaches in the Bear Creek watershed, with the majority of Chinook and sockeye spawning in mainstem channels of Bear and Cottage Lake creeks, and coho spawning in upper reaches of the mainstem and tributaries.

Juvenile salmon produced across mainstem and tributary spawning areas rear in habitats throughout Bear Creek. Results from King County (2017e) indicated that a variety of habitat types are needed to support the freshwater life-stages of juvenile Chinook and coho salmon. While the timing of habitat-specific use varies by salmon species, King County (2017e) indicated that as juvenile salmon grow and transition through early life stages, their habitat use, and distribution appears to shift. Specifically, different habitat types appear to be used at different times of the year likely due to changing biological and behavioral patterns. In order to support the continuum of early life-stages for juvenile Chinook and coho salmon, a variety of freshwater rearing habitats are needed throughout the Bear Creek watershed.

Productivity and overall abundance of Chinook, coho, and sockeye has been much reduced from historic levels (Kerwin 2001, WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017). Salmon populations in Bear Creek are part of the WRIA

(Watershed Resource Inventory Area) 8 populations which are considered depressed and in decline. Specifically, depressed Puget Sound Chinook populations, including those in WRIA 8, were listed as threatened in 1999 under the Endangered Species Act (ESA). Salmon in the Bear Creek watershed are at risk in large part due to reduced productivity, abundance, diversity, and spatial distribution attributed to habitat degradation throughout the watershed (WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017). Habitat degradation influences the diversity (quantity, quality, variety) and connectivity of instream habitats, which impacts both juvenile and adult salmon life-stages.

In an effort to evaluate the degree of habitat degradation in the Bear Creek study area, existing instream habitat conditions were summarized from prior assessments that focused on evaluating salmon habitat conditions (King County, 2017e). The Bear Creek watershed is a core area for Chinook use and has relatively higher levels of watershed function compared to much of WRIA 8 (Lake Washington / Cedar / Sammamish watershed). However, instream habitats within Bear Creek are still degraded compared to well-functioning and unmanaged forested basins. Factors like altered hydrology, the loss of channel complexity and connectivity, degradation of riparian areas, loss of large wood, and increased sedimentation appear to be associated with the decline of naturally produced salmon in the Bear Creek watershed (Kerwin 2001, WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017). Associated factors including increased water temperatures during the summer months, loss of shoreline complexity, instream barriers, and introduced fish and plant species also contribute to salmon decline.

Across the Bear Creek study area, Cottage Lake Creek and Upper Bear Creek have relatively higher levels of watershed function compared to Lower Bear Creek (WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017). Greater watershed function is largely attributed to lower percentages of impervious surface, fewer road crossings, and higher levels of forest cover and riparian forest (WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017). The hydrology of the Bear Creek watershed has been altered primarily due to land conversion from historic forests and wetlands to grass and impervious surfaces (King County 2000). This altered hydrology influences factors like recharge and infiltration, storm-flow volume and run-off rates, and the intensity and frequency of instream high flow events. Changes in these hydrologic responses has subsequently resulted in decreased habitat quality and quantity by influencing bank erosion, instream scour, wood residence time, and juvenile salmonid displacement (King County et al. 1989).

The loss of channel complexity and connectivity throughout the Bear Creek watershed is associated with channelization, the removal of large woody debris, clearing of the riparian corridor, and disconnection with floodplain and off-channel areas. Floodplain connectivity in Bear Creek has been impacted by confinement, channelization, and road crossings (Entranco 1994, King County 2000). Floodplain area has been significantly decreased due to the conversion of floodplain and riparian areas to residential and commercial development. The conversion of the floodplain and riparian areas has subsequently reduced the complexity and diversity of habitats in the Bear Creek watershed (King County 2000).

Instream habitat complexity in Bear Creek is limited due to an insufficient amount of large wood as well as poor pool quality and quantity (King County et al. 1994, Parametrix 2002). Large wood present in Bear Creek tends to be small in volume and low in frequency. Lower and Upper Bear creeks have less large wood than Cottage Lake Creek (King County et al. 1989) and the greater Bear Creek watershed has considerably lower wood volumes than well-functioning and unmanaged forested basins (e.g., Fox and Bolton 2007). Removal of large wood from the stream reduces hydraulic diversity and alters sediment dynamics, decreasing the complexity and heterogeneity of available habitats (Maser et al. 1988, King County et al. 1989). Large wood maintains the hydraulic stability of critical instream habitat features, especially pools (Bilby and Ward 1991), and dissipates hydraulic energy during peak flows providing high-flow refuge for salmonids (Bilby 1984). Additionally, large wood provides excellent cover and habitat diversity for salmonids (Harmon et al. 1986).

Many fish barriers have been documented in the Bear Creek watershed, primarily in smaller streams in the upper reaches (inventory/locations of barriers were not included in this report). Documented passage barriers include culverts, dams, weirs, high velocity stream flows, beaver dams, and choking vegetation. The extent to which these barriers influence salmonids in Bear Creek is not fully known. However, it is likely that juvenile and adult life-history stages among many salmonids are influenced by these barriers.

3.6 Wetlands

Wetlands were mapped in the study area as part of the current conditions assessment (for details on wetland identification methods, see King County, 2017d). Seven different data sources were used from King County, Snohomish County, City of Woodinville, City of Redmond, and the National Wetland Inventory (NWI). The final combined, merged wetland dataset from the seven available data sources show 327 wetland polygons⁹ in the study area totaling 1,793 acres.

Additional analysis conducted for this Study and presented in *Appendix C: Prioritization: Wetland Strategies* included visual inspection of all wetland polygons using aerial imagery (no field surveys were conducted). Nine of the 327 wetland polygons in King County (2017d) were discovered to not be wetlands. There are likely more wetlands in the basin that are not mapped (errors of omission), and it is likely more mapped wetlands are not actually wetlands (errors of commission). The final map, which is used to identify known or potential wetland locations as well as generate the total area of wetland cover, is shown in Figure 5.

⁹ Polygons are a GIS feature class used to represent features and areas, such as wetlands. Because of how the original wetland datasets were combined and merged, a single wetland polygon does not necessarily represent a single wetland – it may be several wetlands in a wetland complex, or it may contain surrounding upland area, depending on the accuracy of the original dataset. Because referring to these areas as “wetlands” implies a greater level of accuracy than is present, they are referred to as wetland polygons in this analysis. See King County 2017b for more detailed discussion of the original wetland datasets.

The available data indicates forested wetlands are the most common wetland type in the Bear Creek study area followed by scrub-shrub wetlands. The third most common type is emergent wetland. Open-water ponds are the least common type present.

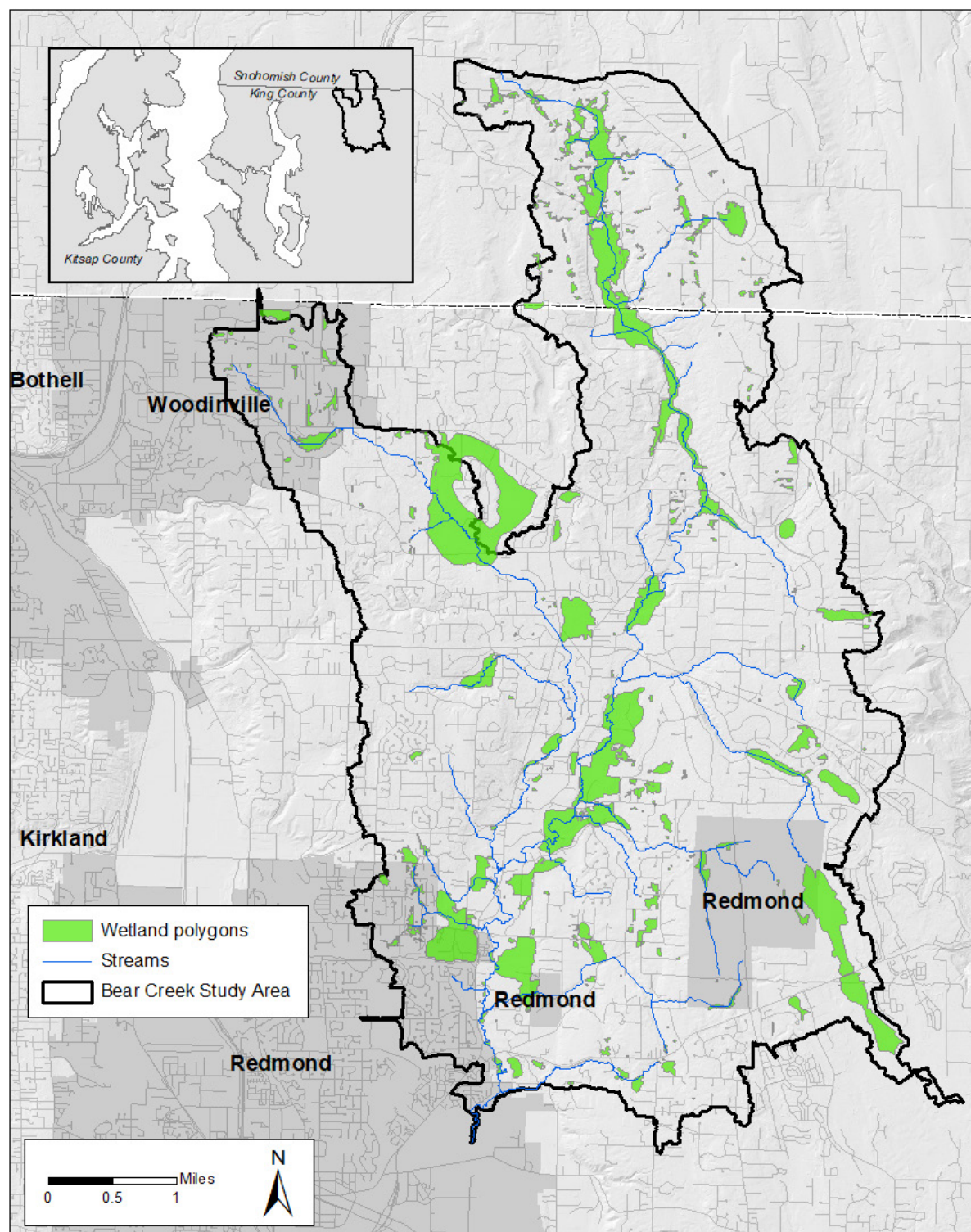


Figure 5. Mapped wetlands in the study area once all wetland data are merged. Note that some wetland polygons span across watershed study area boundaries.

3.7 Riparian Corridors

King County mapped and assessed the current conditions of land cover in the riparian corridor based on 2015 aerial imagery¹⁰ (for details on riparian land cover mapping methods see King County, 2017c). The extent of the riparian corridor assessed is 200 feet on each side of the mapped stream center line (for a total of 400 ft) of salmonid-bearing streams¹¹ (Figure 7). Changes in land use between 1972 and 2015 were also evaluated using 1972 aerial infrared imagery. The major findings from these analyses are:

- As of 2015, 47 percent of the riparian corridor is forested or covered in trees, and 7 percent is impervious surface.
- Approximately 15 percent of the riparian corridor has invasive species present (reed canarygrass and Himalayan blackberry were the only two invasive species mapped and analyzed for this study).
- Of the 46.9 stream miles in the riparian study extent, 17.3 miles (37 percent) were identified as lacking shade on one or both sides of the stream channel.
- Since 1972, the amount of disturbed areas (impervious plus Himalayan blackberry plus “Other”¹²) in the riparian corridor has increased from 13 to 27 percent. The amount of forest/shrub cover decreased from 69 to 58 percent.

¹⁰ 2015 Natural color Pictometry, 0.25ft.

¹¹ All known stream extents within the study area where Chinook, sockeye, coho, kokanee, steelhead, and cutthroat trout were recorded were included in this analysis. For a more detailed description of how the riparian study corridor was built, see King County (2017d).

¹² Other may include bare areas, grass, mud, lawn/yard, landscaping, or roadside mowed areas.

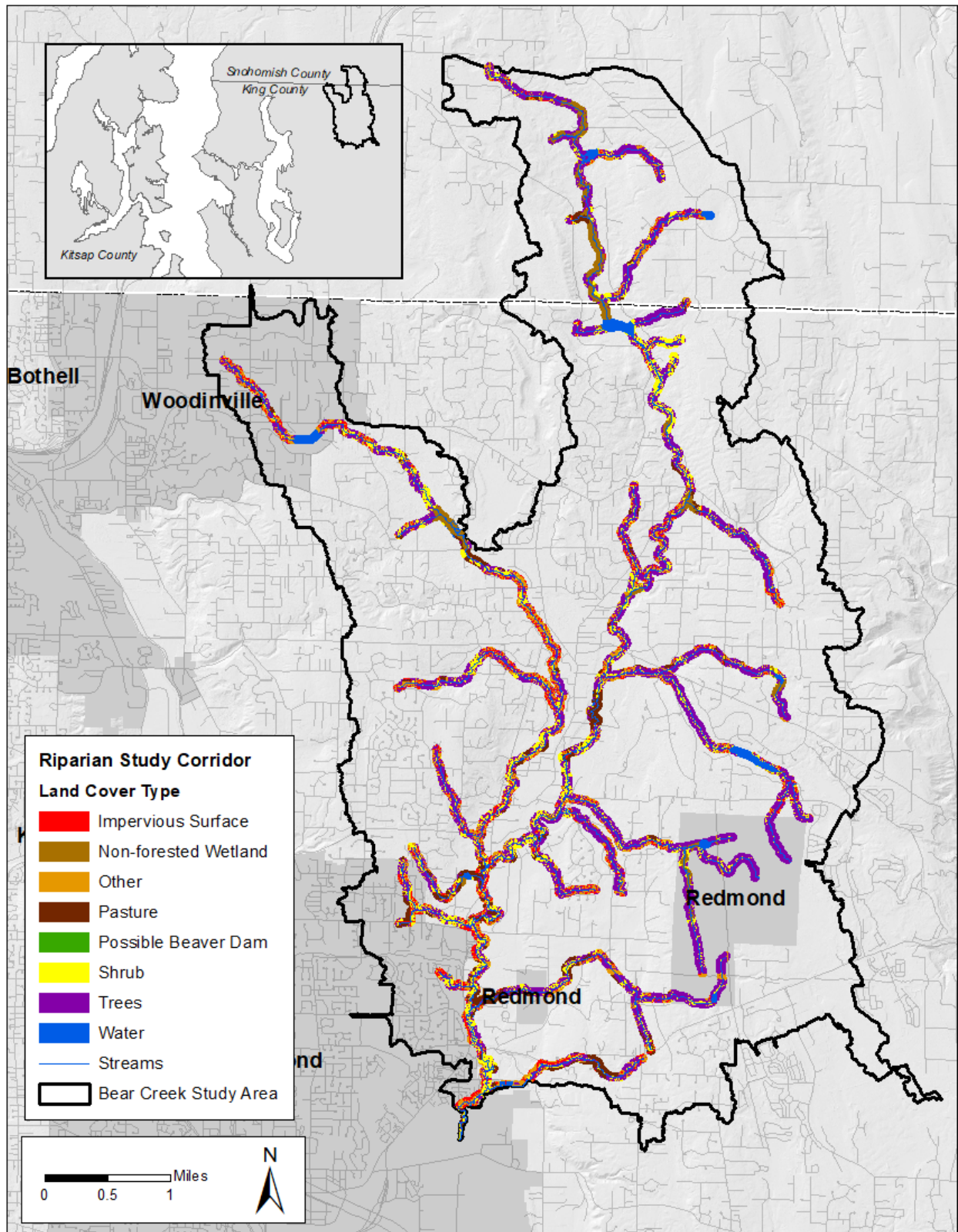


Figure 6. Land cover in the riparian corridor of salmonid-bearing streams in the study area.

4.0 STORMWATER STRATEGY IDENTIFICATION AND PRIORITIZATION

This chapter details the strategies for stormwater control and treatment and their prioritization. The goal is to restore, where feasible, ecologically functioning habitats. The objectives for stormwater projects/programs are to 1) meet state water quality standards in receiving waters (except temperature – see Chapter 7), 2) minimize impacts of stormwater runoff on stream hydrology to promote stable stream morphology, protect habitat, and support biota, 3) minimize human gastrointestinal health risk associated with recreational exposure, and minimize flooding to protect property and human health and safety.

4.1 Structural Stormwater Strategies

Poor water quality (temperature, dissolved oxygen, fecal coliform bacteria, turbidity, copper, and zinc) and altered hydrology are significant factors in causing Bear Creek and its tributaries to not meet their designated uses (King County, 2017a & 2017b). Both water quality and quantity concerns may be improved through stormwater management and treatment.

Stormwater BMPs include both low impact development (LID) type facilities, such as permeable pavement or bioretention systems, and more traditional facilities, such as stormwater detention and treatment ponds. LID BMPs generally address stormwater impacts near the source (developed land where rainfall is unable to infiltrate and/or is contaminated), and traditional facilities can either be local or more regional in nature, serving larger areas further away from the source. The mitigation provided by stormwater BMPs is readily modeled and comprised the primary management strategy used in the SUSTAIN optimization model scenarios.

The stormwater strategies presented in Table 9 were selected for evaluation for the watershed-scale modeling. Each strategy provides different levels of treatment over varying time periods and may be best suited for only certain types of land use. Table 9 is not an exhaustive list of all structural stormwater strategies – these are the strategies with adequate data (i.e., construction cost, treatment/control effectiveness) to be assessed in the SUSTAIN and HSPF models.

During the public engagement process, many residents in attendance at public meetings commented on the design of stormwater control facilities. The residents acknowledged the value of the facilities in terms of environmental impact, but there were several comments expressing the desire for particular aesthetics and/or multi-use facilities. The Study recommends inclusion of the public during the stormwater facility design process to incorporate local values into the final design.

Table 9. Strategies for improving stormwater quality and/or quantity.

Strategy or Facility	Description	Design Drainage Area Land Cover	Life Cycle (years)	Metric(s) Affected
Permeable Pavement BMP	Porous pavement surface, often built with an underlying stone reservoir that temporarily stores surface runoff before it infiltrates into the subsoil. Sand filtration is part of the underlayment for water quality treatment. Porous pavement replaces traditional pavement, allowing stormwater to infiltrate directly into the soil.	Low traffic road surfaces, driveways, parking lots, and runoff from roofs and sidewalks	15	Flow/B-IBI Fecal Coliform Metals TSS/ Turbidity
Bioretention BMP (Raingarden)	Shallow landscaped depression designed to temporarily store and promote infiltration of stormwater runoff.	Roof, urban road, driveway, parking lots	50	Flow/B-IBI Fecal Coliform Metals TSS/ Turbidity
Roadside Bioretention Ditch (bioswale) BMP	Long, gently sloped, vegetated ditch designed to remove pollutants from stormwater. Grass is the most common vegetation, but wetland vegetation can be used if the soil is saturated.	Rural Road Sections	50	Flow/B-IBI Fecal Coliform Metals TSS/ Turbidity
Combination Detention/ Wet Pond Facility	Combined detention and water quality wetpool facilities have the appearance of a detention facility but contain a permanent pool of water as well.	all	30	Flow/B-IBI Metals TSS/ Turbidity
Wet Pond	Pond that retains a permanent pool of water (a "wetpool") at least during the wet season.	all	30	Flow/B-IBI Metals TSS/ Turbidity
Infiltration Pond	Constructed by excavating or constructing berms that allow for temporary storage of runoff while it is being infiltrated.	all	15	Flow/B-IBI Metals Fecal Coliform Temperature TSS/ Turbidity
Wet pond for gravity well	Pond that retains a permanent pool of water. Used here for pretreatment prior to infiltration via a gravity well.	all	30	Flow/B-IBI Metals Fecal Coliform Temperature TSS/Turb.
Gravity Well Infiltration	Also known as deep well injection. Surface water is directed into subsurface soils to infiltrate via an excavated shaft. Typically used to direct water past limiting non infiltrative layers to soils that infiltrate well.	all	50	Flow/B-IBI Metals Fecal Coliform Temperature TSS/ Turbidity
Cisterns	Collection system includes components such as a catchment area (typically a roof), gutters and downspouts, an above or below-ground cistern.	Roof* only	50	Flow/B-IBI

*Roofs are assumed to be non-Pollutant generating surfaces (NPGS).

4.2 Catchment Prioritization

The Bear Creek study area was divided into 87 drainage catchments for modeling and prioritization purposes. Most catchments were about 100 to 400 acres. The largest catchment modeled was 650 acres and the smallest catchment modeled was 10 acres. Catchments within each jurisdiction in the study area were prioritized for early implementation of proposed actions. Figure 7 provides an overview of the prioritization. Catchments were prioritized for focused action to increase the likelihood that stream quality and flow conditions would noticeably improve in those locations early in the implementation. Focused action would allow for the demonstration of success and provide learning opportunities to inform adaptive management of the Study. The prioritization method was developed based on stakeholder input and used a range of criteria. Criteria were developed that evaluated the number/severity of problems and potential opportunities for impactful/cost effective projects in the catchments. Priority catchments are those where the need is greatest and opportunities for cost effective improvement are more available based on criteria detailed in Table 10.

Individual catchments (as delineated for the HSPF and SUSTAIN models) were assessed. Eighty-seven (87) catchments were within the study area, including 6 in Redmond, 70 in King County, 3 in Woodinville, and 8 in Snohomish County (Figure 8). In some cases, several model catchments were grouped due to similar problems, opportunities, and identified strategies. The selected catchments are at a spatial scale that measurable outcomes would be expected if targeted projects were implemented.

Catchments with poor water quality and B-IBI score (i.e., with problems) were given more weight (i.e., a greater prioritization) than catchments with good water quality and B-IBI scores. Catchment opportunity is defined as the expected simplicity to which water quality projects could be implemented in the catchment. Catchments with greater opportunity were given more weight. The criteria used in the prioritization are detailed in Table 10. The prioritization score is the summation of the criteria scores, with higher values representing higher priority.

Catchment prioritization was completed for each jurisdiction. Catchments within multiple jurisdictions were assigned to the jurisdiction with the greatest geographic coverage. The prioritization metric employed is not fixed and may be altered in the future to fit specific jurisdictional goals. Within each catchment (or group of catchments), potential strategies and locations were identified. This may be helpful in the implementation of the Study.

Appendix A: Prioritization: Water Quality and Quantity Strategies provides further detail on the prioritization and scoring metric and details the priority catchments within each partner jurisdiction:

- Four catchments (BEA120, BEA200, BEA300, and BEA740) and one group of catchments (BEA230/240/245/250) are prioritized for King County,
- one catchment (BEA670) and two groups of catchments (BEA620/625/630 and BEA640/660) for Snohomish County,

- three catchments (BEA840, BEA850, and BEA860) for City of Woodinville, and
- four catchments (BEA010, BEA100, BEA110, and BEA190) and one group of catchments (MON) for City of Redmond.

Of the catchments not categorized as high priority, there are 67 catchments remaining in King County, two remaining in Snohomish County, none remaining in City of Woodinville, and one remaining in City of Redmond.

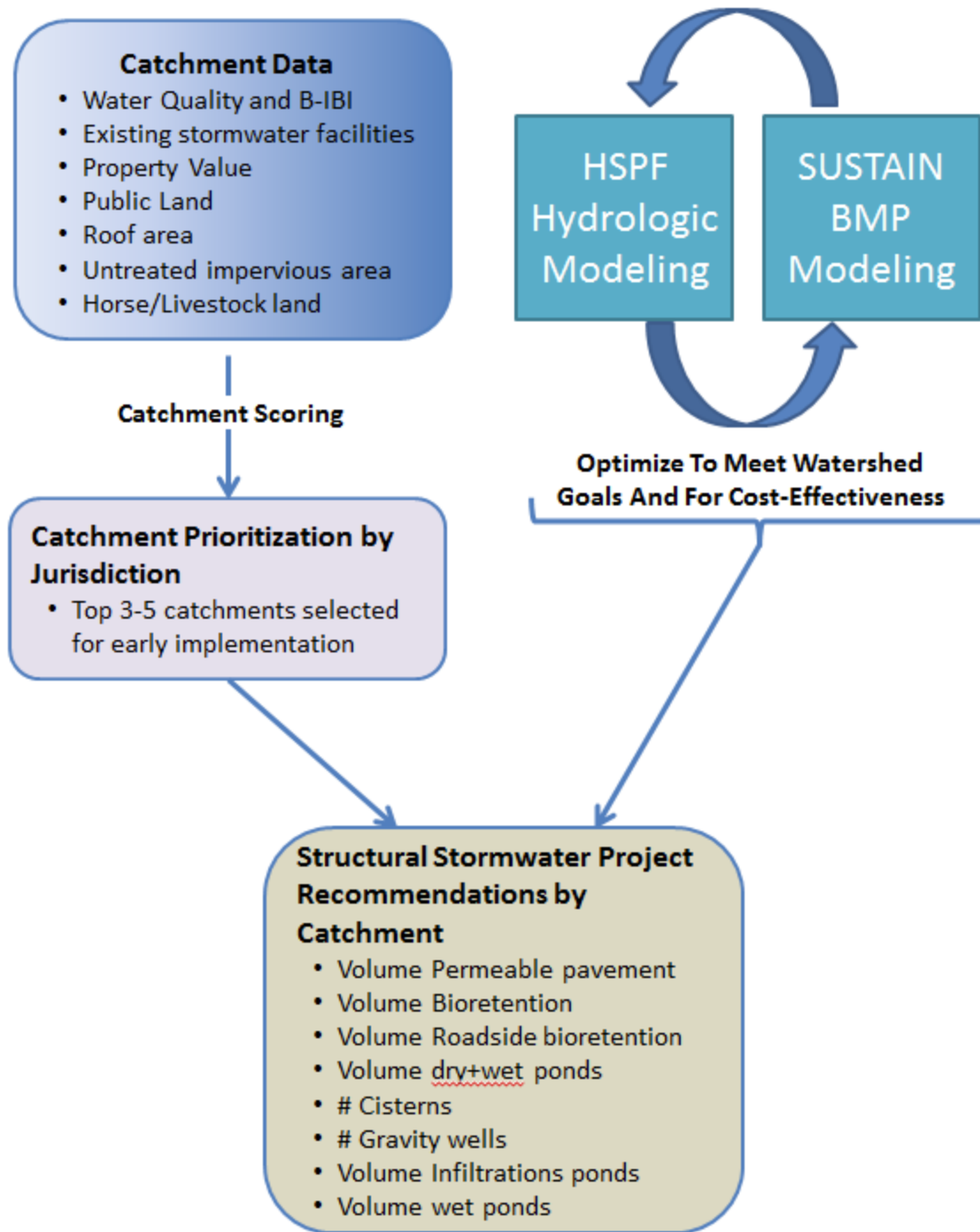


Figure 7. Stormwater structural strategy prioritization schematic.

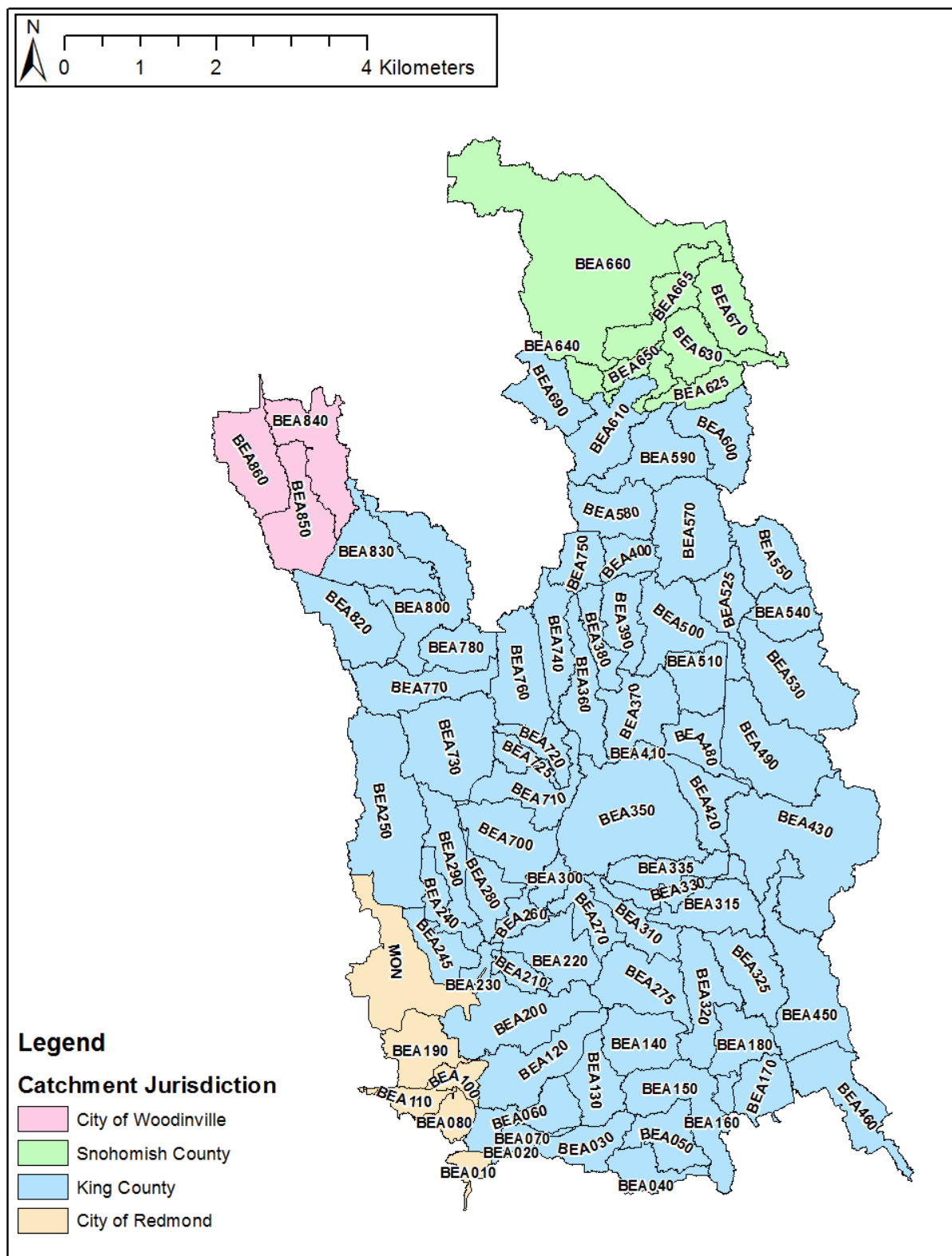


Figure 8. Catchments included in prioritization for stormwater projects and the associated lead jurisdiction.

Table 10. Criteria and datasets used to develop water quality/quantity prioritization.

Criteria	Explanation	Data Source	Important Limitations / Caveats
Water Quality Conditions (Modeled Existing and Future [2050])	Number of modeled exceedances of water quality standards (temperature, turbidity, fecal coliform, copper, zinc) A greater number of exceedances may indicate a greater opportunity for improvement and are higher priority.	Data on modeled water quality were used to highlight areas of the watershed where conditions are not expected to support designated uses.	- Water quality conditions were modeled using HSPF from recent water quality data at a select number of sites. Conditions were extrapolated to un-monitored catchments based on land use. - Future conditions are based on modeled growth and development.
B-IBI (Modeled Existing and Future [2050])	B-IBI associated with the modeled flow metrics in the catchment. Lower B-IBI score may indicate a great need for improvement and are higher priority.	B-IBI is a multi-metric index that calculates a single, numerical score designed to represent information about the ecological health of a stream.	- The modeled B-IBI scores are based on best-fit regressions with flow metrics. - The flow metrics used to estimate B-IBI were modeled through HSPF and SUSTAIN based on land use, stormwater facilities, and monitored flows in the basin. - Future conditions are based on modeled growth and development.

Criteria	Explanation	Data Source	Important Limitations / Caveats
Untreated Impervious Area	Untreated impervious areas are a priority because stormwater may cause flashiness in streams in addition to delivering pollutants.	• 2011 National Land Cover Database Impervious Surface (30 m resolution) • Mapped facility drainages (King County and Monticello Creek only)	• Additional development has occurred between 2011 and 2017 • Many stormwater facilities drainage areas are not mapped and therefore designated as untreated • Not all stormwater facilities may be providing an adequate amount of treatment
Existing Stormwater Facilities	Existing facilities are an opportunity for retrofitting to meet current stormwater design standards, improving both stream flashiness and water quality. Catchments with more existing facility are a higher priority.	• King County Stormwater Facilities Shapefile (storm_fac_point – accessed 2016) • Snohomish County Drainage Inventory • City of Redmond (Pond and swVault) • City of Woodinville (sw_facility)	Existing facilities may not be present in the inventory.
Horse and Livestock (Forage) Land	Un-mitigated horses and livestock can have negative impacts on stream water quality due to bank erosion, runoff from manure, and low riparian and instream habitat complexity. They represent an opportunity to install agricultural BMPs through partnerships with landowners and the King Conservation District.	King County Agricultural Land Use 2013 (ag_landuse2013)	• Existing agricultural BMPs are not available and were not assessed. • Land use may have changed between 2013 and 2017, including conversion to or from horse/livestock land.

Criteria	Explanation	Data Source	Important Limitations / Caveats
Property Value	Catchments with low property values represent an opportunity to purchase property for the purpose of construction regional stormwater facilities in addition to instream and out-of-stream habitat improvement projects	- King County Parcel database using 2016 assessed values - Snohomish County Parcel database using 2016 assessed values	- Assessed value does not always equal the market value. - Willingness to sell was not assessed.
Roof Area	Building rooftops are opportunities for on-site stormwater management (e.g., rain gardens, cisterns, dry wells).	- Puget Sound LiDAR Consortium - King County GIS	Older LiDAR data may not represent the current building roof footprint
Public Lands and Easements	Public lands and existing easements are a priority for stormwater and tree planting projects due to lower costs associated with construction and obtaining access.	- King County Parcel database - Snohomish County Parcel database	Not all public land may be suitable for stormwater facility construction or tree planting.
Right-of-Ways	Right-of-ways represent an opportunity to construct BMPs (or habitat projects) near roadways that can treat stormwater without purchasing private land.	- King County Right of Way - Snohomish County Right of Way	Not all right-of-ways are suitable for stormwater facility construction or tree planting

4.3 Identified Structural Strategies

SUSTAIN optimization modeling was used to determine the number and type of structural strategies required to achieve instream targets (Table 7 in Section 2.2) for water quality and flow metrics for all catchments (see King County [2018] for a description of how the structural strategies were modeled). The structural stormwater strategies identified for the prioritized catchments are presented below. The structural stormwater strategies identified for the entirety of the study area are presented in *Appendix F: Identified Structural Stormwater Strategies for Entire Study Area*.

The priority catchment or catchment-groups, as identified in *Appendix A: Prioritization: Water Quality and Quantity Strategies*, are outlined in Figure 9 for each jurisdiction. Table 11 summarizes the BMPs identified in the priority basins and the costs associated with each. One or two of the prioritized catchments within each jurisdiction were selected for near-term (first 10 years) implementation.

The costs for King County, Snohomish County, and Woodinville priority catchments range from \$9.0 to \$58 million per square mile. Redmond costs (\$132 to \$976 million per square mile) are substantially more given the level of development and increased expense for installation of vaults rather than surface water ponds.

The total structural stormwater capital costs (in non-discounted 2017 dollars) for the prioritized catchments by jurisdiction are:

- King County - \$94 million plus \$1.3 million annual operations and maintenance
- Snohomish County - \$37 million plus \$0.2 million annual operations and maintenance
- Redmond - \$171 million plus \$0.4 million annual operations and maintenance
- Woodinville - \$15 million plus \$0.2 million annual operations and maintenance

The Study identified five of the prioritized catchments that structural stormwater projects could be constructed in within the first 10 years of implementation. These catchments are BEA120 and BEA300 in King County, BEA640/660 in Snohomish County, MON in Redmond, and BEA850 in Woodinville. The near-term priority capital costs are \$8 million for King County, \$19 million for Snohomish County, \$74 million for City of Redmond, and \$5 million for City of Woodinville.

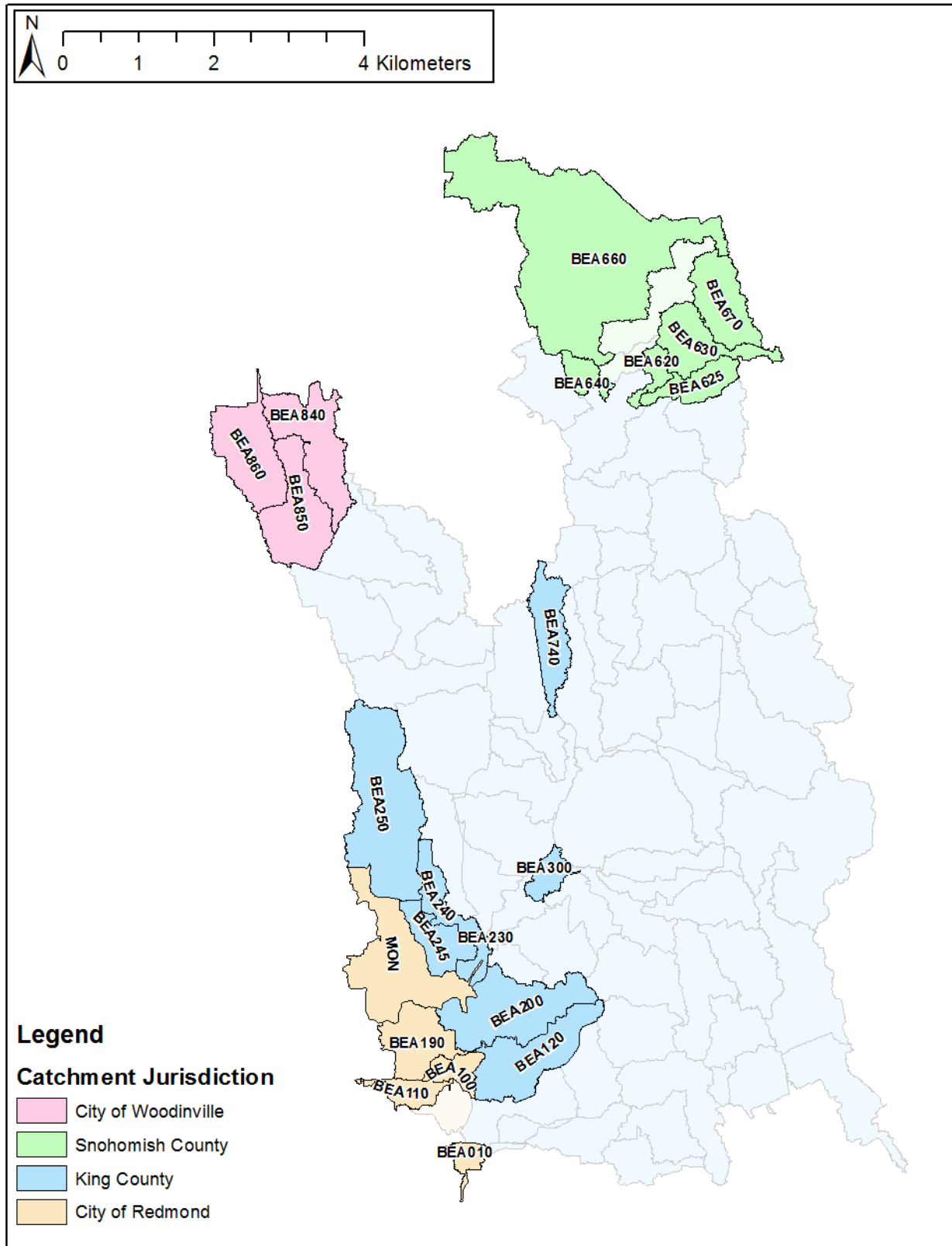


Figure 9. Prioritized catchments for stormwater projects and the associated lead jurisdiction.

Table 11. Summary of BMPs recommended by catchment for priority basins (bold cells are recommended for near-term implementation, i.e., 1-10 years).

Jurisdiction	Catchment	Cost (\$M)		Area (acres)	Bioretention	Roadside Bioretention Ditch	Cisterns	Permeable Pavement	Gravity Wells	Infiltration Ponds	Dry+Wet Ponds	Wet ponds
		Capital	O&M									
		(inches of storage)							Units / acre	(inches of storage)		
King County	BEA120	\$6.43	\$0.09	241.1	0.048	0.008	0.004	0.066	0.025	0.041	0.172	0.093
	BEA200	\$13.88	\$0.18	321.0	0.033	0.025	0.018	0.256	0.022	0.100	0.314	0.133
	BEA230	\$1.97	\$0.03	43.9	0.034	0.056	0.010	0.301	0.114	0.112	0.000	0.255
	BEA240	\$5.68	\$0.11	99.8	0.061	0.096	0.023	0.309	0.040	0.025	0.416	0.149
	BEA245	\$9.51	\$0.16	117.4	0.142	0.055	0.026	0.474	0.102	0.210	0.152	0.317
	BEA250	\$43.42	\$0.59	493.3	0.011	0.096	0.017	0.768	0.187	0.000	0.505	0.336
	BEA300	\$2.04	\$0.03	62.7	0.049	0.013	0.007	0.105	0.048	0.315	0.000	0.030
	BEA740	\$10.88	\$0.15	160.5	0.045	0.075	0.032	0.340	0.118	0.015	0.444	0.278
Redmond	BEA010	\$25.06	\$0.07	44.2	0.198	0.068	0.154	0.212	0.158	0.167	0.000	0.463
	BEA100	\$21.88	\$0.07	62.9	0.129	0.034	0.029	0.324	0.048	0.000	0.283	0.237
	BEA110	\$2.44	\$0.00	64.1	0.001	0.000	0.007	0.000	0.437	0.000	0.000	0.000
	BEA190	\$47.53	\$0.20	169.5	0.148	0.026	0.075	0.397	0.147	0.000	0.350	0.132
	MON	\$73.90	\$0.09	358.8	0.001	0.016	0.000	0.000	0.020	0.000	0.827	0.000
Snohomish County	BEA620	\$3.83	\$0.03	46.1	0.038	0.003	0.005	0.072	0.043	0.748	0.514	0.202
	BEA625	\$3.88	\$0.02	103.5	0.009	0.002	0.005	0.016	0.135	0.024	0.401	0.072
	BEA630	\$4.94	\$0.04	168.3	0.021	0.004	0.001	0.013	0.006	0.015	0.458	0.044
	BEA640	\$2.32	\$0.01	55.2	0.009	0.005	0.008	0.020	0.145	0.313	0.215	0.034
	BEA660	\$16.81	\$0.09	1168.3	0.006	0.003	0.004	0.025	0.111	0.002	0.020	0.041
	BEA670	\$5.60	\$0.04	185.1	0.009	0.010	0.007	0.018	0.049	0.000	0.417	0.070
Woodinville	BEA840	\$3.87	\$0.06	255.1	0.034	0.003	0.010	0.035	0.024	0.068	0.047	0.022
	BEA850	\$5.04	\$0.03	246.7	0.012	0.003	0.002	0.016	0.049	0.210	0.024	0.053
	BEA860	\$6.21	\$0.05	242.0	0.018	0.010	0.003	0.041	0.066	0.173	0.123	0.023

*Total area of catchment includes all land cover surfaces (e.g., Forest, wetland, developed, etc.).

All costs are in 2017 dollars, no discount or inflation rate applied.

4.4 Identified Non-structural (Programmatic) Strategies

Several non-structural strategies are identified. Non-structural strategies may be programs that identify or fund capital (structural) projects; studies that fill data gaps that will inform other programs; and programs that intend to result in behavior change and reduction in pollutant generation. Table 12 details each of the identified non-structural strategies.

Septic inspections and repair are expected to continue as part of the existing King County Public Health program. However, the existing program requires inspections as part of property transfers and in response to problem calls. The Study identified that the existing inspection program could be expanded to include preemptive inspections of septic systems. King County Stormwater Services currently operates an ongoing illicit discharge detection and elimination (IDDE) program in Bear Creek as part of its TMDL requirements. A Fecal Bacteria Source Tracking Study with genetic analysis was identified to provide follow-up bacteria hot spots identified by the IDDE effort. The study could determine the relative contribution of fecal bacteria from several animals groups (e.g., human, rodent, bovine, equine, canine, and feline). Results of the study may be used to drive targeted septic inspections and other source control efforts.

A public outreach/education program is also identified to improve stormwater quality in addition to the other topic areas (instream habitat, wetlands, and riparian corridors). The outreach/education program is detailed in Chapter 8.

Table 12. Non-structural stormwater strategies. FTE-year: a single year of full-time employee work (one-time). FTE/year: an ongoing year of full-time employee work (continuous).

Strategy	Description	Targeted Metric/Benefit(s)	Discussion	Cost	Jurisdiction
LID/ Flow Control BMP incentives/ technical assistance program for private properties.	Develop and implement a program to provide financial assistance, SWM fee discounts/rebates, and /or technical assistance to private property owners to disconnect impervious surfaces from direct drainage systems and infiltrate or disperse runoff via small scale BMPs Target for full retrofit of single-family residences not projected to trigger redevelopment requirements in 100 years.	• B-IBI/Flow Flashiness • Stream temperature • TSS/Turbidity Use program to engage and educate community regarding stormwater issues and how they can help restore the basin.	Likely will require program overhead/ staff and substantial subsidy (100%) due to lack of viable incentives. The payback period for BMP installation costs using SWM Fee discounts on residential lots is substantial. Ensures LID retrofitting occurs at a pace in line with the timeline. Relying on qualifying redevelopment of single family homes to provide LID retrofits would not achieve modeled LID need within timeline.	0.5 FTE-year (to develop program and secure funding) Estimated annual operating/ installation cost of program based on 1% of SFR inventory/year = \$7.5 million	King County City of Woodinville
In-Lieu Fee Program	If it is not feasible to install on-site stormwater management (LID) BMPs in a development project in accordance with existing regulations, the developer would pay a fee commensurate with the cost of constructing such BMPs. King County would use the revenue to fund stormwater mitigation and habitat projects in the watershed	• B-IBI/Flow Flashiness • Metals • Stream temperature • TSS/Turbidity • Wetlands (in-lieu fee) • Instream habitat (in-lieu fee) • Riparian corridor (in-lieu fee)	This proposal does not change the existing stormwater standards. It would provide a funding source that could accelerate the pace at which King County could implement stormwater-related elements of the structural program described in Chapter 6.	0.5 FTE-year (to develop initial In Lieu Fee program)	King County

Strategy	Description	Targeted Metric/Benefit(s)	Discussion	Cost	Jurisdiction
Existing Stormwater Pond Optimization Program	Expand existing King County Stormwater Assets Management Program to focus pond optimization in priority catchments within the study area.	• B-IBI/Flow flashiness • Metals • TSS/Turbidity	Evaluate the existing public inventory of stormwater ponds for opportunities to expand or optimize their function.	.25 FTE/year (part of existing Assets Management Program)	King County
Septic System Inspection Program	Expand existing King County Public Health program. Inspect a fraction of the total number of septic systems in the watershed each year.	• Fecal coliform	Current septic inspection programs are inadequate to preempt impacts to water quality.	Perform 50 inspections per year (~1% of septic systems) 0.10 FTE/year	King County
Flow Transfer Program Feasibility Study	Develop a report that evaluates the feasibility and benefits of setting up a flow transfer program whose goal is more rapidly achieving the implementation Study's targets and/or metrics.	• Potentially allows for more rapid retrofitting of a priority basin by transferring restorative mitigation from lower priority basins.	Redmond currently operates a trading program within its jurisdiction. More information is needed to determine if feasible for the rest of the watershed.	.25 FTE-year (to evaluate feasibility)	King County
Fecal Bacteria Source Tracking Study	Study of bacteria source types (e.g., avian, human, canine, bovine, feline) via genetic analysis of surface waters. Results will be used to identify target areas for source control (e.g., pets, livestock, septic).	• Fecal coliform	Work with the King County Microbial Source Tracking Program, Stormwater Services Illicit Connection/Discharge Elimination Program, and Public Health Septic Program	2 FTE-years over a 5-year period Approximately \$50k (~300 samples) for monitoring	King County
Agricultural BMP Incentive Program Evaluation	Evaluate the efficacy of current agricultural regulations and programs toward improving in stream water quality in Bear Creek. Develop a 'next steps' plan towards aligning and/or improving regulations, program funding for improving water quality impacts from agricultural operations in the watershed.	• Fecal coliform • Stream temperature • TSS/Turbidity	King Conservation District is a potential partner. Coordination with the King County Agriculture Program is important.	.25 FTE-year	King County

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5.0 INSTREAM HABITAT STRATEGY IDENTIFICATION AND PRIORITIZATION

This chapter details the strategies for instream habitat projects and their prioritization. The goal of instream habitat projects is to improve and maintain riverine and floodplain conditions throughout the Bear Creek study area. While the habitat restoration projects do not have specific quantitative goals (see Chapter 2), the objective is to restore, where feasible, ecologically functioning habitats that support salmon and fish.

5.1 Structural Instream Habitat Strategies and Restoration Projects

Salmonids depend on various habitat types throughout their life-cycle to support individual survival as well as population sustainability (Bjornn and Reiser 1991, Roni et al. 2014). The suite of habitats and associated environmental conditions experienced throughout their life-cycle subsequently influence the abundance, productivity, distribution, and diversity of salmonid populations (McElhany et al. 2000). The quantity, quality, and connectivity of these habitats are thus inherently critical to salmonid survival and productivity (Roni et al. 2014). Since salmonid growth and rearing in freshwater habitats have the potential to influence survival at later stages, it is critical to protect and restore freshwater habitats.

As juvenile salmon grow and transition through early life stages, their habitat use and distribution appears to shift with different habitat types being used at different times of the year (King County 2017a). In order to support the continuum of early life stages, a variety of freshwater rearing habitats are needed throughout the Bear Creek study area. Freshwater habitat quantity, quality, and connectivity are inherently related to well-functioning riverine, floodplain, and riparian processes. Supporting these processes through protection and restoration strategies can promote the habitat conditions needed by juvenile salmonids.

Critical salmonid life stages are sustained by protecting areas where habitat conditions are closer to well-functioning as well as actively restoring areas where habitat conditions are degraded. Protection strategies aimed at conserving well-functioning areas are discussed below in Section 5.4: Identified Non-structural (Programmatic) Strategies. In areas of Bear Creek where habitats have been degraded, instream restoration strategies are identified that focus on restoring habitat quantity, quality, variety, and connectivity. Restoration strategies suggested for the Bear Creek study area which promotes these habitat conditions and supports salmonid freshwater life stages are summarized in Table 13. Riparian reforestation is discussed in Chapter 7.

Table 13. Restoration strategies and ecological benefits.

Restoration Strategy	Salmonid Ecological Benefits*
Tributary Confluence Restoration	Provides rearing habitats, high-flow and predator refuge, areas of high food resource availability, potential cold water refugia, increased connectivity to habitat areas, and increased confluence habitat heterogeneity.
Wetland Connection	Provides connection to rearing and overwinter habitats. Improves water quality, hydrology, primary productivity, organic matter retention, and food resources availability.
Floodplain Connection	Reconnects lateral and floodplain habitats important for rearing and refuge, allows channel migration, restores longitudinal connectivity, supports transport of nutrients and sediment. Improves water quality, hydrology, water residence time, overbank fine sediment deposition, primary productivity, and organic matter retention.
Off-channel & Side-Channel Creation	Provides rearing and overwinter habitats, high-flow refuge, areas of food resource availability, spawning habitats, increases habitat heterogeneity and complexity.
Large Woody Debris Addition	Increases pool frequency/depth, woody debris, habitat heterogeneity and complexity, spawning gravel, sediment retention, and organic matter retention. Provides cover from predators, food resources, and promotes hyporheic exchange.
Road/Bridge Crossing Improvements**	Improves channel and floodplain connectivity, fish passage and colonization, water quality, hydrology, and reduces sediment supply.

* Summarized from Roni et al. 2008, Rice et al. 2008, and Roni et al. 2014

** Road/Bridge Crossing Improvements can be accomplished through various efforts and supports fish passage needs, as mentioned in Section 3.5.

Within the Bear Creek study area, one or more of the restoration strategies in Table 13 were included in an instream habitat project. Determination of habitat projects (i.e., which restoration strategies were included in a project) was based on the relative proximity/adjacency of a project area to floodplain features, wetlands, and landscape modifications (Table 14). Additionally, land-use and ownership was considered when selecting appropriate restoration strategies for a restoration project. Further discussion of how restoration projects were determined as well as how specific restoration strategies were selected for a given project is detailed in Appendix B.

Table 14. Determinations of Which Restoration Strategies are included in Restoration Projects.

Restoration Strategy	Determination of Inclusion in a Restoration Project	Data Source	Important Limitations/ Caveats
Tributary Confluence Restoration	<i>Proximity/adjacency to tributary confluences:</i> areas around tributary confluences help to support tributary restoration and connection.	King County Streams and Rivers (King County GIS library)	Some tributaries may not be included in the streams and river inventory.
Wetland Connection	<i>Proximity/adjacency to wetlands:</i> areas around wetlands will help support wetland connection, creation, and restoration.	Bear Creek combined wetlands (from 2017 <i>Assessment of Bear Creek Watershed Wetlands</i>)	Limitation of wetland inventory discussed in <i>Assessment of Bear Creek Watershed Wetlands</i> .
Floodplain Connection	<i>Available floodplain extents:</i> areas where the floodplain is less constricted and has a greater extent will provide more area for floodplain connection.	King County 100 Year Floodplains, LIDAR, orthophotography, Bear Creek combined wetlands	Corrections to the 100 year floodplain were made to account for infrastructures, landscape features, and floodplain features.
Off-channel & Side-Channel Creation	<i>Proximity/adjacency to available floodplain extents:</i> floodplain areas may have topographic and geomorphologic characteristics that support channel migration which help to create and connect off-channel and side-channel features.	King County 100 Year Floodplains, LIDAR, orthophotography, Bear Creek combined wetlands	Corrections to the 100 year floodplain were made to account for infrastructures, landscape features, and floodplain features.
Large Woody Debris Addition	<i>Proximity/adjacency to available floodplain extent as well as areas in public ownership and/or areas with minimal infrastructure:</i> areas in public ownership or with minimal infrastructure may be best suited for large wood placement to ensure minimal risk of wood/river movement to infrastructures and public safety.	King County Public Lands Areas, King County 100 Year Floodplains, LIDAR, orthophotography, Bear Creek combined wetlands	Corrections to the 100 year floodplain were made to account for infrastructures, landscape features, and floodplain features.

A total of 65 instream habitat projects were identified throughout the mainstem of Bear and Cottage Lake Creeks. The upstream extents of all instream projects were based on the upstream extents of mapped floodplains as well as the upstream extents of salmonid use within the Bear Creek study area. A few restoration projects included only one strategy; however, the majority of restoration projects included several strategies. An abbreviated

list of projects and specific restoration strategies is included in Table 15 and the comprehensive list is included in Appendix B.

Table 15. Select Instream Habitat Restoration Projects in the Bear Creek Study Area.

Project	Subbasin	Location	Restoration Strategies
LB3	Lower Bear Creek	Downstream of NE 95 th St.	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB4	Lower Bear Creek	Between NE 95 th Street and NE Novelty Hill Rd.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB5	Lower Bear Creek	Upstream of NE Novelty Hill Rd.	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C7	Cottage Lake Creek	Upstream of NE 136 th St.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
C9	Cottage Lake Creek	Adjacent to 194 th Ave NE	Floodplain Connection, Off-channel & Side-Channel Creation, LWD
C20	Cottage Lake Creek	Upstream of NE 165 th St.	Tributary Confluence Restoration, Wetland Connection, LWD Addition
UB4	Upper Bear Creek	Upstream of NE 127 th St.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD
UB11	Upper Bear Creek	Upstream of NE 141 st St.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD
UB17	Upper Bear Creek	Upstream of NE 155 th St.	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation

The cost of restoration projects in similarly sized creeks average about \$3,000,000 per river mile. Restoration projects identified for the mainstem Bear and Cottage Lake creeks range in estimated construction costs from \$90,000 to \$2,100,000. These approximated construction costs do not include any related acquisition costs, so a separate approach was used to estimate acquisition costs. The acquisition costs for a given project were estimated based on the average cost-per-acre for private parcels within a project area. The cost was based on the acquisition of only the fraction of the parcels within the proposed project areas and does not include acquisition of outside areas or built improvements. Acquisition costs for projects estimated for the mainstem Bear and Cottage Lake creeks range from \$10,000 to \$1,000,000. Appendix B provides further details on the specific instream habitat projects and their estimated costs.

5.2 Instream Project Prioritization

In order to determine the prioritization of individual instream habitat projects, each project was scored and ranked. The process of scoring and ranking instream habitat projects is outlined in the following discussion and detailed in Appendix B. A schematic of instream habitat scoring and prioritization is included in Figure 10 and relevant data sets are included in Table 16. Instream habitat projects within the Bear Creek study area were prioritized based on two main scoring criteria including a **restoration value score** as well as an **opportunity/feasibility score**.

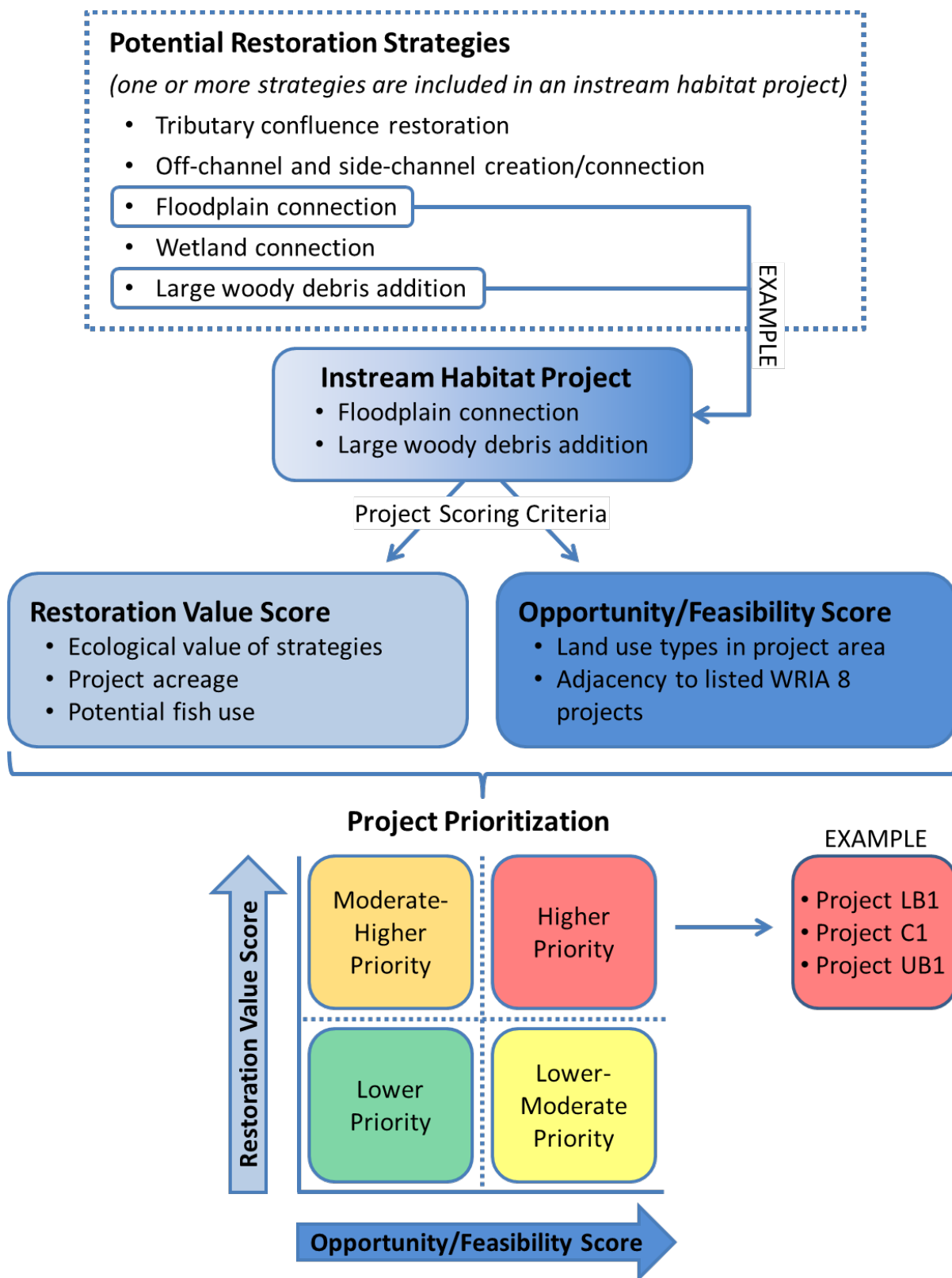


Figure 10. Schematic of instream habitat project scoring and prioritization for the mainstem of Bear and Cottage Lake creeks.

Restoration value scores were based on three elements including: 1) the ecological value of a given project area, 2) the acreage of a given project area, and 3) the potential likelihood of fish use. The ecological value of a project area was based on the selected restoration strategies for a project areas and their relative impact on salmon habitat quality/quantity, variety, and connectivity. Project areas were grouped based on acreage (e.g., smaller, medium, larger) and scored based on the potential benefits to salmon habitat (i.e., larger project areas have greater benefits). Potential fish use was scored based on the location of instream projects across the mainstem of Bear and Cottage Lake creeks and the likelihood of juvenile and adult life-stages to use those reaches.

Opportunity/ feasibility scores were based on two elements including: 1) the land-uses within a given project area and 2) the adjacency of project areas to salmon habitat project locations listed in the WRIA 8 Chinook Salmon Conservation Plan (WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017). The land-use element of the opportunity/feasibility scores was calculated based on the percentage of a project area that was in land-use types which may be conducive to restoration strategies. Land-use types which may be conducive to restoration are discussed in Appendix B. The adjacency of Bear Creek project areas to listed WRIA 8 project locations was considered to increase the opportunity or feasibility of a given project area. Adjacency to WRIA 8 project locations increased the opportunity/feasibility scores since projects on the WRIA 8 Salmon Conservation list have had some degree of vetting, either through salmon recovery forums, through previous planning efforts, or through communication with local jurisdiction, habitat enhancement groups, or private property owners.

Once restoration projects along the mainstem of Bear and Cottage Lake creeks were given a restoration value score and an opportunity/feasibility score, the projects were divided into four prioritization categories (Figure 10). Each category indicated the relative prioritization of restoration projects, with specific projects being categorized as either higher priority, moderate - higher priority, lower - moderate priority, or lower priority. Within these prioritization categories, individual restoration projects can be ranked using the product of the restoration value score and opportunity/feasibility score (hereafter referred to as the **ranking score**). Project ranking scores can be organized by prioritization category or by subbasin area (i.e., Lower Bear Creek, Upper Bear Creek, Cottage Lake Creek). Additionally, supplemental information can also be used to further inform project prioritization and ranking (included in “Additional Information” in Table 16). The criteria and elements used in restoration project prioritization and ranking are further detailed in Table 16 and Appendix B.

Table 16. Datasets used to develop instream habitat prioritization.

Type	Criteria or Element	Explanation	Data Source	Important Limitations/ Caveats
Restoration Value Score	Ecological Value	Based on the influence of a given strategy on habitat quality/quantity, habitat diversity, and habitat connectivity.	Ecological values for each restoration strategy were determined through communication with ecologists at King County Water and Lands Resources Division	The relative value of individual restoration strategies is subject to best professional judgement. Rationale for chosen values is included in Appendix B.
	Project Area	Area score based on the acreage of a given project relative to other project areas in the Bear Creek study area.	Acreages of project footprint areas. Project area delineation discussed in Appendix B.	Project area may not fully reflect the upstream and downstream influence of a given restoration project.
	Potential Fish Use	Potential likelihood of fish use within a given reach. Based on relative locations of projects within the Bear Creek study area.	Bear Creek restoration project locations and King County Streams and Rivers (King County GIS library)	Site-specific and reach-specific fish use is likely variable and based on relative adult and juvenile abundances.
Opportunity/Feasibility Score	Land-Use Type or Designation	Percentage of a project area that is in land-use types and designations which may be conducive to restoration strategies	King County Public Lands Areas, King County Public Benefit Rating System, King County Farm and Agricultural Use, King County Parks Properties (King County GIS library)	While certain land uses and designation may be more conducive to restoration strategies, the opportunities and feasibility of a given area has the potential to change over time.
	Adjacent WRIA 8 Projects	Adjacency of Bear Creek project areas to salmon habitat projects listed in the WRIA 8 Chinook Salmon Conservation Plan	Appendix F of the WRIA 8 Chinook Salmon Conservation Plan: WRIA 8 Salmon Habitat Project List: Bear/Cottage Lake Creeks	Projects listed in Appendix F of the WRIA 8 Chinook Salmon Conservation Plan may or may not be completed.
Additional Information	Ecosystem diagnosis treatment (EDT) ranks	Relative potential of a reach to improve salmon performance based on habitat conditions in the reach and the exposure of Chinook life stages to those habitat conditions.	WRIA 8 EDT Reaches: Restoration Rank	EDT ranks correspond to reaches generally greater in length than project areas. Subsequently, there may be reaches where multiple restoration projects fall within a given prioritization rank.

Type	Criteria or Element	Explanation	Data Source	Important Limitations/ Caveats
	Water Quality and Habitat Problems Score	Frequency of water quality and habitat problems that occur within a project area	Bear Creek water quality and habitat problems heat map.	The frequency of water quality and habitat problems is highly dependent on the available extents and availability of various data sets.
	Approximated Cost	Relative restoration costs of other King County Projects for similar sized creeks (cost estimate based on ~\$3M per river mile)	River length derived from King County Streams and Rivers (King County GIS library)	Approximated cost does not include related property acquisition costs

5.3 Identified Structural Strategies

All of the 65 instream habitat projects identified for the mainstem of Bear and Cottage Lake creeks were prioritized (Figures 11-14; Table 17). Twenty one restoration projects were categorized as higher priority. Projects that ranked as higher priority have the highest restoration value scores and the highest opportunity/feasibility scores. These projects were identified to be the highest priority for restoration and protection in the Bear Creek study area since they have the greatest value and opportunity. Higher priority projects would result in the restoration of ~5.8 river miles.

Fifteen restoration projects were categorized as moderate - higher priority. Moderate-higher priority projects have higher restoration value scores and lower opportunity/feasibility scores. These projects may require further private/public outreach as well as conservation/protection strategies (e.g., easements, Public Benefit Open Space Rating System (PBRs), acquisition, etc.) prior to restoration to help increase opportunities and feasibility. Moderate - higher priority projects would result in the restoration of ~3.8 river miles.

Twelve restoration projects were categorized as lower – moderate priority. Projects that ranked as lower – moderate priority have lower restoration value scores but relatively higher opportunity/feasibility scores. Since these projects may be opportunistic/feasible but have less value, it may make sense to implement these project in concert with higher priority projects (when funding is available) to increase project connectivity and to increase the relative size of higher priority project areas. Lower – moderate priority projects would result in the restoration of ~2.0 river miles.

Seventeen restoration projects were categorized as lower priority. Lower priority projects have relatively lower restoration value scores and lower opportunity/feasibility scores. Since these project rank lower, they are a relatively low priority among all projects but may help supplement habitat needs when other prioritized projects have been addressed.

Additionally, similar to moderate – higher priority projects, these lower priority projects may require further private/public outreach prior to implementation. Lower priority projects would result in the restoration of ~2.3 river miles.

Across the mainstem of the Bear Creek study area, there were 31 identified road and/or bridge crossings. As discussed in Appendix B, road and bridge crossings were not included in the project scoring system, but rather highlighted as important and prioritized similarly across the Bear Creek study area.

The ranking of individual restoration projects within a given prioritization category as well as within a given subbasin area are included in Appendix B.

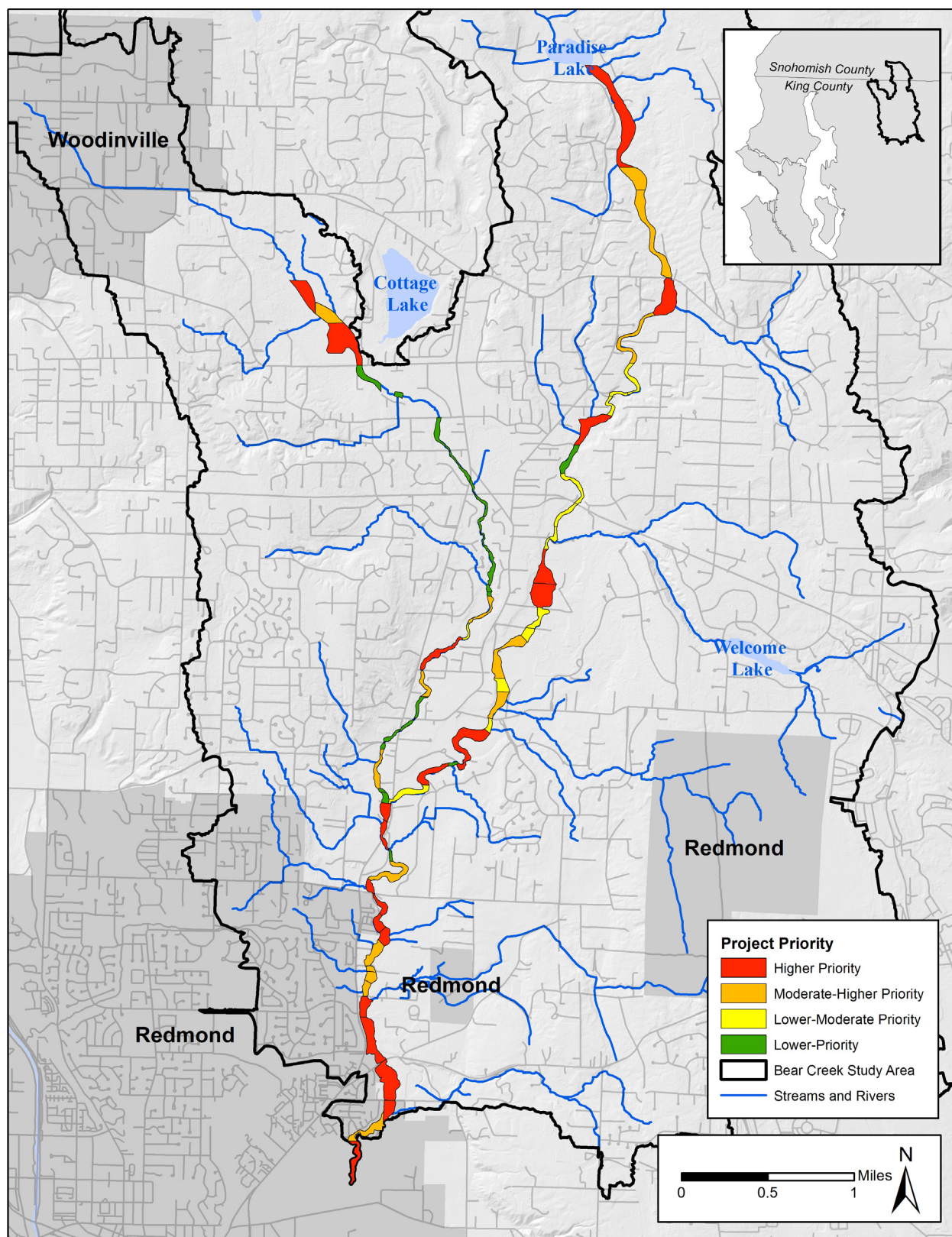


Figure 11. Bear Creek study area instream restoration project prioritization. No projects were identified upstream of Paradise Lake. Specific project numbers as well as road/bridge crossing projects are included in Figure 12-14.

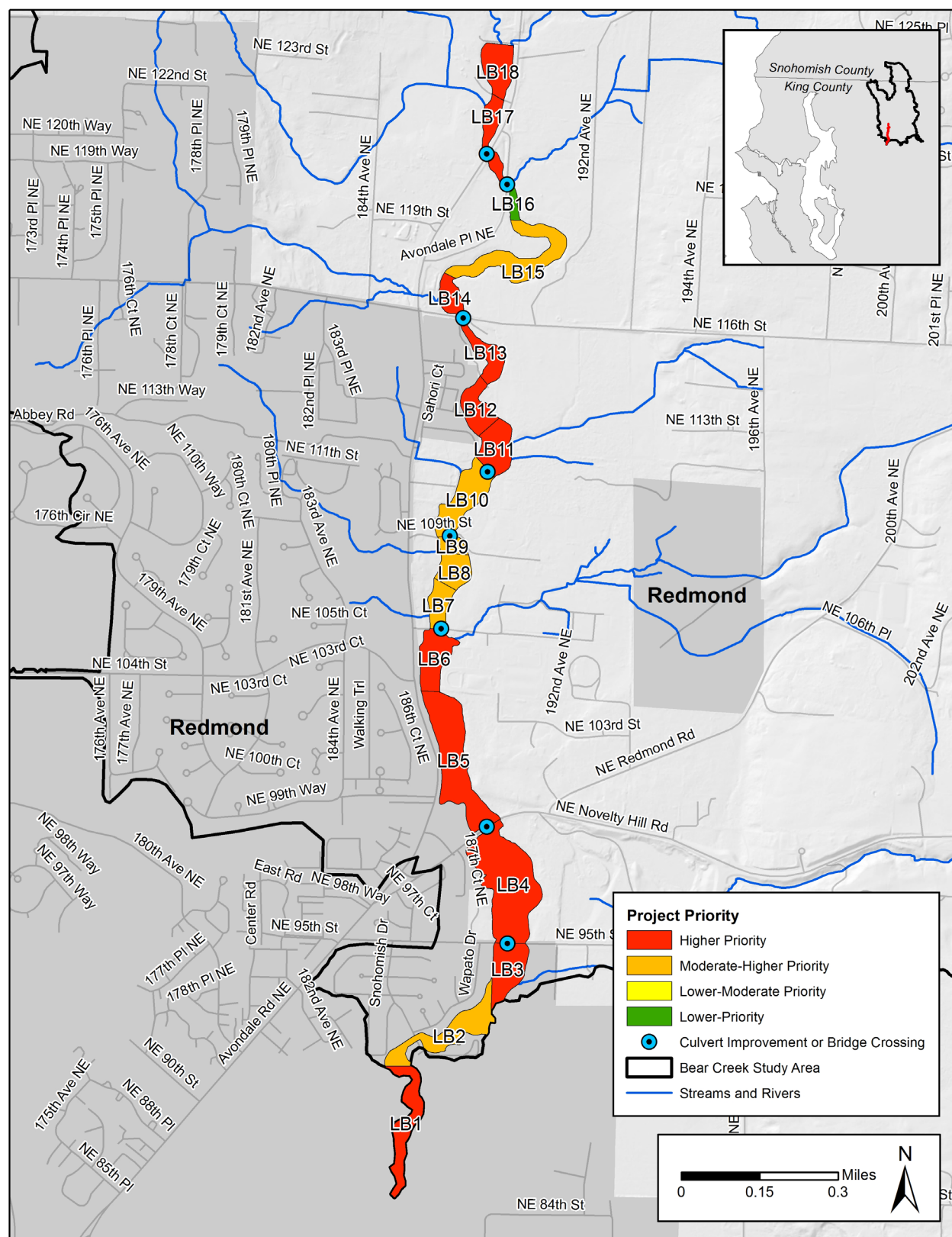


Figure 12. Lower Bear Creek Restoration Project Prioritization (road/bridge crossing projects were not included in the prioritization scoring).

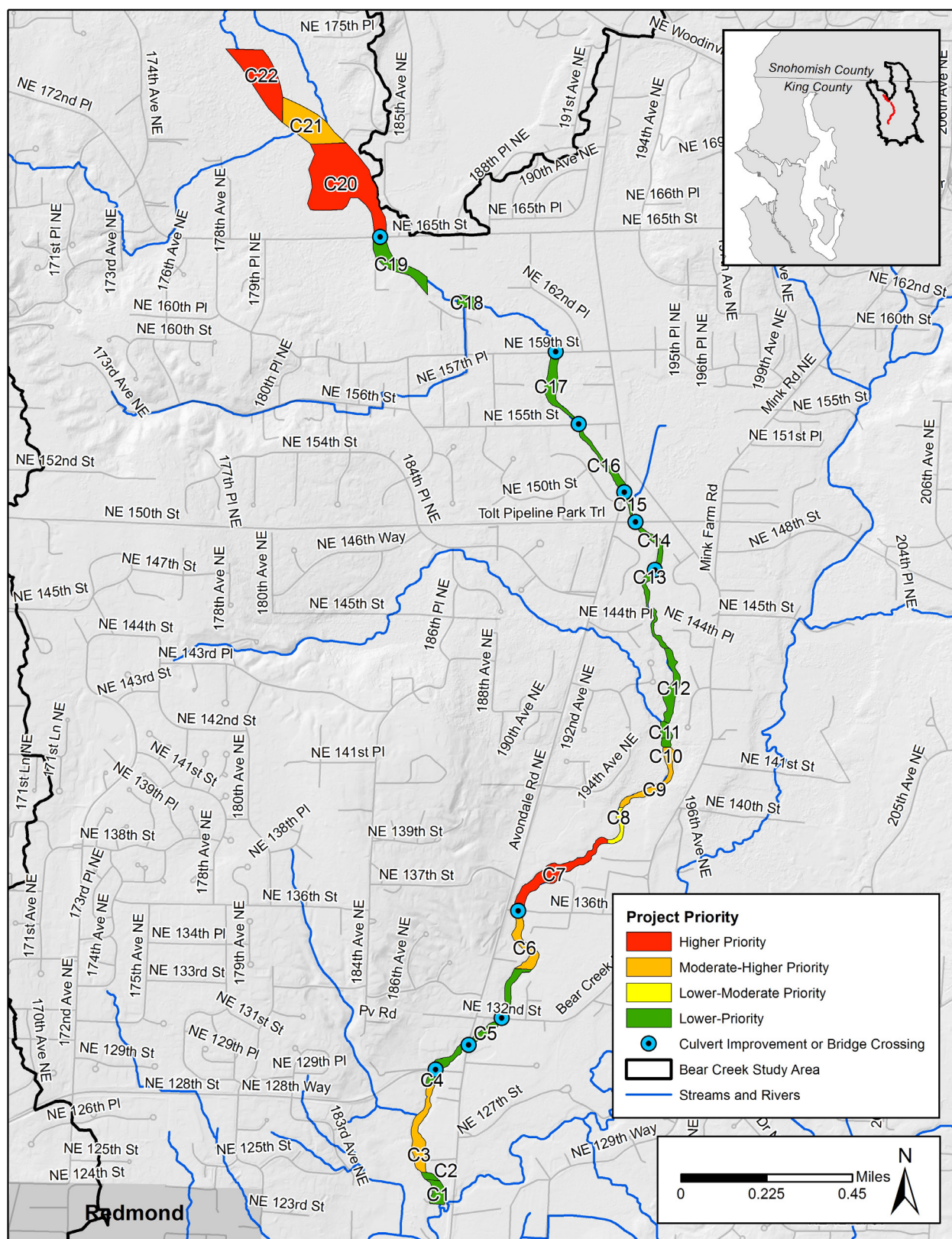


Figure 13. Cottage Lake Creek Restoration Project Prioritization (road/bridge crossing projects were not included in the prioritization scoring).

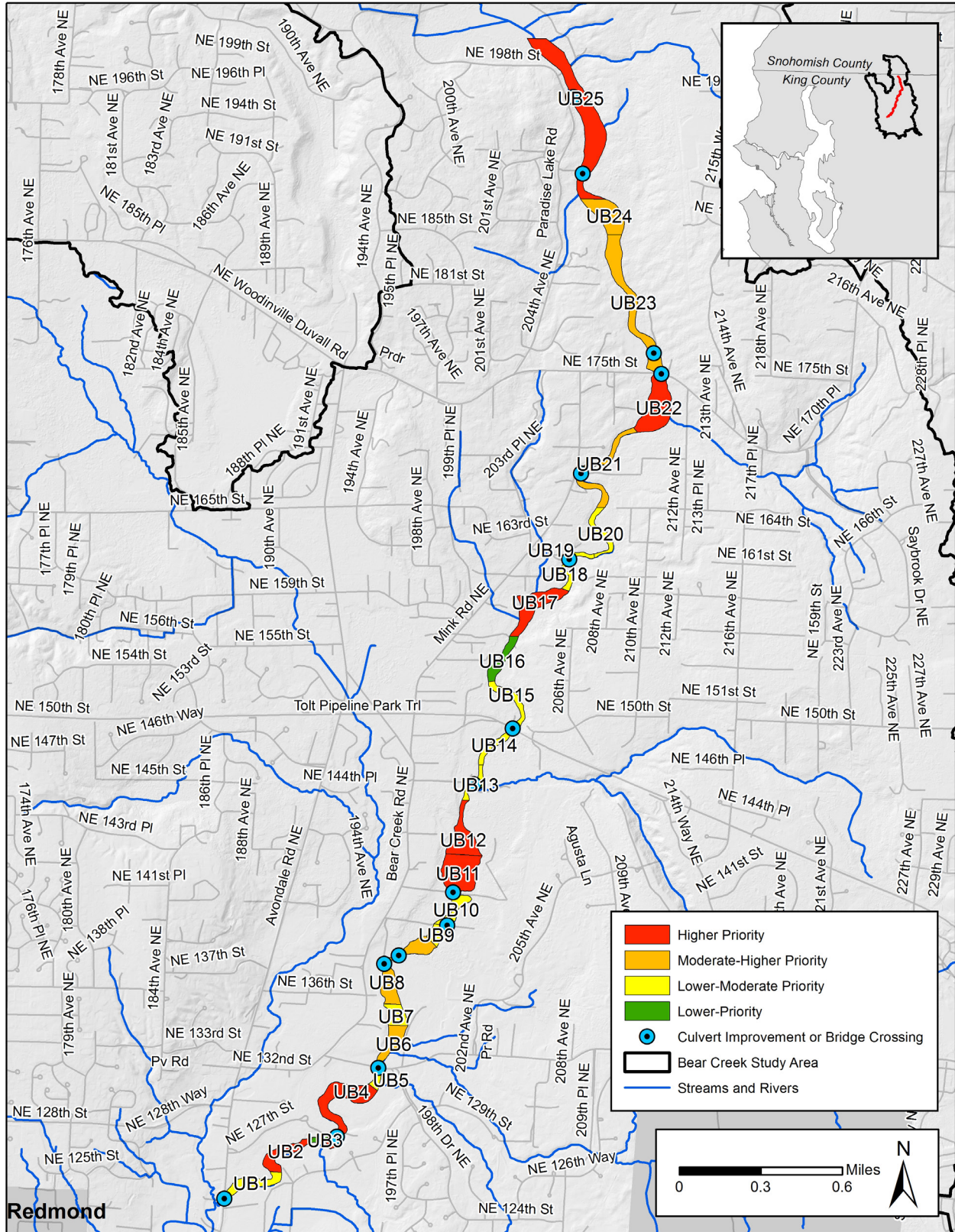


Figure 14. Upper Bear Creek Restoration Project Prioritization (road/bridge crossing projects were not included in the prioritization scoring).

Table 17. Summary of instream habitat projects by waterbody.

Subbasin Area	Priority Category	Number of Projects
Lower Bear Creek	Higher	11
	Moderate-Higher	6
	Lower-Moderate	0
	Lower	1
	Sub Total	18
Upper Bear Creek	Higher	7
	Moderate-Higher	5
	Lower-Moderate	11
	Lower	2
	Sub Total	25
Cottage Lake Creek	Higher	3
	Moderate-Higher	4
	Lower-Moderate	1
	Lower	14
	Sub Total	22
Grand Total		65

5.4 Identified Non-structural (Programmatic) Strategies

Protection strategies for the Bear Creek watershed may include continued or further implementation of land-use policies that protect habitat areas including regulatory mechanisms such as comprehensive plans, critical areas ordinance, shoreline programs, zoning regulations, stormwater management, and reduction of development impacts. Additional strategies aimed at protecting critical habitat areas include conservation easements and transfers/purchase of development rights, water rights and instream flow protection, best management practices and voluntary measures, as well as other strategies. Protection strategies are integral in ensuring that well-functioning area remain intact and help to minimize the net loss and degradation of available habitat areas.

The location and impact of fish passage barriers were acknowledged data gaps. A potential path forward is to develop a plan to inventory and prioritize mitigation or replacement of fish barriers in the study area (Table 18). The mitigation plan would allow for prioritization for cost effectiveness.

Fish habitat in the tributaries to Bear and Cottage Lake creeks were not evaluated as part of the Study. These tributaries may be assessed in the future (Table 18). Following the

assessment, the compilation of potential instream habitat projects following the methods detailed previously in this chapter could occur.

A public outreach/education program is also identified to improve stormwater quality in addition to the other topic areas (stormwater, wetland, and riparian corridors). The outreach/education program is detailed in Chapter 8.

Table 18. Non-structural instream habitat strategies. FTE-year: a single year of full-time employee work (one-time). FTE/year: an ongoing year of full-time employee work (continuous).

Strategy	Description	Targeted Metric/Benefit(s)	Discussion	Cost	Jurisdiction
Fish Passage Study and Mitigation Plan	Develop a plan to inventory and prioritize mitigation/replacement of fish barriers in the watershed.	Instream habitat	Mitigation plan will allow for prioritization for cost effectiveness.	.25 FTE/year (to develop study and implement plan)	King County
Tributary Fish Habitat Assessment, Project Prioritization, and Implementation	Develop an assessment plan, apply the prioritization method described in Appendix B, and construct high priority restoration projects.	Instream habitat	Fish habitat in the tributaries to Bear and Cottage Lake creeks were not evaluated as part of the Plan.	2 FTE-years (to assess and prioritize) The cost of the prioritized tributary habitat projects were not estimated due to limited information.	King County

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6.0 WETLAND STRATEGY IDENTIFICATION AND PRIORITIZATION

This chapter details the strategies for wetland restoration and conservation and their prioritization. The proposed wetland habitat strategies focus on restoring ecologic function throughout the watershed. There is no specific quantitative goal associated with the habitat projects (see Chapter 2). The goal is to restore, where feasible, ecologically functioning habitats. The objectives for wetland restoration are (1) to provide habitat supportive of aquatic, terrestrial, and avian life and (2) provide natural water quality treatment (not stormwater) and hydrology.

6.1 Structural Wetland Strategies

Wetlands provide a variety of ecological, water quality, and landscape services and functions. Services and functions provided by wetlands include (Michaud 2001):

- protecting water quality by trapping sediments and retaining excess nutrients and other pollutants such as heavy metals.
- providing flood protection by holding the excess runoff after a storm, and then releasing it slowly, thereby maintaining streamflows.
- recharging groundwater systems/aquifers, which, in turn, provide water for drinking, irrigation, and maintenance of streamflow and lake and reservoir levels.
- providing habitat for species of birds, fish, mammals, reptiles, and amphibians that rely on wetlands for breeding, foraging, and cover.

Wetland restoration is defined herein as the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to degraded or former wetland (definitions based on EPA, 2017). Restoration of a degraded wetland is referred to as wetland rehabilitation. Wetland rehabilitation is defined in this Study to include:

- The repair of natural/historic functions of a *degraded* wetland.
- A gain in wetland function, but does not a gain in wetland acres.
- The planting native of vegetation (trees and shrubs) around the periphery of the wetland in areas that are currently covered in grass, impervious surface, or some other non-native vegetation.

Restoration of a former wetland is referred to as wetland re-establishment. Wetland re-establishment is defined in this Study to include:

- The return of natural/historic functions to a *former* wetland.
- The building of a functional wetland where one does not currently exist but did exist within the past 100-200 years.
- A gain in wetland acres.

- The transformation of a wet field of reed canarygrass into a wetland with native vegetation, potentially including an open-water component, and improved function.

Stormwater treatment wetlands may also be created to perform water quality treatment functions. Stormwater wetlands are typically constructed where no wetland previously existed. Site selection for created stormwater treatment wetlands was not in the scope of the Study.

Planting native vegetation for wetland rehabilitation typically consists of site preparation, purchasing the trees and shrubs, labor for doing the planting, and follow-up maintenance (e.g., watering, weeding). Wetland rehabilitation costs can vary widely based on site conditions. Average wetland rehabilitation costs in the Bear Creek study area are expected to be about \$30,000 per acre¹³. The average cost does not include related property acquisition costs.

Wetland re-establishment typically costs substantially more than wetland rehabilitation. Wetland re-establishment typically requires the use of earth-moving equipment to create shallow depressions. Wetland re-establishment costs can vary widely based on site conditions. Average wetland re-establishment costs are expected to be over \$100,000 per acre. The average wetland re-establishment cost does not include related property acquisition costs.

6.2 Wetland Project Prioritization

Criteria from Cappiella et al. (2006) were adapted to use with wetland and landcover data to prioritize wetlands for restoration and conservation. Table 19 summarizes the criteria used to develop a point system for scoring each wetland and subsequently each parcel associated with the wetlands. *Appendix C: Prioritization: Wetland Strategies* provides detail on the methods and point system used to identify and prioritize wetlands for restoration and conservation.

For wetland restoration the scoring is intended to indicate greatest potential to rehabilitate one or more wetland functions. Prioritization is highest for wetlands that have:

- the greatest value in terms of connectivity
- the least amount of impervious surface
- highest potential for improving water temperatures
- the greatest feasibility for planting (are publicly owned)

These criteria and associated scoring are intended to be used to get the most out of

¹³ Rehabilitation costs vary widely depending on site conditions and habitat type. Costs vary depending on the amount of site prep required, amount of weeding and watering afterwards, the trees and shrubs and what type they are (stake versus potted plant, and if potted, size of plant), and how many plants installed per acre. Costs also include all labor associated with site prep, planting, monitoring, and maintenance. Difficult site access or other extenuating circumstances can dramatically increase planting costs. Cost estimates can typically range between \$15,000 and \$36,000. \$30,000 is assumed to be a conservative average estimate.

restoration dollars. Emphasis is placed on bog wetlands, those wetlands in public ownership, and wetlands lacking shade. Because bogs are the wetland type most sensitive to disturbance in the study area, they are assumed to be the most important to restore whenever possible. They are therefore a high priority for restoration. It is assumed that it will be much more feasible to conduct wetland restoration projects on public lands over private lands. Planting trees around a wetland lacking in native vegetation is assumed to provide both water quality and wildlife benefits.

For wetland conservation, emphasis is placed on bog wetlands for the reasons described above as well as those wetlands already in partial public ownership in native vegetation. If the wetland is already partially protected, conservation for the remaining portion is considered highly desirable because not only will the wetland be fully protected, but an increased area of connectivity is also protected.

Table 19. Criteria used to prioritize wetlands for conservation and restoration.

Criteria	Definition	Question derived from criteria	Rationale	Conservation / Restoration?
Type	Sensitive, locally rare, or difficult-to-replace wetland types. Prioritize bogs over other wetland types.	Is the wetland a bog?	Because of the sensitive and relatively rare nature of bogs, the point value assigned for them is high enough to elevate them to a top priority.	Used as criterion for both conservation and restoration.
Function	Lack of native vegetation present.	Does the wetland have reed canarygrass present? Is the wetland mowed on some portion of its shoreline? (Surrogates for the following questions: Can water quality functions be improved? Can wildlife habitat functions be improved?)	The two primary wetland-related problems that may be addressed with rehabilitation (tree planting) are lack of shade and invasive species. Even in the absence of an open-water component, replacing reed canarygrass with native vegetation will improve wildlife habitat. However, planting trees along a shoreline is assumed to provide both water quality and wildlife benefits, hence the higher score for "mowed."	Used as criterion for restoration.
	Water is present.	Is there water present?	This question addresses both feasibility and the impact a planting project will have. If the wetland is an agriculture field full of reed canarygrass, planting trees will not result in cooling water temperatures. This element raises the priority for wetlands that have water present to some degree.	Used as criterion for restoration.

Criteria	Definition	Question derived from criteria	Rationale	Conservation / Restoration?
Condition	Good or Excellent condition.	What is the percentage of impervious land cover within 300 ft of the wetland?	No impervious surface within the buffer of a wetland should indicate a wetland in relatively better condition than those with buffers that do have impervious surface. Above 10 percent impervious surface in a wetland buffer area is assumed to degrade wetland condition.	Used as criterion for both conservation and restoration.
	King County Wildlife Habitat Network intersects wetland or parcel associated with wetland.	Does the King County Wildlife Habitat Network intersect the wetland or parcel associated with wetland?	Regulated connectivity increases the wildlife habitat value of the wetland.	Used as criterion for both conservation and restoration.
Connectivity	Part of a wetland complex.	Is the wetland part of a wetland complex?	Wetland connectivity is very important for wildlife survival and biodiversity. But because of the limitations of identifying wetland complexes geospatially, the scoring for wetlands defined herein as being in a complex is relatively low. Additionally, many of the single wetland polygons are actually wetland complexes.	Used as criterion for both conservation and restoration.
	Wetland is located fully or partially on protected lands.	Is the wetland already fully or partially protected (e.g., public lands, Tract parcels, Home Owners Associations (HOA), green space)?	If the wetland is partially protected, completing the level of conservation is considered highly desirable. It is assumed that it will be much more feasible to conduct wetland restoration projects on public lands over private lands.	Used as criterion for both conservation and restoration.

Criteria	Definition	Question derived from criteria	Rationale	Conservation / Restoration?
	Adjacent to other protected undeveloped open space (public lands, Tract parcels, HOA green space).	Is the parcel containing the wetland adjacent to other protected, undeveloped open space?	This attribute is already partially covered by tagging the wetlands for whether they are already protected. However, parcels play a role in connectivity and so are also scored for whether they are connected to other protected lands, because in some instances the parcels will be connected and the wetland will not have been.	Used as criterion for conservation.
Location in watershed	Located in headwaters.	Is the wetland located in headwaters?	Headwaters of streams impact water quality, including water temperature. Lowering a headwater wetland's water temperature should also lower the stream water temperature.	Used as criterion for both conservation and restoration.
	Located in areas of known high water temperature.	Does the stream water temperature exceed the standards?	If the wetland is located along a stream reach with elevated water temperatures, it is assumed that tree planting may help alleviate the high water temperatures.	Used as criterion for restoration.
Development pressure	Parcels are not currently subdivided as small as they may be.	Is the parcel containing the wetland currently not subdivided as small as it can be? That is, can the parcel be subdivided?	If the parcel associated with the wetland can be further subdivided, the development pressure is assumed to be higher than undividable parcels.	Used as criterion for conservation.
Special designation	Identified in riparian analysis (King County, 2017c) or King County Land Conservation Initiative (which includes salmon recovery priorities).	Are associated parcels identified as part of the riparian analysis (King County, 2017c), King County Land Conservation Initiative, or similar program?	Assumes that if there are multiple values associated with preservation versus only one conservation target, parcel is more valuable from a conservation standpoint.	Used as criterion for conservation.

6.3 Identified Structural Strategies

6.3.1 Restoration strategies

6.3.1.1 Rehabilitation

A total of 198 wetland polygons (“wetlands”), totaling approximately 1500 acres, were identified in the study area with some level of degradation. Of these 198 wetlands, 86 of them were degraded in ways that are not addressed in this Study. For example, many of these mapped wetlands are currently wet farm fields. Others are scrub-shrub wetlands with roads crossing through them. Of the other 112 wetlands, 67 were identified as having reed canarygrass present, and 55 were mowed along at least some portion of the edge plus 3 appeared to be degraded from livestock access (for a total of 58 generally referred to as “mowed”). These 112 wetlands are potential targets for rehabilitation in this Study. The distribution of the 112 is as follows:

- King County: 89
- Redmond: 4
- Snohomish County: 15
- Snohomish County and King County shared: 1
- Woodinville: 3

Of the 58 wetlands identified as being mowed to the edge:

- 6 are fully on public property and 3 are partially on public property.
- 13 also have reed canarygrass.
- 5 are also in the riparian corridor (total of 8.4 acres in need of trees around the wetlands).
- 2 have concrete paving around some of the edges, and one has a gravel driveway.
- 5 are ponds on golf courses.
- Not including golf course ponds and lawns along residential lakes, approximately 34.5 acres could be planted in trees and shrubs around these “mowed” wetlands if all landowners fully cooperated (Table 20).

Table 20. Acres of land, by jurisdiction and ownership, that would benefit from tree-planting restoration. Includes areas around wetlands mowed to the edge of the open-water component and areas covered in reed canarygrass. For areas that are mowed and have reed canarygrass present, acreage is included with mowed wetlands. Area in this table does not overlap with restoration areas identified in Section 6.4, Riparian Restoration.

Jurisdiction	Mowed to edge (58 wetlands)				Reed canarygrass (67 wetlands)			
	Total	Public	Private	Est. Cost*	Total	Public	Private	Est. Cost*
King	30.5	2.7	27.8	\$915,000	70.5	5.6	64.9	\$2,115,000
Snohomish	1.8	0.0	1.8	\$54,000	2.0	0	2.0	\$60,000
Redmond	1.6	1.6	0	\$48,000	1.5	0	1.5	\$45,000
Woodinville	0.6	0.3	0.3	\$18,000	0	0	0	\$0

*Costs are estimated to be \$30,000 per acre.

Of the 67 wetlands identified as having reed canarygrass present:

- 11 are fully on public lands, and 16 are partially on public property.
- 3 are beaver ponds, which pose extra challenges for tree plantings because they are so wet.
- 25 do not have an open-water component associated with them, and approximately 8 of these are farm fields with no other indication of a wetland present beyond the reed canarygrass.

Many of the wetlands that have reed canarygrass present but are not identified as being mowed to the edge are in stream riparian corridors, and there is no open water component to the wetland other than the stream. These riparian areas would benefit from tree planting. Many of these areas are captured in the riparian analysis (*Appendix D: Prioritization: Riparian Corridor Strategies*). Other areas with reed canarygrass but no “mowed edges” are farm fields. Planting trees in these farm fields would have terrestrial habitat benefits but likely very low benefits for wetland function. Reed canarygrass areas not associated with the riparian analysis, not included in the mowed estimates, and not including farm fields make up the 67 wetlands described above and total approximately 74 acres (Table 20).

The cost of rehabilitation was evaluated for the 112 wetlands identified as having reed canarygrass or being mowed along at least some portion of the edge. Tree-planting projects are assumed to cost about \$30,000 per acre in 2017 dollars. The cost of wetland rehabilitation on public lands throughout the study area is estimated to be \$306,000 (Table 20). The total cost to rehabilitate wetlands on private lands (excluding any costs to acquire the land or easement to the land) is estimated to be \$2.95 million.

Wetlands were ranked for planting prioritization using the methods described in detail in *Appendix C: Prioritization: Wetland Strategies*. Figure 15 indicates a ranking of high, medium, low, and very low for restoration planting of the wetlands, where:

- High = 110-165 points

- Medium = 70-105 points
- Low = 20-65 points
- Very Low = 0-10 points

It is useful to keep in mind that the entirety of a wetland does not necessarily need rehabilitation. Areas in need of rehabilitation may be small in relation to the size of the wetland. For example, a wetland polygon mapped in Snohomish County is 284 acres in size, but the size of the area in need of native tree planting is 37 acres.

Table 21 provides a sample of the highest ranked wetlands for rehabilitation in each jurisdiction and estimated cost per project. All information generated from this analysis for tree planting will be provided to all of the partnering jurisdictions.

Table 21. Sample of highest ranked wetlands for rehabilitation for each jurisdiction. Whether the wetland has reed canarygrass present and/or is mowed to the edge are noted. Also presented are approximate sizes of areas to be planted associated with each wetland and cost estimate assuming \$30,000 per acre.

Jurisdiction	Wetland ID	Ranking	Wetland size (acres)	Reed canarygrass	Mowed	Acres to be planted	Cost estimate (\$)
King County	233	High	0.23	Yes	Yes	0.10	3,000
	215	High	308.38	Yes		37.3	1,119,000
	118	High	79.79	Yes		**	
	105	High	6.64	Yes		3.69	110,000
	23	High	0.06	Yes	Yes	0.18	5,400
Redmond	103	High	9.94	Yes		**	
	62	High	3.15	Yes	Yes	1.64	49,200
	61	Medium	0.23	Yes		0.35	10,500
	75	Low	2.77	Yes		1.11	33,300
Snohomish County	327	High	9.98	Yes		**	
	284	Medium	0.09	Yes		0.15	4,500
	288	Medium	25.05		Yes	***	
	260	Medium	0.22		Yes	0.76	22,800
	283	Medium	0.82	Yes		1.42	42,600
Snohomish Co. – King Co.*	323	High	284.84	Yes		**	
Woodinville	240	High	0.06		Yes	0.33	9,900
	213	Medium	17.70		Yes	***	
	223	Medium	0.43		Yes	0.26	7,800

*This is a large wetland complex that spans across county boundaries.

**Captured in riparian analysis.

***These “wetlands” are residential lakes with numerous lawns along the lakeshore. These lawn areas were not tabulated for this exercise.

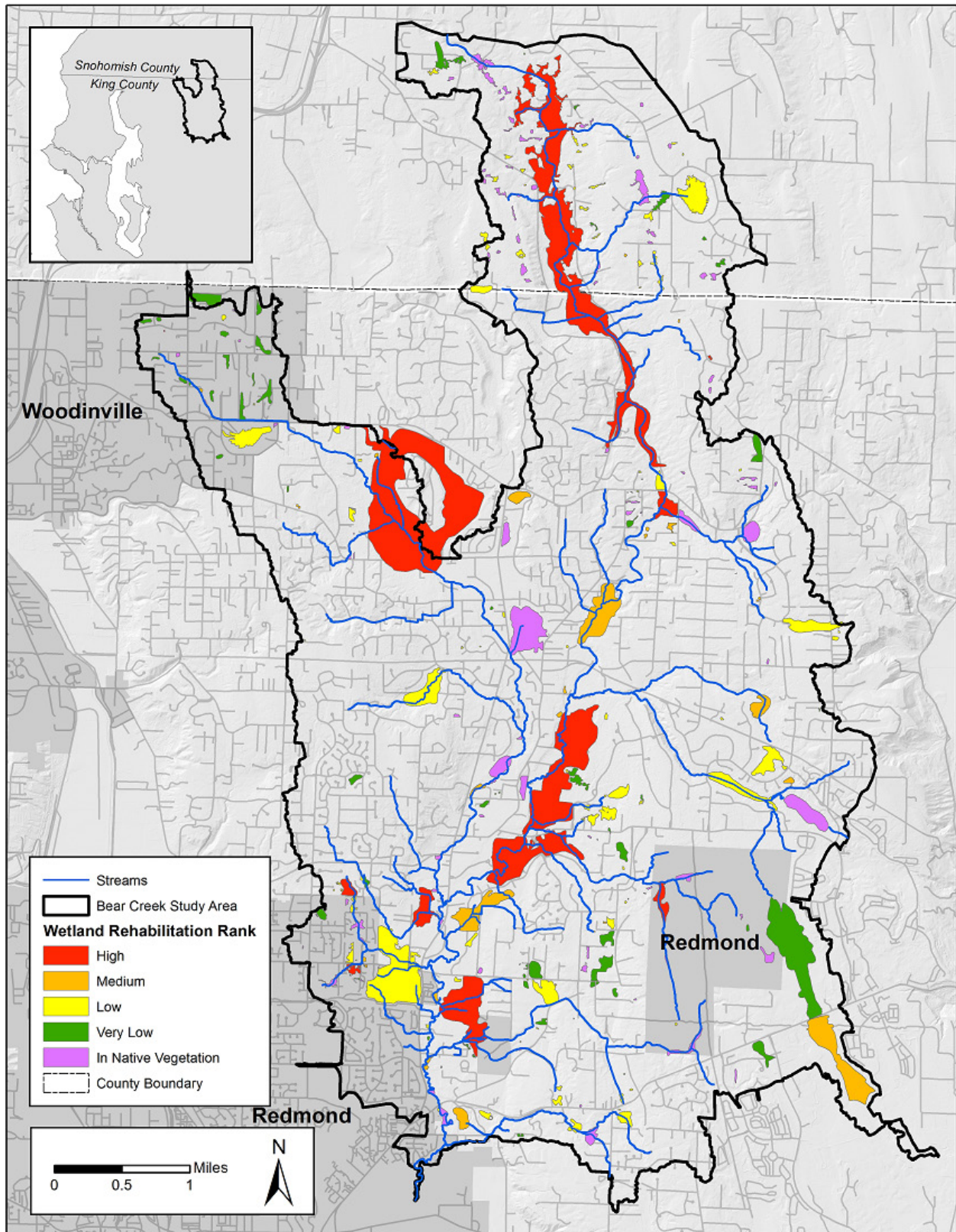


Figure 15. Prioritization of wetlands for rehabilitation strategies (tree planting).

6.3.1.2 Re-establishment

Wetland polygons were intersected with soil data to identify all potential mapped wetlands that intersect mapped hydric soils. All wetland polygons showing open water were removed from consideration, because a wetland typically already exists in those locations or they are addressed above under “Rehabilitation.” Wetland polygons showing native vegetation were removed from consideration under the assumption they may be forested or scrub-shrub wetlands. Nine wetlands remained for consideration of re-establishment.

Six of the 9 polygons are on farm fields or pasture, and 2 of the polygons are actually in a single farm field. Two of the areas have reed canarygrass. These 9 wetland polygons intersect a total of 15 parcels, and none are publicly owned. All of the potential re-establishment sites are all in King County’s jurisdiction.

These potential re-establishment sites could be evaluated further in the field to confirm assumptions based on mapping data and further evaluate restoration feasibility. If wetland re-establishment were to occur at any of these sites, excavation combined with native vegetation planting would transform these sites from fields to wetlands with habitat value, flood storage, and groundwater recharge functions.

6.3.2 Conservation strategies

A total of 588 parcels were identified that were associated with the 268 wetland polygons:

- 107 undeveloped privately owned parcels containing all or part of a mapped wetland polygon.
- 462 developed residential parcels that might be candidates for conservation easements or partial acquisition because they contain part or all of a wetland.
- 19 undeveloped forested parcels directly adjacent to parcels with wetlands.
- 17 parcels with easements already in place.

Wetland scores were combined with points from parcel-specific criteria to prioritize the parcels for conservation. The 588 parcels had scores ranging from 0 to 220. Parcels were ranked as high, medium, low, and very low, where:

- High = 160-220 points
- Medium = 80-150 points
- Low = 20-70 points
- Very Low = 0-10 points

Parcels that scored only 0 or 10 points are assumed to not be a priority for conservation. The distribution of parcels that scored at least 20 points for conservation is as follows:

- King County – 335 parcels out of 409 scored; points ranging from 20 to 220
- Redmond – 21 parcels out of 23 scored; points ranging from 20 to 80
- Snohomish County – 71 parcels out of 94 scored; points ranging from 20 to 210
- Woodinville – 22 parcels out of 62 scored; points ranging from 20 to 180

Undeveloped parcels are candidates for acquisition or easement; cost analyses assume acquisition, which is more costly. Parcels with development are assumed to be candidates for easements and not acquisitions, though there may be some circumstances when a developed parcel is purchased and any structures demolished.

Costs of acquisition were calculated by first obtaining the combined assessed land value and assessed improved value (value of improvements, such as houses) from King County parcel data and the combined market land value and market improved value from the Snohomish County parcel data. Next, a multiplier of 115 percent¹⁴ was applied to those values to account for the difference between the assessed value and appraised value. Costs of easements were calculated by taking the assessed land value from King County parcel data and the market land value from the Snohomish County data and using a multiplier of 40 percent¹⁵. Easement calculations assumed less than half the parcel would be put in easement.

For the cost analysis, in all instances where parcels in the riparian analysis in Section 7.3 overlapped parcels in this wetland analysis, they were removed from this wetland analysis.

A total of 126 parcels were identified for potential wetland acquisition (had no development). Sixty-four (64) of those parcels were also identified in the riparian analysis for acquisition. This wetland cost analysis for acquisition only includes the remaining 62 parcels.

Costs for acquisition for each partner jurisdiction are present in Table 22. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total costs for acquisition in priority basins and remaining High and Medium ranked parcels would be approximately \$5,520,000.

¹⁴ 15 percent is added to the assessed value because appraisals were running higher than assessed value by about 15 percent in 2015 and 2016.

¹⁵ 40 percent assumes the following: (a) the amount of the parcel that would be placed under easement would be less than 50 percent and more than 1 percent, and 25 percent is the average between 1 and 50, and (b) 15 percent is added to the 25 percent to account for the difference between assessed value and appraised value.

Table 22. Cost estimates for all 62 parcels identified for potential acquisition. Priority catchments described in Section 4.2 are identified separately.

Prioritization Ranking	Catchment	Cost	number of parcels
King County			
High	All others	\$1,431,000	4
Medium	BEA120	\$99,000	1
Medium	All others	\$2,650,000	9
Low	BEA120	\$86,000	1
Snohomish County			
High	BEA660	\$600	1
High	All others	\$1,000	1
Low	BEA660	\$488,000	2
Very Low	BEA660	\$264,000	1
Unknown	BEA660	\$289,000	3
Woodinville			
Very Low	BEA850	\$210,000	1

A total of 462 parcels had some development on them and thus were identified for potential wetland easements. One hundred and eighty-seven (187) of those parcels were also identified in the riparian analysis for easements. This wetland cost analysis for easements only includes the remaining 275 parcels.

Costs for easements for each partner jurisdiction are presented below in Table 23. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total costs for easements in priority basins and remaining High and Medium ranked parcels would be approximately \$11,190,000.

Table 23. Cost estimates to for all 275 parcels identified for potential easements. Priority catchments described in Section 4.2 are identified separately.

Prioritization Ranking	Catchment	Cost	number of parcels
King County			
High	All others	\$1,632,000	12
Medium	All others	\$6,835,000	48
Low	BEA120	\$205,000	2
Redmond			
Medium	All others	\$975,000	10
Snohomish County			
High	BEA660	\$410,000	5
High	All others	\$183,000	2
Medium	All others	\$112,000	1
Low	BEA660	\$581,000	6
Very Low	BEA660	\$252,000	3

6.4 Identified Non-structural (Programmatic) Strategies

Underlying the implementation of structural wetland strategies detailed in this chapter, three programs are identified (Table 24). King County may coordinate with internal and external conservation programs to acquire and preserve identified priority open space lands that align with recommended mitigation of the basin (e.g. wetland mitigation, expansion, and connections; riparian buffer planting). Examples of conservation programs include King County Acquisitions and the Nature Conservancy. King County is pursuing expanded funding via the Land Conservation Initiative (LCI).

A tree-planting incentive program was identified. A potential program could provide private individuals and businesses with incentives (such as SWM fee reduction) and technical assistance to plant trees along degraded wetland perimeters within their property. Coordination with the existing mitigation banking program may also assist with reaching objectives.

A public outreach/education program was identified to improve appreciation of wetlands and desire for landowners to protect or restore them in addition to the other topic areas (stormwater, instream habitat, and riparian corridors). The outreach/education program is detailed in Chapter 8.

Table 24. Non-structural strategies for wetland restoration and conservation. FTE-year: a single year of full-time employee work (one-time). FTE/year: an ongoing year of full-time employee work (continuous).

Strategy	Description	Targeted Metric/Benefit(s)	Discussion	Cost	Jurisdiction
Tree Planting Incentive Program (Also part of riparian strategy)	Develop and implement a program to provide financial assistance, SWM fee discounts/rebates, and /or technical assistance to private property owners to plant trees, especially in the riparian area.	• B-IBI/Flow Flashiness • Stream temperature • Instream habitat • TSS/Turbidity	City of Redmond currently operates a tree-planting incentive program in its jurisdiction. Can leverage King County's One Million Trees Initiative	.25 FTE-year (to develop program) .25 FTE/year (to implement program)	King County
Preservation and Acquisition of high priority open space (Also part of riparian strategy)	Coordinate with internal and external conservation programs to acquire and preserve identified priority open space lands that align with recommended mitigation of the basin (e.g. wetland mitigation, expansion, and connections; riparian buffer planting).	• Wetlands • Riparian corridors Purchase or easement of/on critical properties at a faster pace before further development occurs will ensure that critical mitigation projects can be accomplished.	Examples of conservation programs include KC Acquisitions, Nature Conservancy, etc. KC is pursuing expanded funding via the Land Conservation Initiative (LCI).	.10 FTE/year	King County
Mitigation Banking (Also part of riparian strategy)	Identified wetland and/or riparian projects in the plan use KC existing banking programs as a method of funding critical projects.	• Wetlands • Riparian corridors	This type of program could essentially pay for an identified critical wetland or riparian project by selling mitigation credits to developers in the watershed.	N/A	King County

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7.0 RIPARIAN CORRIDOR STRATEGY IDENTIFICATION AND PRIORITIZATION

This chapter details the strategies for riparian corridor restoration and conservation and their prioritization. The proposed riparian habitat strategies focus on restoring ecologic function throughout the watershed. There is no specific quantitative goal associated with the habitat projects, with the exception of temperature reduction associated with riparian shading (see Chapter 2). The goal is to restore, where feasible, ecologically functioning habitats. The objectives for riparian corridor restoration are (1) to provide stream shading for attaining temperatures within state water quality standards and (2) to provide habitat supportive of aquatic life.

7.1 Structural Riparian Corridor Strategies

The riparian zone or area is the interface between land and a natural body of water. Natural riparian areas provide a wide range of highly valuable ecological functions. Healthy riparian areas are vegetated in native trees and shrubs. They help maintain good water quality by filtering nutrients, sediments, and pathogens before they reach waterways. Healthy riparian areas are important habitats for a wide range of wildlife (Knutson and Naef 1997) and are considered essential for sustaining wild fish populations (Naiman et al. 1993). Healthy riparian areas:

- improve water quality by filtering pollutants
- reduce stream bank erosion
- increase instream shade, which helps water temperatures from increasing, which in turn supports the higher dissolved oxygen levels important to salmonids
- provide a source for the natural recruitment of large wood into streams to create channel complexity needed for salmonid refugia and protection from predators
- provide over-hanging vegetation, a source of food (invertebrates) for juvenile salmonids

Restoration of riparian areas means replacing existing non-native vegetation or other land cover with native trees and shrubs within the riparian corridor. In this Study, the riparian corridor is generally defined as the 165-ft buffer on each side of all streams in the study area with salmonid presence (see King County 2017c). As with wetland vegetation planting, riparian planting costs are variable based on existing conditions. Riparian

planting projects are expected average about \$30,000 per acre¹⁶, not including related property acquisition costs.

7.2 Riparian Corridor Prioritization

Criteria from Cappiella et al. (2006) were adapted to use with riparian and landcover data to prioritize the riparian corridor in the Bear Creek study area for conservation and restoration. Table 25 summarizes the criteria and rationale used to assign a point system for parcels along the riparian corridor. *Appendix D: Prioritization: Riparian Corridor Strategies* provides detail on the methods and point systems used to identify and prioritize lands along the riparian corridor for conservation and restoration.

In the Study, riparian restoration (tree planting) was identified for those areas lacking vegetation along the streams and in public ownership. It is assumed that it will be more feasible to conduct tree planting projects on public lands over private lands.

Riparian conservation was identified for those areas already fully forested and undeveloped as well as those areas adjacent to lands already protected. This approach to land conservation focuses on acquiring and protecting the highest value lands from a stormwater and an ecological perspective. By protecting lands adjacent to lands already in protection, connectivity of conserved lands is increased.

¹⁶ Rehabilitation costs vary widely depending on site conditions and habitat type. Costs vary depending on the amount of site prep required, amount of weeding and watering afterwards, the trees and shrubs and what type they are (stake versus potted plant, and if potted, size of plant), and how many plants installed per acre. Costs also include all labor associated with site prep, planting, monitoring, and maintenance. Difficult site access or other extenuating circumstances can dramatically increase planting costs. Cost estimates can typically range between \$15,000 and \$36,000. \$30,000 is assumed to be a conservative average estimate.

Table 25. Criteria used to develop riparian corridor prioritization scheme.

Category	Criteria	Rationale	Conservation / Restoration?
Condition	No shade/mowed to edge of water	This criteria implicitly includes immediate proximity to stream and so gets a high point value.	Used as criterion for restoration.
	Presence of invasive species	Reed canarygrass is an invasive monoculture that reduces biodiversity and native habitat. Parcels includes areas that lack shade <u>and</u> contain reed canarygrass or Himalayan blackberry, as identified in aerial imagery.	Used as criterion for restoration.
	Area currently forested	No apparent restoration activities are needed; most cost-effective; zero wait time for tree-growth.	Used as criterion for conservation.
Connectivity	Along the Wildlife Habitat Network (WHN)	Trees planted here contribute to vegetated wildlife corridors.	Used as criteria for both conservation and restoration.
	Adjacent to public, Tract, and HOA parcels	Parcels adjacent to parcels that are already protected increase the contiguously protected area and may fill in gaps in protected areas.	Used as criterion for conservation.
Location in watershed	Along headwater streams, defined as first-order streams.	Trees planted along the stream here help contribute to lower water temperatures at the stream's source.	Used as criteria for both conservation and restoration.
	Where water temperature exceedances are known to occur.	Trees planted here help to lower or at least maintain water temperatures.	Used as criterion for restoration.
	Along Chinook-bearing waters	Trees planted here will eventually contribute to large wood in the streams.	Used as criteria for both conservation and restoration.
Development pressure	Parcels are not currently subdivided as small as they may be.	Parcels that are not currently subdivided as small as they may be.	Used as criterion for conservation.
Special designation	Identified in wetland analysis (King County, 2017d) or King County Land Conservation Initiative (which includes salmon recovery priorities).	Assumes that if there are multiple values associated with preservation versus only one conservation target, parcel is more valuable from a conservation standpoint.	Used as criterion for conservation.
Feasibility	On public land.	This criteria gets a high point value because of presumed agency cooperation	Used as criterion for restoration.

7.3 Identified Structural Strategies

The strategies for riparian corridor preservation and restoration are based on both the output of the parcel-scale riparian analysis described in Section 7.2 and the output of the HSPF model indicating the shading necessary to meet state temperature standards (King County, 2018). The parcel-scale analysis in Section 7.2 was completed for salmon-bearing streams, whereas the modeled shade analysis in the Modeling Report (King County, 2018) included all flowing surface waters in the study area. In salmon-bearing streams, a 165-foot buffer was evaluated to provide shading and habitat.

It should be noted that even if riparian corridors were fully restored to forested conditions, the results of the modeling indicated that state water quality standards for temperature are anticipated to be exceeded (King County, 2018). Further analyses of microclimate benefits from fully forested conditions and increasing groundwater infiltration, and thus baseflows with cooler temperatures, are recommended to better determine methods for lowering stream temperatures.

7.3.1 Restoration strategies

In the study area, a total of approximately 316 acres of riparian area spread across 371 parcels are identified that would benefit from tree planting (Table 26). These areas lack trees either along the stream channel or in the regulated riparian buffer. The calculated area is approximate and would need to be verified on a site-by-site basis.

Table 26. Acres of riparian corridors prioritized for restoration by jurisdiction and ownership. Public indicates areas that are fully or partially on public lands.

Jurisdiction	165-ft Habitat and Shade Buffer (Salmon-Bearing Streams)		
	Public	Private	Total
King	83	141	224
Snohomish	31	19	50
Redmond	25	10	35
Woodinville	0	7	7

Prioritization of parcels in the 165-ft buffer was accomplished by applying the criteria and associated points described in Table 25 and *Appendix D – Prioritization: Riparian Corridor Strategies* and then summing the points per parcel to score the 371 parcels. Riparian restoration parcels were ranked based on their scores, where:

- High = 90-120 points
- Medium = 70-80 points
- Low = 20-60 points
- Very Low = 0-10 points

Parcels that scored only 0 or 10 points are assumed to not be a priority for 165-ft buffer restoration (59 parcels scored 0 or 10 points). Parcels that scored at least 20 points for riparian restoration (tree planting), by partner jurisdiction are:

- King County – 262 parcels; points ranging from 20 to 120
- Redmond – 20 parcels; points ranging from 20 to 100
- Snohomish County – 13 parcels; points ranging from 20 to 60
- Woodinville – 16 parcels; points ranging from 20 to 80
- WSDOT – 1 parcel; 100 points

Some parcels were examined but not ranked. Parcels that were fully vegetated are classified as “Vegetated.” Parcels whose riparian buffers were constructed because of houses or other development but whose remaining riparian buffer was vegetated are classified as “Vegetated small buffers.”

The cost of tree-planting was assumed to average \$30,000 per acre, not including any land acquisition costs. The cost of restoring salmon-bearing stream riparian corridors on public lands is estimated to be \$4.2 million (\$2.5 million for King County; \$930,000 for Snohomish County; \$750,000 for City of Redmond; and \$0 for City of Woodinville). The private lands are identified to be targeted through an incentive program (see Section 7.4). The total cost to restore riparian corridors on private lands is estimated to be \$5.3 million. These costs include areas of riparian corridor that are ranked low or very low.

7.3.2 Conservation strategies

A total of 741 parcels in the 165-ft salmon-bearing stream riparian corridor were ranked for conservation priority, including:

- 128 undeveloped privately owned parcels (71 forested, 54 associated with wetlands, and 3 in non-native vegetation)
- 498 developed residential parcels that might be candidates for conservation easements or partial acquisition because they contain stream or stream buffer
- 115 developed residential parcels denoted as having limited options; typically these parcels are better candidates for tree planting/restoration than conservation, as they are smaller, developed parcels that did not score highly
- 59 undeveloped parcels are directly adjacent to publicly owned parcels

Publicly owned parcels, TRACT parcels, and Home Owners Associations (HOA) parcels were not considered for land conservation because they are already publicly owned or otherwise conserved.

Potential conservation parcels were put into one of the following categories:

- *Undeveloped*: Undeveloped parcels may be covered in forest, wetland, shrub, or grass.
- *Potential Easement*: development is present on some portion of the parcel as well as some portion of the riparian corridor.

- *Limited Options*: Parcels with riparian corridors reduced in size and constrained by roads, driveways, or buildings.

Prioritization ranking was accomplished by applying the criteria and associated points described in *Appendix D – Prioritization: Riparian Corridor Strategies* and then summing the points per parcel to score the 741 parcels. Riparian conservation parcels were ranked as high, medium, low, and very low, where:

- High = 100 to 140 points
- Medium = 70 to 90 points
- Low = 20 to 60 points
- Very Low = 0 to 10 points

Parcels that scored 0 or 10 points are assumed to be a very low priority for conservation. Of the 741 parcels that were scored, 524 scored at least 20 points for conservation. The 524 parcels are spread across the partner jurisdictions:

- King County – 444 parcels; points ranging from 20 to 140
- Redmond – 16 parcels; points ranging from 20 to 110
- Snohomish County – 48 parcels; points ranging from 30 to 120
- Woodinville – 16 parcels; points ranging from 20 to 100

Of the 741 parcels, 115 were identified as “Limited Options.” Of those parcels, 40 scored between 0 and 30 points and are included in their respective low and very low categories. The remaining 75 limited options parcels scored a negative number (from -10 to -30). Those 75 parcels are identified as “Limited Options,” and no action was identified for those parcels.

Undeveloped parcels are candidates for acquisition or easement; cost analyses assume acquisition. “Potential easement” parcels are assumed to be candidates for easements and not acquisitions, though there may be some circumstances when a developed parcel is purchased and any structures demolished. Parcels categorized as “Limited Options” were considered for easements when they scored low and very low.

Costs of acquisition were calculated by first obtaining the combined assessed land value and assessed improved value (value of improvements, such as houses) from King County parcel data and the combined market land value and market improved value from the Snohomish County parcel data. Next, a multiplier of 115 percent¹⁷ was applied to those values to account for the difference between the assessed value and appraised value. Costs of easements were calculated by taking the assessed land value from King County parcel data and the market land value from the Snohomish County data and using a multiplier of

¹⁷ 15 percent is added to the assessed value because appraisals were running higher than assessed value by about 15 percent in 2015 and 2016.

40 percent¹⁸. Easement calculations assumed less than half the parcel would be put in easement.

Costs for acquisition for each partner jurisdiction are presented in Table 27. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total costs for acquisition in priority basins and remaining High and Medium ranked parcels would be \$31,750,000.

Table 27. Cost estimates for all 128 parcels identified for potential acquisition. Priority catchments described in Section 4.2 are identified separately.

Prioritization Ranking	Catchment	Cost	number of parcels
King County			
High	BEA300	\$43,000	1
High	All others	\$10,087,000	28
Medium	All others	\$13,060,000	50
Low	BEA120	\$1,044,000	3
Low	BEA300	\$32,000	1
Redmond			
High	All others	\$1,611,000	1
Medium	All others	\$145,000	2
Snohomish County			
High	BEA640	\$363,000	1
High	BEA660	\$1,179,000	4
Medium	BEA660	\$572,000	3
Medium	All others	\$1,535,000	6
Low	BEA660	\$281,000	2
Woodinville			
High	BEA850	\$292,000	1
Medium	BEA850	\$1,114,000	2
Medium	All others	\$394,000	1

Costs for easements for each partner jurisdiction are present in Table 28. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total costs for easements in priority basins and remaining High and Medium ranked parcels would be \$29,230,000.

¹⁸ 40 percent assumes the following: (a) the amount of the parcel that would be placed under easement would be less than 50 percent and more than 1 percent, and 25 percent is the average between 1 and 50, and (b) 15 percent is added to the 25 percent to account for the difference between assessed value and appraised value.

Table 28. Cost estimates for all 538 parcels identified for potential easements. Priority catchments described in Section 4.2 are identified separately.

Prioritization Ranking	Catchment	Cost	number of parcels
King County			
High	All others	\$590,000	1
Medium	All others	\$16,389,000	41
Low	BEA120	\$3,125,000	6
Low	BEA300	\$1,571,000	5
Very Low	BEA120	\$1,710,000	8
Snohomish County			
Medium	BEA660	\$444,000	2
Low	BEA640	\$201,000	1
Low	BEA660	\$3,058,000	17
Very Low	BEA660	\$624,000	4
Woodinville			
Low	BEA850	\$1,521,000	5

7.4 Identified Non-structural (Programmatic) Strategies

Underlying the implementation of structural wetland strategies detailed in this chapter, three programs were identified (Table 29). King County may coordinate with internal and external conservation programs to acquire and preserve identified priority open space lands that align with recommended mitigation of the basin (e.g. wetland mitigation, expansion, and connections; riparian buffer planting). Examples of conservation programs include King County Acquisitions and the Nature Conservancy. King County is pursuing expanded funding via the Land Conservation Initiative (LCI).

A tree-planting incentive program was identified. A potential program could provide private individuals and businesses with incentives (such as SWM fee reduction) and technical assistance to plant trees degraded wetland perimeters within their property. Coordination with the existing mitigation banking program may also assist with reaching objectives.

A public outreach/education program was identified to improve appreciation of riparian corridors and desire for landowners to protect or restore them in addition to the other topic areas (stormwater, instream habitat, and wetlands). The outreach/education program is detailed in Chapter 8.

Table 29. Non-structural riparian strategies. FTE-year: a single year of full-time employee work (one-time). FTE/year: an ongoing year of full-time employee work (continuous).

Strategy	Description	Targeted Metric/Benefit(s)	Discussion	Cost	Jurisdiction
Tree Planting Incentive Program (Also part of wetland strategy)	Develop and implement a program to provide financial assistance, SWM fee discounts/rebates, and /or technical assistance to private property owners to plant trees, especially in the riparian area.	• B-IBI/Flow Flashiness • Stream temperature • Instream habitat • TSS/Turbidity	City of Redmond currently operates a tree-planting incentive program in its jurisdiction. Can leverage King County's One Million Trees Initiative	.25 FTE-year (to develop program) .25 FTE/year (to implement program)	King County
Preservation and Acquisition of high priority open space (Also part of wetland strategy)	Coordinate with internal and external conservation programs to acquire and preserve identified priority open space lands that align with recommended mitigation of the basin (e.g. wetland mitigation, expansion, and connections; riparian buffer planting).	• Wetlands • Riparian corridors Purchase or easement of/on critical properties at a faster pace before further development occurs will ensure that critical mitigation projects can be accomplished.	Examples of conservation programs include KC Acquisitions, Nature Conservancy, etc. KC is pursuing expanded funding via the Land Conservation Initiative (LCI).	.10 FTE/year	King County
Mitigation Banking (Also part of wetland strategy)	Identified wetland and/or riparian projects in the plan use KC existing banking programs as a method of funding critical projects.	• Wetlands • Riparian corridors	This type of program could essentially pay for an identified critical wetland or riparian project by selling mitigation credits to developers in the watershed.	N/A	King County

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8.0 OTHER NON-STRUCTURAL (PROGRAMMATIC) STRATEGIES

Chapters 4 to 7 present some non-structural strategies to meet the watershed goals and objectives detailed in Chapter 2. In addition to those, Table 30 describes non-structural strategies that are not specific or unique to stormwater, instream habitat, riparian corridors, or wetland. These strategies are expected to accelerate and track the rate at which the watershed goals and objectives are achieved.

Table 30. Programmatic (non-structural) strategies. FTE-year: one discrete year of full-time employee work. FTE/year: one year of ongoing FTE work.

Strategy	Description	Targeted Metric/Benefit(s)	Discussion	Cost	Jurisdiction
Monitoring and Assessment Management Program (Chapter 10)	Develop and implement plan for monitoring targeted metrics (i.e., B-IBI, water quantity and quality) in the watershed.	Provides information for adaptive management. Provides info for effectiveness of BMPs.	Monitoring is critical to adaptive management and measuring success.	.25 FTE-year (to develop plan) .25 FTE/year (to manage plan) \$100K per year ongoing.	King County <i>Cost-Sharing:</i> Snohomish County City of Redmond City of Woodinville
Public Outreach/Engagement/Training	Develop and implement a public education and outreach program that trains and supports local community members to effectively participate and impact the Study goals. Education/training may include addressing source control of pollutants; natural yard care; operation and maintenance of onsite structural BMPs; importance of shaded streams, etc. The program will include methods to connect the community to funding and NGOs that support small projects, volunteer stream monitoring, etc.	Public education and perception of water quality leading to behavior/practices that result in improved water quality in the stream system and stewardship.	There are many potential public and NGO partners, e.g., the King Conservation District, King County Lake Stewardship Program. A robust sampling program through a Stream Steward program can provide critical data for tracking water quality over time.	.25 FTE-year (to develop program) .25 FTE/year (to implement program)	King County <i>Cost-Sharing:</i> Snohomish County City of Redmond City of Woodinville

Strategy	Description	Targeted Metric/Benefit(s)	Discussion	Cost	Jurisdiction
Bear Creek Watershed Website and Watershed Committee Coordination	Set up and manage a clearing house/ informational webpage that connects interested parties in the watershed. The page will inform on ongoing monitoring, capital projects, collaborative and funding opportunities, ongoing programs, progress on implementation, contact information, volunteer events, and organizations that contribute to watershed restoration goals.	No direct impact on environmental quality.	The website will provide program transparency and useful for tracking Study progress.	.25 FTE/year (ongoing) .05 FTE/year for Partner jurisdictions	King County <i>Participatory Only:</i> Snohomish County City of Redmond City of Woodinville

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9.0 POTENTIAL IMPLEMENTATION FRAMEWORK

The implementation of the identified suite of strategies would require a concerted effort among many governmental and non-governmental entities. Because of the long-term nature of this Study, the establishment of an ongoing organizational structure to oversee, secure funding for, monitor, document, and, as needed, modify the Study is suggested. A structure that will support the scope of project work and effectively involve necessary partners is recommended. The implementation framework may build upon the framework established in the development of the Study and other existing relationships. A potential organization structure is as follows:

There are two key elements of the identified potential watershed management organization:

- **Bear Creek Watershed Coordinator** – a full-time employee
- **Bear Creek Watershed Committee** – an inter-organizational network composed of the Watershed Coordinator and self-appointed representatives from the City of Redmond, City of Woodinville, King County, Snohomish County, and WSDOT.

The role of Watershed Coordinator may include the coordination of the following activities:

- Facilitation of Watershed Committee meetings twice per year
- External partner engagement and coordination, including but not limited to:
 - watershed residents and businesses,
 - Washington State Department of Ecology,
 - Washington State Department of Fish and Wildlife,
 - environmental and salmon recovery groups,
 - WRIA 8 Salmon Recovery Council, and
 - the Muckleshoot Indian Tribe Fisheries Division
- Initiation and coordination of a monitoring program
- Identification and promotion of potential multi-objective (e.g., water quality and habitat) projects
- Program and policy development
- Grant application and management
- Management of staffing
- Tracking and public reporting of status
- Publication of annual reports summarizing activities
- Publication of 5-year Study effectiveness reports

- Publication of 10-year Study updates

The Watershed Committee may be responsible for the following:

- Coordinating implementation of the Study and other actions with the Watershed Coordinator and partner jurisdictions
- Reviewing and approving of program documents and Study updates

The WRIA 8 Salmon Recovery Council may be a key partner in the successful implementation of the Study. The WRIA 8 Council is composed of

- elected representatives from 26 local cities and two counties (King and Snohomish),
- concerned citizens,
- scientists, and
- representatives from environmental interests and state agencies.

The WRIA 8 Council coordinates the implementation of the Chinook Salmon Conservation Plan within the WRIA 8 basin (which includes the Bear Creek study area). The focus of WRIA 8 is the recovery and conservation of Chinook salmon. The goals of the Study align well with the goals of WRIA 8 but with a greater focus on stormwater management and wetlands.

The Watershed Coordinator may represent Bear Creek interests on the WRIA 8 salmon recovery council with regards to existing programs and rule/policy changes and updates. These include, but are not limited to, transfer of development rights program, land conservation programs, and comprehensive plan updates. The Watershed Coordinator is encouraged to provide comments and assist in making connections that align with watershed goals.

Several of the non-structural programs identified in Chapters 4 through 8 are may be the responsibility of the Watershed Coordinator. Table 31 provides a breakdown of the Watershed Coordinator's potential one-time (discrete) responsibilities, such as plan/policy development, and potential ongoing responsibilities, such as program management. As funding is secured, programs expanded, and staffing added, it is anticipated that these responsibilities would be reassigned within the program team.

Table 31. Watershed coordinator one-time and ongoing responsibilities and time commitment.

	Responsibility	Time (Year-Fraction)
(0-5 years) One-time	LID/ Flow Control BMP incentivization/ technical assistance program for private properties.	0.50
	Policy Changes: • In-Lieu Fee Program, and • Flow Transfer Program Feasibility Study	0.75
	Tree Planting Incentive Program Development	0.25
	Monitoring and Assessment Management Plan (MAMP) Development (See Chapter 10 - Measuring Progress and Success)	0.25
	Agricultural BMP Incentive Program Evaluation	0.25
	Public Engagement Plan	0.25
	Total	2.25
Ongoing	Program administration, status reports, staff oversight, and grant management	0.15
	Preservation and Acquisition coordination	0.10
	MAMP Management and Reporting	0.25
	Bear Creek Watershed Website and Watershed Committee coordination	0.25
	Public Engagement	0.25
	Total	1.00

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10.0 ADAPTIVE MANAGEMENT AND MEASURING PROGRESS AND SUCCESS

There are many projects and programs identified by the Study that would support the achievement of the watershed goals outlined in Chapter 2 based on the best available science. The effectiveness of these projects and programs in achieving watershed goals and objectives is important information for managers. An adaptive management framework is recommended for implementation. The framework is recommended to utilize a monitoring program to evaluate strategy effectiveness and inform future Study updates.

10.1 Adaptive Management

The Study recommends an adaptive management framework for implementation. Adaptive management is a systematic process for improving future management actions by learning from the outcomes of implemented actions. Figure 16 depicts the cycle of adaptive management. The figure shows both a series of specific activities and arrows that indicate the importance of establishing purposeful and explicit connections between the activities – each action informs the next action. Undertaking actions that address the individual activities without giving similar consideration to the connections between them will lead to ineffective or inefficient Study implementation.

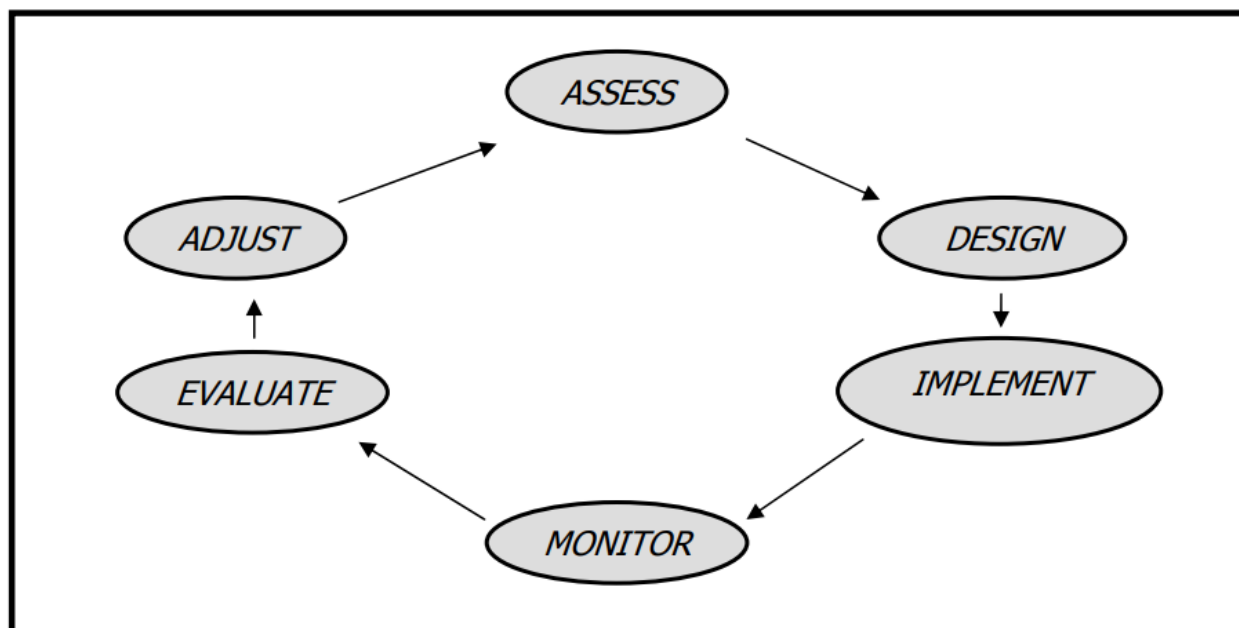


Figure 16. Adaptive management framework.

Effective implementation of the Study requires adaptive management. The major steps of an adaptive management cycle are to:

1. **Assess** - Identify goals and objectives
2. **Design** - Plan actions for achieving identified goals and objectives and plan monitoring
3. **Implement** – Construct structural projects and implement programs
4. **Monitor** – Measure implementation (actions taken), project effectiveness (individual results), and overall effectiveness (cumulative results)
5. **Evaluate** - Analyze data and use results to adapt assumptions and approach
6. **Adjust** – Adjust project and program designs based on evaluated data

This Study represents the initial assessment and design for the Bear Creek study area. The Study recommends a monitoring program (see Section 10.2) that will track implemented projects and programs and measure degree of success. Implementation of the Study is recommended to be adaptively managed by linking monitoring and new and emerging information to decision-making through reports and presentations to the Watershed Committee and stakeholders, and through specific recommendations from the Watershed Coordinator. The 5-year Study effectiveness reporting provides opportunity for evaluating effectiveness. The 10-year Study updates are recommended to use these evaluations and partner and stakeholder feedback to adjust strategies to more efficiently and effectively work towards meeting watershed goals.

The Study has identified long-term goals in Chapter 2. For the purposes of adaptive management, interim, short-term (5 to 10 year) strategy-specific objectives with quantitative elements may be developed as part of the monitoring plan (see Section 10.2). Assessing whether these short-term objectives are met would assist in determining overall effectiveness and the need to make changes in implementation strategy.

10.2 Monitoring and Assessment Management Plan

Monitoring and evaluation are crucial components of adaptive management. In the first year of implementing this Study, it is recommended a Monitoring and Assessment Management Plan (MAMP) be developed. The MAMP can track Study actions, effectiveness, and outcomes. There are three types of monitoring necessary to track the progress and success of the Study: implementation monitoring, effectiveness monitoring, and cumulative effectiveness monitoring (Table 32). Development of the MAMP will include any relevant existing monitoring efforts that support the MAMP needs. It may be necessary to revisit the objectives of the current monitoring programs and, if possible, modify to meet the multiple objectives.

Table 32. Monitoring plan elements for the MAMP.

Monitoring Type	Central Question(s)	Example Measures of Success
Implementation monitoring	• What strategies and actions have been carried out as recommended? • Are strategies and actions being implemented on schedule?	• Number of stormwater facility retrofits • Percent of impervious area with flow control • Acres of wetland preserved • Number of LID BMPs installed through incentive program • Number of trees planted • Acres of riparian area planted • Grants awarded
Project/ program effectiveness monitoring	• Are the strategies and actions working as intended (i.e., did the activity have the desired effect)?	• Increase in habitat quantity, quality, and connectivity as well as increased salmonid use following instream habitat projects • Temperature changes of stream following increase in shade • Public stewardship program involvement and participants • Pollutant reduction from public outreach campaign
Cumulative effectiveness monitoring	• Are watershed conditions improving? • Is the strategy progressing towards its goals?	• Surface water quality (fecal coliform, metals) adherence to state standards • Improved B-IBI scores • Decreased stream flashiness • Acres of high-quality wetlands • Ongoing stakeholder/ resident engagement • Cumulative increases in habitat quantity, quality, and connectivity as well as improved salmon abundance, productivity, and diversity

The watershed website (clearinghouse), as mentioned in Table 29 in Chapter 8, may be a tool for assisting with implementation monitoring. The development and management of a public website is recommended. The content of the website may be populated with project information and status updates provided by the watershed partners. Information on structural and non-structural strategies/actions that have been implemented is recommended to both be tracked internally and be made publicly available.

Some of the non-structural (and some structural) stormwater BMPs and habitat projects do not have quantified effectiveness data. For strategies and actions lacking published effectiveness data, monitoring and evaluation is recommended to be undertaken as strategies and actions are implemented over time. By tracking the effectiveness of individual projects and programs, future decisions and actions can be better informed. Knowledge of past successes and problems can lead to more cost-effective and substantial improvements to the Bear Creek watershed.

The cumulative effectiveness monitoring element of the MAMP may aim to track the collective, medium- to large-scale impacts of the Study actions and strategies. This monitoring component can evaluate whether the suite of implemented projects and program are resulting in a measurable improvement in Bear Creek habitat and water quality. The purpose of the monitoring is to answer if the Study is on track to meet its watershed goals and management objectives.

In the development of the MAMP, it is recommended that existing resources and monitoring programs that may be utilized be evaluated. For example, King County WLRD maintains several long-term water quality monitoring stations and flow/temperature gages in the Bear Creek watershed. These stations can be used to assess cumulative effectiveness of water quality and flow projects implemented within their drainages. However, there are gaps in the existing program and additional monitoring may be recommended in streams currently lacking a monitoring station.

The measures of success within the MAMP are recommended to align with the goals and management objectives defined in Chapter 2. For the purposes of adaptive management, it is recommended that interim, short-term (5 to 10 year) goals with quantitative elements be developed. Assessing whether these short-term goals are met can assist in determining Study effectiveness and the need to make changes in Study implementation.

The MAMP is estimated to cost approximately \$100,000 per year on average for multi-metric monitoring. This cost is in addition to the existing routine stream monitoring program, which has two stations in the study area (these two stations annually cost approximately \$3,000 each for monthly water quality monitoring). The \$100,000 estimate is based on the cost of additional monitoring completed for this Study, which included water quality, fish use, instream habitat, riparian, and wetland assessments. Costs will vary year-to-year depending on the type and frequency of monitoring undertaken. For example, an intensive fish habitat survey may be undertaken every 5 or 10 years, resulting in a high short-term cost, whereas stream temperature monitoring can be an ongoing, lower cost. The MAMP, when developed, would have more detailed cost estimates of the plan and its components. The Partners may complete monitoring within their individual jurisdiction or contribute funding to watershed-wide monitoring.

10.3 Timeline for Reporting and Evaluation

Reporting of activities and their effectiveness may be done to inform adaptive management decisions. The reports are recommended to follow a predictable timeline that remains current to decision-making. The following are the initial recommendations for such a timeline.

- **Annually:** Publish report summarizing the Study activities undertaken over the course of the year.
- **Every 5 years:** Public report assessing the Study effectiveness including:
 - A high-level summary suitable for policy-makers

- Summary of projects completed since the start of implementation and in-progress
- Summary of monitoring data collected to date
- Identification of important data gaps
- Breakdown of funding sources and amounts
- Recommendations for adaptive management
- **Every 10 years:** Publish updated management strategy incorporating analyzed monitoring data and lessons learned over past 10 years.

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11.0 POTENTIAL NEAR-TERM ACTIONS SCHEDULE AND BUDGET

The Study has identified a potential suite of strategies that if implemented would result in achieving the targets for instream flow metrics and water quality as defined in the Permit. The Study has also identified several instream, riparian, and wetland habitat improvement strategies. This chapter identifies the schedule and provides cost estimates for the near-term strategies if they were to be implemented. Specificity on the mid-term and long-term actions can be found in Appendix G.

The schedule and budget below is organized by near-term actions within each of the partner jurisdictions. The long-term nature of the watershed management stresses the importance of adaptive management to better track, handle, and incorporate new information. The results of the near-term actions may be used to inform future management decisions in Bear Creek and elsewhere.

The budgets detailed in this chapter represent costs associated with additional projects and programs on top of those already in place. This is useful for defining the level of additional funding that would be needed if projects and programs were fully implemented to meet watershed goals.

11.1 Schedule of Potential Near-term Actions

The identified schedule and cost for implementing the Study is summarized in Tables 33 to 36 for the respective partner jurisdictions: King County, Snohomish County, City of Redmond, and City of Woodinville.

The time horizon for near-term actions is the 10 years following the finalization of the Study. Following the finalization of the Study, King County may hire the Watershed Coordinator, if funding is secured. The Watershed Coordinator could then begin the development, implementation, and funding of the non-structural programs detailed in Chapters 4, 5, 6, 7, and 8 within the first five years. Early enactment of the programs will secure the greatest ongoing, long-term benefits for the watershed. These programs are less costly than structural projects, do not require substantial ongoing maintenance, and are expected to grow and expand over the Study timeline.

In the second five years of the near-term phase, King County could focus on coordinating the implementation of instream habitat, riparian, and wetland projects and stormwater projects associated with the prioritized catchments such as:

- Completing stormwater projects in two of the five prioritized King County stormwater catchments (or catchment groups) via new facilities and retrofits.
- Completing ten percent of the higher priority instream habitat projects.

- Planting trees on half (50 percent) of the prioritized riparian corridors and all wetlands located on public land in unincorporated King County during the near-term.
- In addition, the tree planting incentive program, one of the nonstructural programs implemented immediately, may be conservatively expected to result in planting on five percent of the privately-owned parcels identified for riparian and wetland restorations in the near-term.

The City of Redmond plans to implement its Monticello Creek Watershed Restoration Plan, which is expected to take place over a 60-year period. That plan's goals and objectives are strongly aligned with the goals and objectives of the Study. The City of Redmond may continue implementing its tree planting incentive program and focus on planting in the riparian corridor.

Snohomish County may focus on constructing new stormwater facilities and retrofits in the two of the five prioritized catchments (or catchment groups) during the near-term.

The City of Woodinville may focus on constructing new stormwater facilities and retrofits in the one of the three prioritized catchments. The city may develop a tree planting incentive program during the last five years of the near-term.

In the tenth year of implementation, the Study may be updated. The update process could be led by the Watershed Coordinator. The update is advised to include the assessment of the effectiveness of past actions, including an evaluation of to what degree stormwater projects have improved conditions in the priority catchments. The HSPF and SUSTAIN models may also be updated with the most recent environmental data and in consideration of the actions completed through the programs implemented during the near-term phase. Riparian and wetland change analysis and instream habitat condition and fish use analysis could be done to identify and reprioritize projects. The update can recommend adaptive management that are expected to result in a more effective and efficient method for meeting the Study's goals. The updates may consider climate change impacts on storm event intensity and stormwater facility sizing.

The schedule and budget for the implementation of potential mid- and long-term actions is presented in Appendix G.

Table 33. King County Watershed Study potential near-term actions if implemented.

Category	Description	Near-term Action (Years 1-10)
Program	Public Engagement/ Education Program	Develop Public Engagement/ Education Program
		\$100,000 over 2 years
	LID Incentive Program	Develop LID Incentive Program
		\$100,000 over 2 years to develop \$2M/year over 5 years to implement
	In-lieu fee Program	Develop In-lieu fee Program
		\$100,000 over 2 years
	Monitoring and Assessment Management Plan	Develop Monitoring Plan
		\$50,000 over 2 years
	Tree Planting Incentive Program	Tree Planting Incentive Program
		\$50,000 over 2 years
	Fish Passage Study	Complete Inventory of Fish Barriers
		\$100,000 over 2 years
Structural Projects	Construct Stormwater Facilities	Build new facilities in priority catchments
		\$846,000/year
	Evaluate and Optimize Existing Stormwater Facilities	Evaluate/optimize in priority catchments
		No Additional Cost
	Instream Habitat Projects	Construct high priority projects
		\$343,000/year over 5 years
	Riparian Restoration	Acquire/ease and preserve high priority areas
		\$91,000/year over 5 years
	Wetland Restoration	Acquire/ease and preserve high priority areas
		\$19,000/year over 5 years
Studies, Analyses	Flow Transfer Program (Done in First 5 Years)	Study program feasibility
		\$50,000 over 2 years
	Agricultural BMP Program	Assess existing regulation and incentive programs
		\$50,000 over 2 years

Category	Description	Near-term Action (Years 1-10)
	Fecal Bacteria Source Tracking Study	Follow-up IDDE work for TMDL by King County SWS
		\$60,000/year over 5 years
Watershed Coordination and Strategy Administration	Program Management	Watershed Coordinator holds Committee meetings, prepares reports, oversees grants, and supervises staff
		\$30,000/year
	Update Watershed Study	Update every 10 Years
		\$200,000

All costs are in 2017 dollars, no discount or inflation rate applied.

Table 34. Snohomish County Watershed Study potential near-term actions if implemented.

Category	Description	Near-term Action
Structural Projects	Construct Stormwater Facilities	Build new facilities in priority catchments
		\$1.9M / year
Studies and Analyses	MAMP (or equivalent)	Monitor and Evaluate Results
		\$9,000 / year last 5 years
Watershed Coordination and Strategy Administration	Watershed Committee Participation	Participate in bi-annual watershed committee coordination meetings
		\$10,000 / year
	Update Watershed Study	Update every 10 Years
		\$9,000

All costs are in 2017 dollars, no discount or inflation rate applied.

Table 35. City of Redmond Watershed Study potential near-term actions if implemented.

Category	Description	Near-term Action
Structural Projects	Construct Stormwater Facilities	Complete Monticello Creek Restoration Plan
		\$7.3M / year
Implement Programs	Tree Planting Program	Plant trees on willing private property
		\$7,000 / year
Studies and Analyses	MAMP (or equivalent)	Monitor and Evaluate Results
		\$10,000 / year (last 5 years)
Watershed Coordination and Strategy Administration	Watershed Committee	Participate in bi-annual watershed committee coordination meetings
		\$10,000 / year
	Update Watershed Study	Update every 10 Years
		\$10,000

All costs are in 2017 dollars, no discount or inflation rate applied.

Table 36. City of Woodinville Watershed Study potential near-term actions if implemented.

Category	Description	Near-term Action
Structural Projects	Construct Stormwater Facilities	Build new facilities in priority catchments
		\$500,000 / year
	Tree Planting Incentive Program	Program Development
		\$19,000 / year last 5 years
Studies and Analyses	MAMP (or equivalent)	Monitor and Evaluate Results
		\$6,000 / year
Watershed Coordination and Strategy Administration	Watershed Committee	Participate in bi-annual watershed committee coordination meetings
		\$10,000 / year
	Update Watershed Study	Update every 10 Years
		\$6,000 / year

All costs are in 2017 dollars, no discount or inflation rate applied.

11.2 Summary of Estimated Near-term Costs

Table 37 summarizes the estimated costs of the Study's elements during the near-term phase of the Study if the recommendations were fully implemented. Cost estimates are based on the best available information for instream habitat project costs (\$3M per mile), tree planting costs (\$30K per acre), stormwater structural strategy (construction, maintenance, and replacement) costs, property acquisition costs, and program management costs.

Table 37. Watershed Study near-term budget summary.

Jurisdiction	Expense Type	Cost Incurred by Juris. or Private Indiv./Entity	Near-Term Actions (\$M) (Year 1-10)
King County	Capital	Private	\$0.55
		Public	\$7.91
	O & M	Private	\$0.23
		Public	\$0.09
	Habitat	Public	\$3.22
	Programs		\$2.57
	Studies		\$1.05
	Acquisitions		\$8.39
	Total Private		\$0.78
	Total Public		\$21.23
Snohomish County	Capital	Private	\$0.76
		Public	\$18.36
	O & M	Private	\$0.16
		Public	\$0.12
	Habitat	Public	\$1.32
	Programs		\$0.11
	Acquisitions		\$9.22
	Total Private		\$0.93
	Total Public		\$29.13
	Redmond	Capital	Private
Public			\$19.44
O & M		Private	\$0.16
		Public	\$0.10
Habitat		Public	\$0.05
Programs			\$0.16
Acquisitions			\$0.00
Total Private			\$54.62
Total Public		\$19.76	
Woodinville	Capital	Private	\$0.25
		Public	\$4.79

Jurisdiction	Expense Type	Cost Incurred by Juris. or Private Indiv./Entity	Near-Term Actions (\$M) (Year 1-10)	
	O & M	Private	\$0.04	
		Public	\$0.05	
	Habitat	Public	\$0.09	
	Programs		\$0.34	
	Acquisitions		\$4.06	
	Total Private		\$0.30	
	Total Public		\$9.33	

ALL PARTNERS	Capital	Private	\$56.02
		Public	\$50.50
	O & M	Private	\$0.59
		Public	\$0.36
	Habitat	Public	\$4.68
	Programs		\$3.18
	Studies		\$1.05
	Acquisitions		\$21.67
	Total Private		\$56.63
	Total Public		\$81.45

Public: Cost incurred by public institutions

Private: Cost incurred by private developers, firms, or individuals

All costs are in 2017 dollars, no discount or inflation rate applied.

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12.0 FUNDING STRATEGY

To successfully fulfill the goals of the Study, additional funding would be needed beyond what is currently invested in the watershed. Additional funding may be pursued from a variety of local, state, federal, and private sources and through collaboration with complementary efforts in the watershed.

If fully implemented, the estimated public cost to perform the identified near-term actions over the ten year period is \$81 million across the partner jurisdictions. These near-term actions are targeted in a subset of the 26 square mile study area. As a point of comparison, the annual SWM utility fee revenues for the municipalities that developed this Study is approximately \$67 million for a service area that is over 1800 square miles. Each of the municipalities currently allocates SWM revenues to a variety of projects and programs that are required by NPDES permits and other state and federal regulations. In order to implement the identified full suite of strategies, a substantial level of funding would need to be secured.

The jurisdictions would need to aggressively apply for and secure grants and/or increase revenues through fee increases. During the initial years of implementation, in addition to program development, staff may focus on securing funding for additional staffing to manage aspects of the Study (e.g., public engagement) and to apply for grants.

Tables 38 to 41 list the additional funding that may be pursued from a variety of local, state, federal, and private sources, respectively. When possible, the amount of accessible funds for these sources is provided. In many cases, however, the level of funding from a source varies from year to year. The funding sources are often dedicated to certain types of projects or programs. Dedicated staff time would be required to coordinate identifying and attaining funding for ongoing and capital projects/programs.

One of the non-structural (programmatic) strategies for King County represents potential funding mechanisms. An in-lieu fee program may be used to transfer funds from development projects where on-site stormwater management BMPs are not feasible. King County would use the revenue to fund stormwater mitigation and habitat projects in the watershed.

Table 38. Potential Local Funding Sources

Fund/ Grant Name	Funding Source (Agency)	Description	Total Accessible Funds
Surface Water Management (SWM) Service Fees	King County Snohomish County City of Woodinville City of Redmond	Each jurisdiction is required by state and federal law to provide surface water management services to address problems impacting local water bodies such as erosion, flooding, and increased water temperatures, habitat degradation, and low stream flows. In order to pay for these services, property owners pay an assessed SWM fee. SWM fees support several ongoing as well as new efforts across the region. Some of these efforts include; • mapping stormwater conveyance systems, • increasing habitat restoration projects, • managing stormwater assets, • maintaining and replacing aging stormwater infrastructure, • improving conditions of stormwater flow control structures, and • addressing chronic drainage and flooding management issues.	The total amount accessible cannot be estimated. Funds may be allocated from existing Service Fees OR A fee increase may be imposed to partially cover implementation
Urban Growth Area (UGA) Service Charges	Snohomish County	Under the authority of RCW 36.89, UGA service charge rates are specified in Snohomish County Code Title 25. This an additional surcharge to SWM service charges, in part to reflect a higher level of service in UGA areas.	The funding availability varies. Very little of this would be accessible for Bear Creek projects.
Real Estate Excise Tax (REET)	King and Snohomish Counties and Cities of Woodinville and Redmond	All real estate transactions that involve conveyance of property require consideration of excise tax	The funding varies year to year based on taxable real estate sales in unincorporated King County but the anticipated revenue for 2017 is about \$15.5 million. Very little of this would be accessible for Bear Creek projects.

Fund/ Grant Name	Funding Source (Agency)	Description	Total Accessible Funds
Road Fund	King County	The Road Services Division adopted six year Capital Improvement Program for 2017-2022 is programmed using the Strategic Plan for Road Services that guides and directs priorities for road investments. The capital program reflects an on-going, evolving response to significant structural funding challenges that are affecting the county's ability to preserve and maintain the roadways in the unincorporated areas.	The total six year program is approximately \$169.7 million. In prioritizing capital investments, the division is guided by the priority framework in the Strategic Plan for Road Services.
WaterWorks Grant Program	King County Wastewater Treatment Division	• WaterWorks provides funding for projects that improve water quality in the service area for King County's regional wastewater system. • Eligible areas: Redmond, Woodinville, Redmond Ridge, Maltby, North Redmond unincorporated urban area.	\$2 million every two years for projects within the wastewater service area.
In-lieu fees	King County Snohomish County City of Woodinville City of Redmond	A program involving the restoration, establishment, enhancement, and/or preservation of aquatic resources through funds paid to a governmental or nonprofit natural resources management entity to satisfy compensatory mitigation requirements. Similar to a mitigation bank, an in-lieu fee program sells compensatory mitigation credits to permittees whose obligation to provide compensatory mitigation is then transferred to the in-lieu program sponsor.	The funding availability varies.
Community Engagement Grants	King County	The purpose of the Community Engagement Grants is to fund community projects that offer unincorporated area residents the Community Service Areas an opportunity to participate and be more connected in their communities. Funded projects must demonstrate how activities are accessible to all residents regardless of race, income, or language spoken. Funds available: (2014) \$60,000 with amounts limited to less than \$5,000 per project.	\$90,000 annually / \$5,000 per project.
Cooperative Watershed Management (CWM) Grants	King County Flood Control District (FCD)	In 2012 the KC FCD began providing funding to support watershed salmon recovery projects and activities in King County watersheds through a CWM Grant Program.	The award range varies by WRIA and the length of awards is two to three years.

Table 39. State Funding Sources

Fund/ Grant Name	Funding Source (Agency)	Description	Total Accessible Funds Statewide
Section 319 Grants	Washington Department of Ecology Ecology)	Typical water quality projects include agricultural BMPs; education and stewardship; water quality monitoring; lake water quality monitoring; riparian and wetlands habitat restoration and enhancement; stream restoration; TMDL plan development and implementation; and wellhead protection.	\$250,000 with any combination match option, \$500,000 with cash only match option, 25% match required.
Centennial Grants	Ecology	Provides grants for water quality infrastructure and nonpoint source pollution projects to improve and protect water quality. Eligible infrastructure projects are limited to wastewater treatment construction projects for financially distressed communities. Eligible nonpoint projects include stream restoration and buffers, on-site septic repair and replacement, education and outreach, and other eligible nonpoint activities.	Cash only match - \$500,000, In-kind contributions - \$250,000, 25% for non-point source pollution projects
Watershed Planning Implementation and Flow Achievement Grants	Ecology	Funds projects that increase flows below the project site; improve instream and riparian zone conditions (such as enhancing fish passage or habitat); reorganizing or concentrating points of diversion; establishing water banks, water exchanges, or pursuing trust water opportunities; improving public water supply or irrigation district infrastructure that leads to water savings.	No set limit, no match required.
Municipal Stormwater Capacity Building Grants	Ecology	This grant is a biannual opportunity dependent on approved state budget and funds activities and equipment necessary for permit implementation among Phase I and Phase II NPDES municipal permittees. No match is required.	\$50,000 per recipient every two years.

Fund/ Grant Name	Funding Source (Agency)	Description	Total Accessible Funds Statewide
Water Quality Financial Assistance	Ecology	These grants and loans are for high-priority projects to protect and improve the health of Washington's lakes, rivers, streams and marine waters. Jurisdictions eligible to apply for this funding include local governments, tribes, special purpose districts, conservation districts and nonprofits. Funding comes from a mix of state and federal funds dedicated for water quality improvement and protection.	Wastewater facilities hardship grants: \$5 million, Nonpoint source activities grants: \$250,000 or \$500,000 depending on match, Stormwater activities grants: \$250,000 or \$500,000 depending on match, Stormwater facilities grants: \$5 million.
Grants of Regional or Statewide Significance (GROSS)	Ecology	This grant funds projects that provide benefits for more than one permittee and are offered to Phase I and Phase II NPDES municipal permittees. No match is required.	\$300,000 every two years.
Salmon Recovery Grants	Washington State Recreation and Conservation Office (RCO) Salmon Recovery Board	Projects that protect existing, high-quality habitats for salmon, and restore degraded habitat to increase overall habitat health and biological productivity. Typical projects include replacing fish barriers, replanting stream banks, removing dikes and levees, installing large woody debris to protect shorelines, and buying pristine habitat.	Operations - \$4 million Capital - \$222.1 million every 2 years.
Puget Sound Acquisition and Restoration/ Salmon Recovery Funding Program	RCO	Funds projects that protect existing, high-quality habitats for salmon, and that restore degraded habitat to increase overall habitat health and biological productivity. Projects may include the actual habitat used by salmon and the land and water that support ecosystem functions and processes important to salmon.	The funding availability varies.
Land and Water Conservation Fund (LWCF)	RCO	Funding to preserve and develop outdoor recreation resources, including parks, trails, and wildlife lands. Typical LWCF projects include land acquisition and development or renovation, such as renovating community parks, building new parks and trails, protecting wildlife habitat, and building athletic fields.	\$500,000 State program. \$750,000 Legacy program. 50% match. For local agencies and special purpose districts, at least 10% of the total project cost must be from a non-state, non-federal contribution.
Washington Wildlife and	RCO	Funding for a range of land protection and outdoor recreation projects,	\$55 million biennially. Local agencies, special

Fund/ Grant Name	Funding Source (Agency)	Description	Total Accessible Funds Statewide
Recreation Program		including park acquisition and development, habitat conservation, farmland preservation, and construction of outdoor recreation facilities.	purpose districts, salmon recovery lead entities, and nonprofits must provide 50% match and at least 10 % of the total project cost must be from a non-state, non-federal contribution. State agencies do not have to provide match. Native American tribes must provide 50% match. Local agencies, special purpose districts, salmon recovery lead entities, and nonprofits must provide 50% match and at least 10% of the total project cost must be from a non-state, non-federal contribution. State agencies do not have to provide match. Native American tribes must provide 50% match
Estuary and Salmon Restoration Program (ESRP)	WA State Department of Fish and Wildlife	ESRP was created to support the emerging priorities of the Puget Sound Nearshore Ecosystem Restoration Program. Typical projects include nearshore restoration and protection activities that restore natural ecosystem processes and functions, including protection of nearshore and wetland habitat, restoration of salmon habitat and estuaries, removing or breaching dikes, removing bulkheads, feasibility and design, and decommissioning roads and removing fill.	\$10 million biennially. A match of cash or in-kind services equaling 30% of the total project cost is required.
Landscape Scale Restoration	WA State Department of Natural Resources	Funds projects that address priorities identified in Washington's Forest Action Plan and national themes of conserving working forests and enhancing public benefits from trees and forests, which include: clean air and water, fish and wildlife habitat, open space, outdoor recreation opportunities, and climate change buffering.	Maximum grant request of \$240,000.

Table 40. Federal Funding Sources

Fund/ Grant Name	Funding Source (Agency)	Description	Total Accessible Funds Nationwide
Pollution Prevention Grant Program	US Environmental Protection Agency (EPA)	The Pollution Prevention Grant Program supports State and Tribal technical assistance programs which help businesses identify better environmental strategies and solutions for reducing or eliminating waste at the source. Grants will be awarded and managed by each of EPA's 10 Regional Pollution Prevention Program Offices. Grant amounts awarded are dependent on the Congressional appropriations for this program and the quality of proposals received.	Overall award is around \$4 million with a proposed range of around \$40,000-\$360,000 for a two-year funding period. A 50% match is required.
Water Pollution Control Program	US EPA	Section 106 of the Clean Water Act authorizes EPA to provide federal assistance to states (including territories, the District of Columbia, and Indian Tribes) and interstate agencies to establish and implement ongoing water pollution control programs. Prevention and control measures supported by State Water Quality Management programs include permitting, pollution control activities, surveillance, monitoring, and enforcement; advice and assistance to local agencies; and the provision of training and public information.	There are no funds specifically appropriated or otherwise allocated for these grants.
Conservation Stewardship Program	US Department of Agriculture Natural Resources Conservation Service (USDA NRCS)	Assists agricultural and forest landowners build on existing conservation efforts while strengthening their operation. From improved grazing conditions, increased crop yields, to developing wildlife habitat, CSP can help. CSP offers annual incentive payments for installing these practices on your land.	The funding availability varies.
Environmental Quality Incentive Program	USDA NRCS	Provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air, and related natural resources on agricultural land and non-industrial private forestland.	The contracts are limited to \$20,000 per fiscal year and \$80,000 during any 6-year period for persons or legal entities.

Fund/ Grant Name	Funding Source (Agency)	Description	Total Accessible Funds Nationwide
Regional Conservation Partnership Program	USDA NRCS	Partners (recipient of program funding) help producers and private landowners install and maintain conservation activities in selected project areas. Partners leverage RCPP funding in project areas and report on the benefits achieved.	NRCS will award up to \$252 million dollars to locally driven, public-private partnerships that improve the nation's water quality, combat drought, enhance soil health, support wildlife habitat and protect agricultural viability.
Agricultural Conservation Easement Program	USDA NRCS	Provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps American Indian tribes, state and local governments, and non-governmental organizations protect working agricultural lands.	NRCS and partners are investing \$15 million in technical and financial assistance available to help eligible conservation partners leverage local resources to voluntarily protect, restore, and enhance critical wetlands on agricultural lands.
Community-based Coastal and Marine Habitat Restoration	National Oceanic and Atmospheric Administration U.S Department of Commerce	Seeks restoration projects that use a habitat-based approach to promote productive and sustainable fisheries, improve the recovery and conservation of protected resources, and promote healthy ecosystems and resilient communities.	Up to \$5 million available and proposals with a range from \$100,000 to \$4 million over a one- to three- year period will be accepted.
National Fish Passage Program	US Fish and Wildlife Service	Funds fish passage projects. A fish passage project is any activity that improves the ability of fish or other aquatic species to move by reconnecting habitat that has been fragmented by barriers.	On average the fish passage program contributes between \$70,000, there is no upper limit and strives to achieve a 50% match.

Table 41. Private Funding Sources

Fund/ Grant Name	Funding Source (Agency)	Description	Accessible Funds
Trout and Salmon Foundation	Private Funding and donations	Provides matching for an individual project that aids in the restoration or improvement of any trout stream, salmon fishery, and/or ambient stream conditions through research, education, publication, and physical stream restoration that will result in improved fish reproduction, fish growth and survival, or expansion of the trout/salmon fisheries.	Since 1972, the Foundation has donated over \$1.3 million towards projects across North America. The annual average funds available are around \$35,000 with each project receiving around \$2,000 - \$3,000.
Five Star & Urban Waters Restoration Programs	National Fish and Wildlife Foundations (NFWF)	Assists with projects focused on improving water quality, watersheds, and the species and habitats they support. Funding priorities for this program include on-the-ground wetland, riparian, in-stream, and/or coastal habitat restoration; education and training activities; measurable ecological, education, and community benefits; and partnerships to achieve ecological and educational outcomes.	Approximately \$2.5 million nationwide. Awards range from \$20,000 to \$50,000 with an average size of \$30,000 and 40-50 grants awarded per year.
Bring Back the Natives/ More Fish	NFWF	Funding priorities focus on projects that produce measurable outcomes for native fish species of conservation concern. Projects should focus on restoring habitat connectivity; restoring riparian, instream habitat, and water quality; invasive species management; and innovation and game changing research.	Up to \$1,000,000 in grant funds is available. Grant awards generally range in size from \$50,000 to \$100,000, although grants greater than \$100,000 will be considered on a case by case basis. Applicants must provide at least \$1 in matching non-federal funds for every \$1 of NFWF grant funds requested.

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13.0 RECOMMENDED NEXT STEPS

The Study found that a substantial effort would be necessary to achieve the desired objectives. For example, the majority of hard surfaces (roads, driveways, houses, parking lots, etc.) in the watershed would require treatment with LID BMPs and/or traditional stormwater facilities. While the identified strategies reflect the best available science, the effectiveness of many of these actions is not yet fully understood. As a consequence, the Study suggests a realistic, long term timeframe for achieving these objectives, allowing for adaptive management. The long term actions called for (and any associated costs) are therefore highly uncertain—new approaches and technologies are likely to modify what is ultimately needed.

Despite these challenges, King County and its partners recognize the need and opportunity to move beyond planning. To that end, the Study recommends a set of near term actions – over the next ten years – to improve water quality in select catchments (small, subbasins within the Bear Creek Watershed) and begin to restore habitat throughout the Bear Creek watershed. While many factors, including jurisdictional priorities, available funding, and other ongoing activities will affect how different recommendations are implemented, they reflect a potential path toward restoring the basin. Focusing intense stormwater efforts in smaller geographic areas increases the likelihood of achieving measurable instream improvements earlier, compared to more diffused efforts throughout the watershed. Besides demonstrating results, focused implementation will also provide timely, useful feedback on the strategies employed so that they can be modified, as needed, to ensure effectiveness.

The Study recommends that structural stormwater projects be constructed in five of the prioritized catchments identified in Section 4.3:

- One catchment along upper Bear Creek in unincorporated King County (BEA300),
- One catchment along Lower Mackey Creek in unincorporated King County (BEA120),
- Monticello Creek subbasin for the City of Redmond (MON),
- The upper Cold Creek catchment, which is the western-most of three catchments in the watershed in the City of Woodinville (BEA 850), and
- The catchment immediately draining to upper Bear Creek directly upstream of Paradise Lake in unincorporated Snohomish County (BEA 640/660).

The near-term recommendations for the jurisdictions are described in Table 42. If fully implemented, the estimated public costs to perform the recommended near term actions over the ten year period is \$81 million. The near-term capital construction cost for stormwater facilities in the priority catchments on public land is estimated to be \$51 million. The near-term capital cost for habitat improvement projects is estimated to be \$26 million. Program costs including recommended studies and monitoring are estimated at \$4 million (\$400K per year).

Table 42. Near-term (first 10 years) recommendations for restoring the Bear Creek watershed.

	Recommendation	King County	Snohomish County	City of Redmond	City of Woodinville
Funding	Aggressively seek funding (e.g., grants to implement recommendations)	✓	✓	✓	✓
	Develop an in-lieu fee program that allows those proposing development activities to pay for mitigation in the watershed when it is infeasible to provide mitigation on a development site	✓			
Stormwater	Construct the recommended stormwater management facilities and LID BMPs on public land in the high priority catchments	✓	✓	✓	✓
	Provide incentive for LID BMP construction on private residential properties	✓			✓
Habitat	Restore 50 percent of degraded wetlands and riparian corridors	✓	✓	✓	✓
	Install 10 percent of the high priority instream habitat projects	✓			
	Provide incentives to plant trees along stream corridors	✓		✓	✓
	Complete a study that identifies and prioritizes fish barriers in the Bear Creek stream system	✓			
Education and Studies	Implementing a public education campaign targeting reduction of fecal bacteria and other pollutants	✓	✓	✓	✓
	Complete a study that analyzes the feasibility of a flow-control credit trading program between watersheds in unincorporated King County	✓			
Adaptive Management	Implement a monitoring program to track strategy effectiveness, to be used in adaptively managing the plan	✓	✓	✓	✓
	Complete a program review at completion of the ten year period, to inform next steps	✓	✓	✓	✓

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APPENDIX A: Prioritization: Water Quality and Quantity Strategies

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1.0 INTRODUCTION

The Permit-defined objective of watershed-scale stormwater planning is to identify a stormwater management strategy or strategies that would result in hydrologic and water quality conditions that fully support “existing uses,” and “designated uses,” as those terms are defined in WAC 173-201A-020, throughout the stream system. Poor water quality (temperature, dissolved oxygen, fecal coliform bacteria, turbidity, and toxicants) and altered hydrology in the Bear Creek study area are significant factors in causing the stream and its tributaries to not meet their designated uses (King County, 2017). With the exception of temperature and dissolved oxygen, overall water quality in the Bear Creek watershed appears to be improving since the 1970s. Current fecal coliform concentrations indicate a potential risk to human health, but the concentrations have decreased over the past three decades. Temperature and dissolved oxygen levels are not conducive for salmonids (as represented by violations of the state water quality standards), and long-term trends have indicated that conditions have worsened over the past four decades. The average qualitative Benthic Index of Biotic Integrity (B-IBI) score in the study area is considered “fair.” The “flashiness” of a stream has been linked to poor macroinvertebrate health as measured by B-IBI. Both water quality and quantity concerns may be improved through stormwater management and treatment.

Stormwater best management practices (BMPs) include both low impact development (LID) type facilities, such as pervious pavement or bioretention systems, and more traditional facilities, such as stormwater detention and treatment. LID BMPs generally address stormwater impacts near the source, and traditional facilities are more regional in nature, serving larger areas further away from the source. The impacts of stormwater BMPs are most readily modeled and comprised the primary component of the SUSTAIN optimization model scenarios.

A prioritization method was developed based on stakeholder input with the goal of focusing mitigation in identified, smaller catchments to achieve improvements early in the Bear Creek Watershed-scale Stormwater Management Study (the Study) implementation. To determine these priority catchments, criteria were developed that allowed for evaluating the number/severity of problems and potential opportunities for impactful/cost effective projects in the catchments. Priority catchments are those where the need is greatest and opportunities for cost effective improvement are more available. Individual catchments (as delineated for the Hydrological Simulation Program (HSPF) and System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) models) were assessed (Figure 1). In some cases, several model catchments were grouped due to similar problems, opportunities, and identified strategies. The selected catchments are at a spatial scale that measurable outcomes would be expected if targeted projects were implemented.

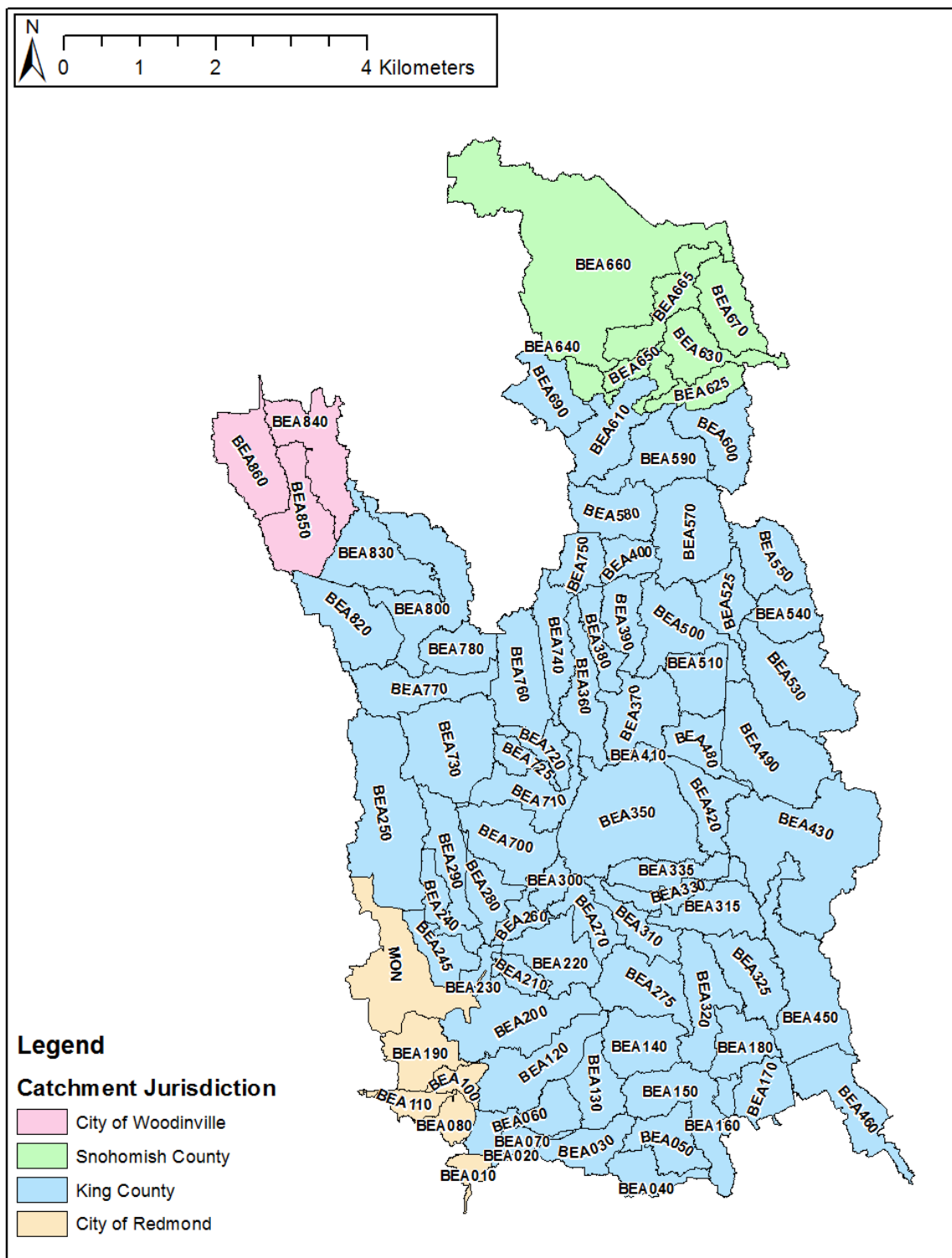


Figure 1. Catchments used for modeling current and future water quality conditions and prioritizing projects.

2.0 CATCHMENT PRIORITIZATION

Several criteria were assessed to prioritize catchments for stormwater projects within each partner jurisdiction. Catchments with poor water quality and B-IBI score (i.e., with problems) were given more weight (i.e., a greater prioritization) than catchments with good water quality and B-IBI scores. Catchment opportunity is defined as the expected simplicity (or complexity) to which water quality projects could be implemented in the catchment. Catchments with greater opportunity were given more weight. The criteria used in the prioritization are detailed in Table 1.

The prioritization score is the summation of the criteria scores, with higher values representing higher priority.

Table 1. Criteria for evaluating catchments for water quality and hydrology projects.

Criteria	Definition	Explanation	Data Source	Scoring	Important Limitations/ Caveats
Water Quality Conditions (Modeled Existing)	Number of modeled exceedances of water quality standards (temperature, turbidity, fecal coliform, copper, zinc)	Data on modeled water quality were used to highlight areas of the watershed where conditions are not expected to support designated uses	HSPF Model	Number of parameters with exceedances ○ 5 parameters - 30 points ○ 4 parameters- 25 points ○ 2 to 3 parameters – 15 points ○ 1 parameter - 10 points ○ 0 parameters – 0 points	• Water quality conditions were modeled using HSPF from recent water quality data at a select number of sites. Conditions were extrapolated to un-monitored catchments based on land use
B-IBI (Modeled Existing)	B-IBI associated with the modeled flow metrics in the catchment	B-IBI is a multi-metric index that calculates a single, numerical score designed to represent information about the ecological health of a stream.	HSPF Model and WRIA 8 B-IBI Regression	B-IBI Score ○ Less than 40 - 20 points ○ 40 to 60 - 10 points ○ More than 60 - 5 points	• The modeled B-IBI scores are based on best-fit regressions with flow metrics. • The flow metrics used to estimate B-IBI were modeled through HSPF based on land use, stormwater facilities, and monitored flows in the basin.

Criteria	Definition	Explanation	Data Source	Scoring	Important Limitations/ Caveats
Untreated Impervious Area	The amount of impervious area in the catchment without existing stormwater treatment	Untreated impervious areas are a priority because stormwater may cause flashiness in streams in addition to delivering pollutants.	• 2011 National Land Cover Database Impervious Surface (30 m resolution) • Mapped King County and Redmond stormwater catchments	Percent impervious surface without treatment in catchment ○ More than 80% - 30 points ○ 50 to 80% - 20 points ○ 30 to 50% - 10 points ○ Less than 30% - 5 points	• Additional development has occurred between 2011 and 2017. • Many stormwater facilities drainage areas' are not mapped and therefore designated as untreated. • Not all stormwater facilities may be providing an adequate amount of treatment.
Existing Stormwater Facilities	The number of existing stormwater facilities in the catchment	Existing facilities are an opportunity for retrofitting to meet current stormwater design standards, improving both stream flashiness and water quality.	• King County Stormwater Facilities Shapefile (storm_fac_point – accessed 2016). • City of Redmond • Snohomish County	Number of existing stormwater facilities in catchment ○ More than 5 facilities – 10 points ○ 2 to 5 facilities – 5 points ○ 0 to 1 facilities – 0 points	Existing facilities may not be present in the inventory.

Criteria	Definition	Explanation	Data Source	Scoring	Important Limitations/ Caveats
Horse and Livestock (Forage) Land	The amount of land in the catchment with land use designated as horse or livestock	Horses and livestock can have negative impacts on stream water quality due to bank erosion, runoff from manure, and low riparian and instream habitat complexity. They represent an opportunity to install agricultural BMPs through partnerships with landowners and the King Conservation District.	King County Agricultural Land Use 2013 (ag_landuse2013)	Acres of 200ft stream buffer in horse or livestock land - More than 10 acres – 15 points 5 to 10 acres – 10 points - Less than 5 acres – 5 points	- Existing agricultural BMPs are not available and were not assessed. - Land use may have changed between 2013 and 2017, including conversion to or from horse/livestock land.
Property Value	The average assessed value of property from King and Snohomish counties normalized by area within the catchment	Catchments with low property values represent an opportunity to purchase property for the purpose of construction regional stormwater facilities in addition to instream and out-of-stream habitat improvement projects.	- King County Parcel database using 2016 assessed values - Snohomish County Parcel database using 2016 assessed values	Average cost per acre in catchment - Less than \$500,000/acre – 20 points \$500,000 to \$1,000,000/acre – 10 points \$1,000,000 to \$5,000,000/acre – 10 points - More than \$5,000,000/acres – 2 points	- Assessed value does not always equal the market value. - Willingness to sell was not assessed.

Criteria	Definition	Explanation	Data Source	Scoring	Important Limitations/ Caveats
Public Lands and Easements	The amount of publicly owned land within the catchment	Public lands are a priority for stormwater and tree planting projects due to lower costs associated with construction and obtaining access.	- King County Parcel database - Snohomish County Parcel database	Fraction of catchment that is public land - More than 30% – 20 points 10 to 30% – 10 points - Less than 10% – 5 points	Not all public land may be suitable for stormwater facility construction or tree planting.
Right-of-Ways	The amount of city and county road right-of-ways in the catchment	Right-of-ways represent an opportunity to construct BMPs (or habitat projects) near roadways that can treat stormwater without purchasing private land.	- King County Right of Way - Snohomish County Right of Way (2015-07)	Fraction of catchment that is ROW - More than 20% – 15 points 10 to 20% – 8 points - Less than 10% – 5 points	Not all right-of-ways are suitable for stormwater facility construction or tree planting
Roof Area	Building roof area within catchment	Building rooftops are opportunities for on-site stormwater management (e.g., rain gardens, cisterns, dry wells)	LiDAR data (does not include Snohomish County)	Fraction of catchment that is rooftop - More than 10% - 15 points 5 to 10% - 10 points - Less than 5% - 5 points	Older LiDAR data may not represent the current building roof footprint

Criteria	Definition	Explanation	Data Source	Scoring	Important Limitations/ Caveats
Areas Susceptible to Groundwater Contamination (ASGWC) and Wellhead Protection Zones (WPZ)	ASGWC and WPZs have specific regulations for maintaining groundwater quality	CARAs and WPZs represent a potential limitation to constructing stormwater BMPs that utilize infiltration.	• King County Areas Susceptible to Groundwater Contamination • Redmond Wellhead Protection Zones (WPZ) • WA Department of Health Wellhead Protection Areas (WHPA)	Not scored but evaluated along other attributes	New WPZs are anticipated from the City of Redmond in the near future.

3.0 PRIORITY KING COUNTY CATCHMENTS

For catchments located primarily within unincorporated King County, The data input to the prioritization metric and the resulting final score are displayed in Table 2 with the catchments ranked. The following sections detail the five top-ranked catchments and discuss potential projects and actions to improve water quality and hydrology.

Table 2. Ranked catchments located primarily in King County and prioritization metric input data. Grouped catchments highlighted with the same color, except catchment outside study area shaded in grey.

Catchment	Scoring Metrics									Total Score
	Water Quality Score	B-IBI Score	Untreated Impervious Score	Stormwater Facility Score	Forage Livestock Score	Property Cost Score	Public Land Score	Right-of-Way Score	Roof Score	
BEA120	15	10	10	5	15	10	20	0	5	90
BEA230	15	10	30	0	0	15	0	8	5	83
BEA200	15	10	10	5	15	5	10	0	10	80
BEA740	15	20	10	0	0	10	0	8	10	73
BEA250	15	20	0	10	0	5	0	8	15	73
BEA300	15	10	5	0	0	15	20	0	5	70
BEA800	10	10	5	5	0	10	20	0	5	70
BEA160	15	20	5	0	0	5	10	8	5	68
BEA280	15	10	10	5	0	10	0	8	10	68
BEA170	15	20	0	5	0	5	0	8	15	68
BEA750	15	20	10	0	0	5	0	8	10	68
BEA770	15	20	10	0	0	5	0	8	10	68
BEA245	15	10	10	5	10	5	0	0	10	65
BEA030	15	10	5	0	15	15	0	0	5	65
BEA040	15	20	10	0	0	10	0	0	10	65
BEA060	25	10	10	0	0	5	10	0	5	65
BEA130	15	10	10	10	0	15	0	0	5	65
BEA430	15	10	5	10	0	5	10	0	10	65
BEA990	15	10	10	0	10	10	0	0	10	65
BEA450	15	10	0	10	0	5	20	0	5	65
BEA510	15	10	10	5	0	15	0	0	10	65
BEA690	15	10	0	5	0	10	20	0	5	65
BEA070	5	0	10	0	0	15	20	8	5	63

Catchment	Scoring Metrics									Total Score
	Water Quality Score	B-IBI Score	Untreated Impervious Score	Stormwater Facility Score	Forage Livestock Score	Property Cost Score	Public Land Score	Right-of-Way Score	Roof Score	
BEA020	15	10	5	0	0	10	10	8	5	63
BEA240	15	10	10	5	0	5	0	8	10	63
BEA710	15	10	0	10	0	10	0	8	10	63
BEA940	15	10	10	0	0	10	0	8	10	63
BEA335	15	10	10	5	0	10	0	0	10	60
BEA350	15	10	10	0	0	5	10	0	10	60
BEA590	15	10	0	0	0	10	20	0	5	60
BEA600	15	10	0	10	0	10	10	0	5	60
BEA720	15	10	10	5	0	10	0	0	10	60
BEA830	15	10	5	5	0	10	10	0	5	60
BEA460	15	10	5	0	0	5	20	0	5	60
BEA540	15	10	0	0	0	10	20	0	5	60
BEA760	15	10	10	0	0	5	0	8	10	58
BEA400	15	10	5	0	0	10	0	8	10	58
BEA210	15	10	10	0	0	15	0	0	5	55
BEA050	15	10	10	0	0	10	0	0	10	55
BEA275	15	10	5	0	0	10	10	0	5	55
BEA490	15	10	5	10	0	10	0	0	5	55
BEA570	15	10	0	0	0	15	10	0	5	55
BEA910	15	10	10	0	0	10	0	0	10	55
BEA950	15	10	10	0	0	10	0	0	10	55
BEA325	5	10	0	0	0	15	20	0	5	55
BEA380	15	10	10	0	0	10	0	0	10	55
BEA390	15	10	5	0	0	15	0	0	10	55
BEA525	15	10	5	5	0	15	0	0	5	55

Catchment	Scoring Metrics									Total Score
	Water Quality Score	B-IBI Score	Untreated Impervious Score	Stormwater Facility Score	Forage Livestock Score	Property Cost Score	Public Land Score	Right-of-Way Score	Roof Score	
BEA530	15	10	5	5	0	10	0	0	10	55
BEA270	15	10	5	0	0	5	0	8	10	53
BEA610	15	10	5	0	0	15	0	0	5	50
BEA150	15	10	10	0	0	10	0	0	5	50
BEA220	15	10	5	5	0	5	0	0	10	50
BEA370	15	10	5	0	0	15	0	0	5	50
BEA500	15	10	5	0	0	15	0	0	5	50
BEA580	15	10	5	5	0	10	0	0	5	50
BEA780	15	10	10	0	0	10	0	0	5	50
BEA140	15	10	5	0	0	15	0	0	5	50
BEA315	5	10	0	5	0	5	20	0	5	50
BEA360	15	10	10	0	0	5	0	0	10	50
BEA410	15	10	5	0	0	15	0	0	5	50
BEA420	15	10	10	0	0	5	0	0	10	50
BEA480	15	10	10	0	0	10	0	0	5	50
BEA550	15	10	5	0	0	15	0	0	5	50
BEA725	15	10	10	0	0	10	0	0	5	50
BEA820	15	10	0	5	0	10	0	0	10	50
BEA900	15	0	10	0	0	5	10	0	5	45
BEA730	15	10	10	0	0	10	0	0	10	45
BEA180	5	0	0	0	0	15	20	0	5	45
BEA260	15	10	10	0	0	5	0	0	5	45
BEA290	15	10	0	5	0	5	0	0	10	45
BEA700	15	10	5	0	0	10	0	0	5	45
BEA330	15	10	0	0	0	10	0	0	5	40

Catchment	Scoring Metrics									Total Score
	Water Quality Score	B-IBI Score	Untreated Impervious Score	Stormwater Facility Score	Forage Livestock Score	Property Cost Score	Public Land Score	Right-of-Way Score	Roof Score	
BEA320	5	0	0	0	0	2	20	0	5	32
BEA310	5	10	5	0	0	5	0	0	5	30

3.1 BEA120 – Lower Mackey Creek (Score: 95)

The Lower Mackey Creek (BEA120) catchment includes lower Mackey Creek to its mouth at the confluence with Bear Creek (Table 3). The catchment is 256 acres in area. Much of the catchment is horse pasture, which may or may not have agricultural BMPs in place. A program to identify missing agricultural BMPs and incentive their installation is identified, with a specific focus on the parcels in this catchment (Table 4). The catchment is one-quarter public land, with Mackey Creek running through public land (Figure 2). With a focus on public lands, a program to identify and improve poor riparian habitat is identified. This can be done in concert with instream habitat restoration projects.

The retention/detention (RD) facilities were both constructed prior to 1990 and likely do not meet current design standards (Figure 3). It is identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment (Table 4). Because the area is highly susceptible to groundwater contamination, road runoff would need to be treated prior to infiltration (Figure 4 and Figure 5).

Table 3. Available data for Lower Mackey Creek (BEA120) catchment.

Criteria	Data
Existing water quality problems	• Temperature (40% of summer 7-DADMax temperatures exceed water quality standards) • Dissolved Oxygen (3 of 3 summer samples did not meet water quality standards) • Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria) • Total Suspended Solids (wet-weather samples are twice that of baseflow samples) • Copper (one wet-weather sample exceeded the chronic toxicity criterion)
Existing instream habitat problems	Loss of vegetation and instream large organic debris (Entranco, 1994)
B-IBI (WRIA8 Regression)	Fair (46.9)
Riparian land cover	Pasture: 28% Trees: 42% Shrub: 19% Impervious: 4% Other: 8%
Public Lands	25% public land
City of Redmond	Farrell McWhirter Farm Park (3126069017, 3126069004)
King County Parks	3126069052
Horse and Livestock Lands	35 acres 3126069099, 3126069064, 3126069147, 3126069011, 3126069017 (City of Redmond), 1243100060, 1243100063, 1243100025, 1243100033, 1243100045, 1243100049, 1243100016, 1243100030, 1243100040, 1243100111, 1243100112

Criteria	Data
Right-of-Ways	13 acres (including road surface) 196th Ave NE NE 103rd St NE 106th St (near confluence) NE Redmond Way ROW W to E from 196th AVE NE (just south of NE 113th St) to NE Redmond Rd (intersects Mackey) ROW NNW to SSE from NE 116th St (near 200th Ave NE) to NE Redmond Rd (intersects Mackey)
Property Value	\$313,825 Lower costs along Lower Mackey (below McWhirter Park)
Untreated Impervious Area	8% of catchment is untreated impervious land • Horse barns/house in lower Mackey Creek • Generally pasture/open land/forest
Existing Stormwater Facilities	• RD Pond for Little Bit Therapeutic (D99099) – date built unknown • RD Pond for Tall Firs Equestrian (D97150) – date built unknown • RD Pond/trench for residential at west end of NE 103rd St – built 1990
Easements	None
Groundwater	• Lower Mackey Creek – High Susceptible to Groundwater Contamination and in Redmond Wellhead Protection Zone 2 (outside Redmond jurisdiction) • Upper catchment – medium/low susceptibility • WPZ Avon Villa Trailer Park – north end of lower Mackey
Stream Shade	53% of the stream has less than 50% shading Hot spots of low shade: • Confluence with Bear Creek (owned by King County Parks) • PSE Easement over Mackey Creek from 196th Ave NE to NE Redmond Rd (W to E)

Table 4. Summary of Identified Strategies for Lower Mackey Creek (BEA120) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	
Plant trees on public land with poor stream shading - McWhirter Park		X		X	
Inspect and optimize the existing D97150 and D90930 stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

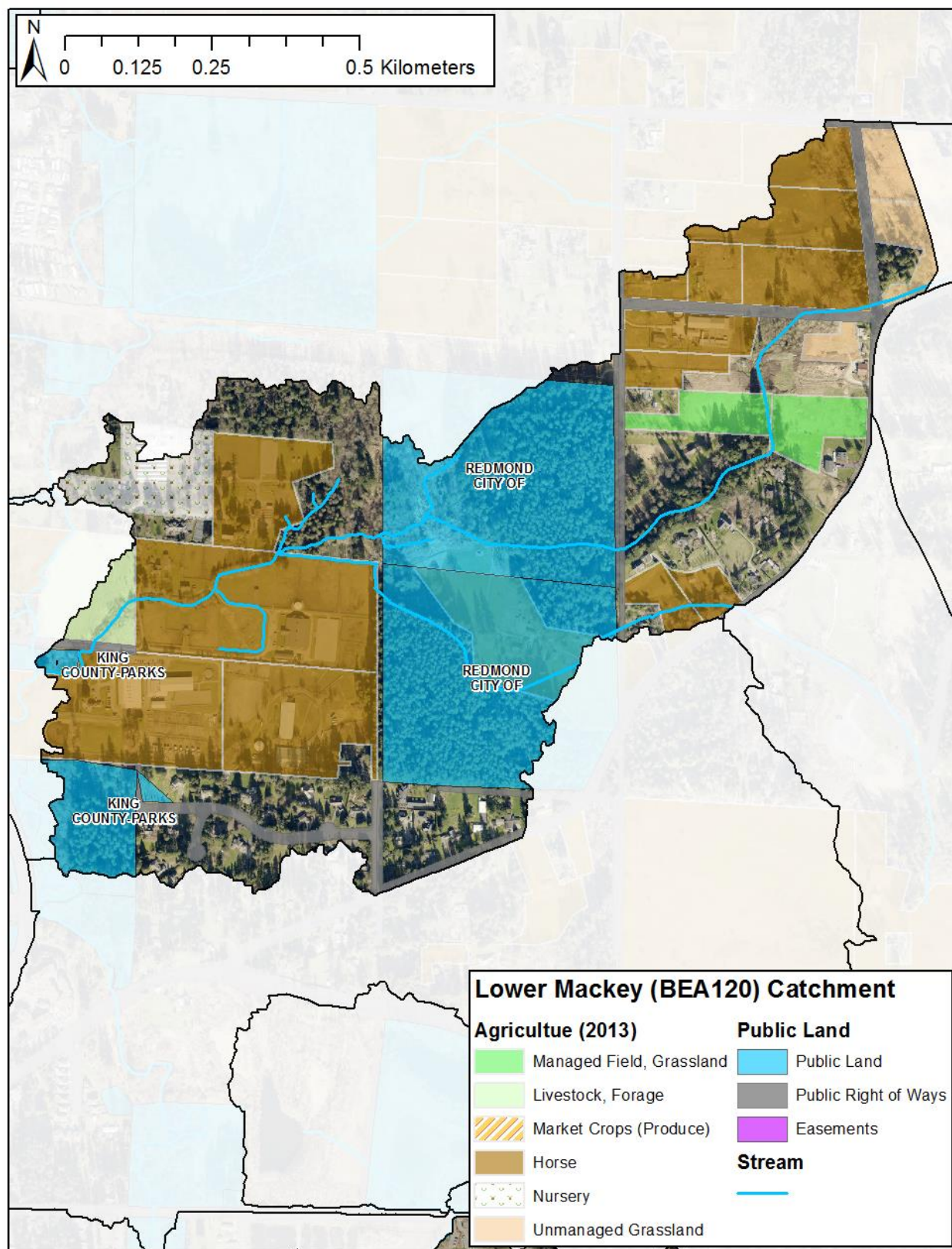


Figure 2. Lower Mackey Creek (BEA120) catchment agricultural and public land.

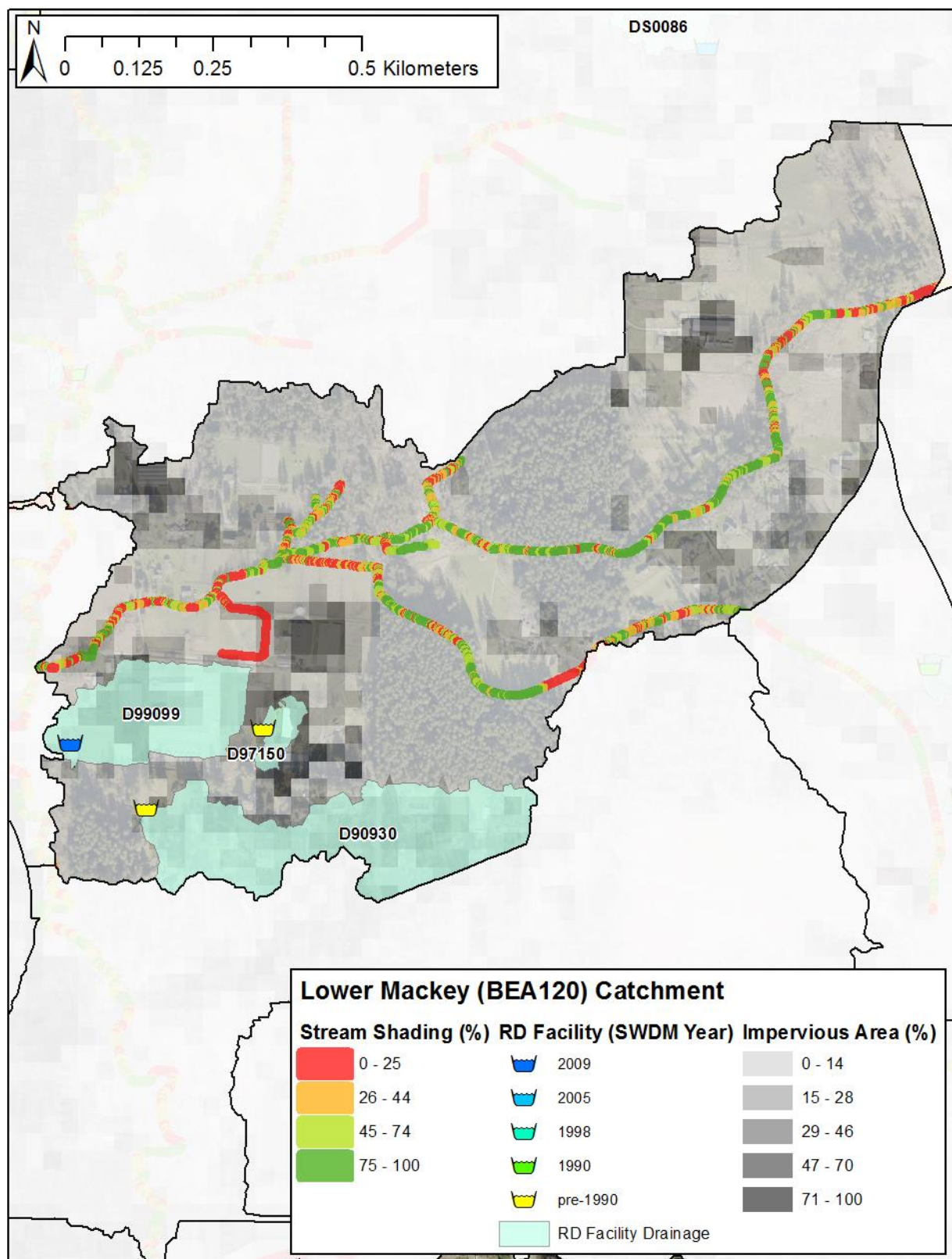


Figure 3. Lower Mackey Creek (BEA120) catchment stream shading, impervious area, and RD facilities and their drainage area.

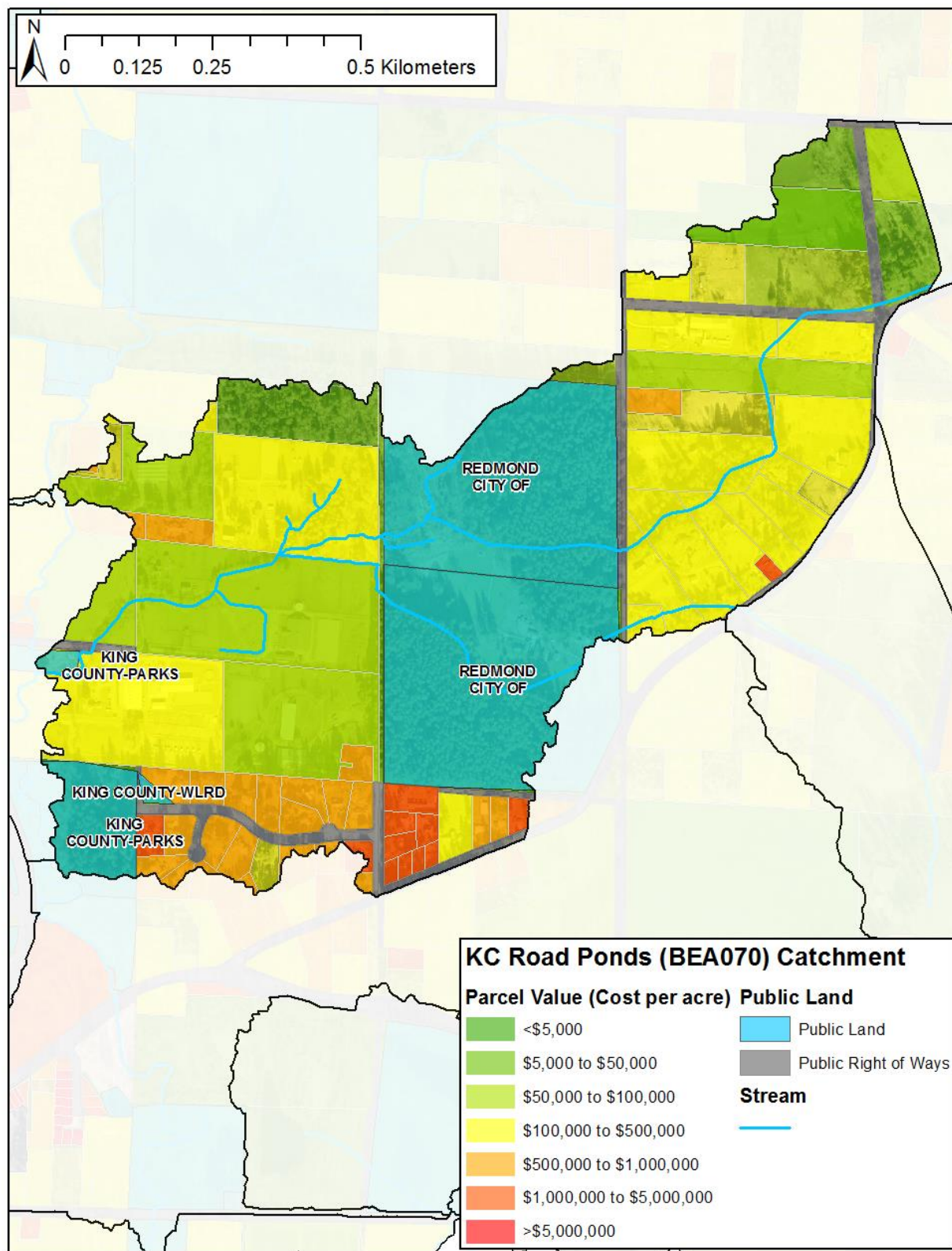


Figure 4. Lower Mackey Creek (BEA120) catchment parcel values and public lands.

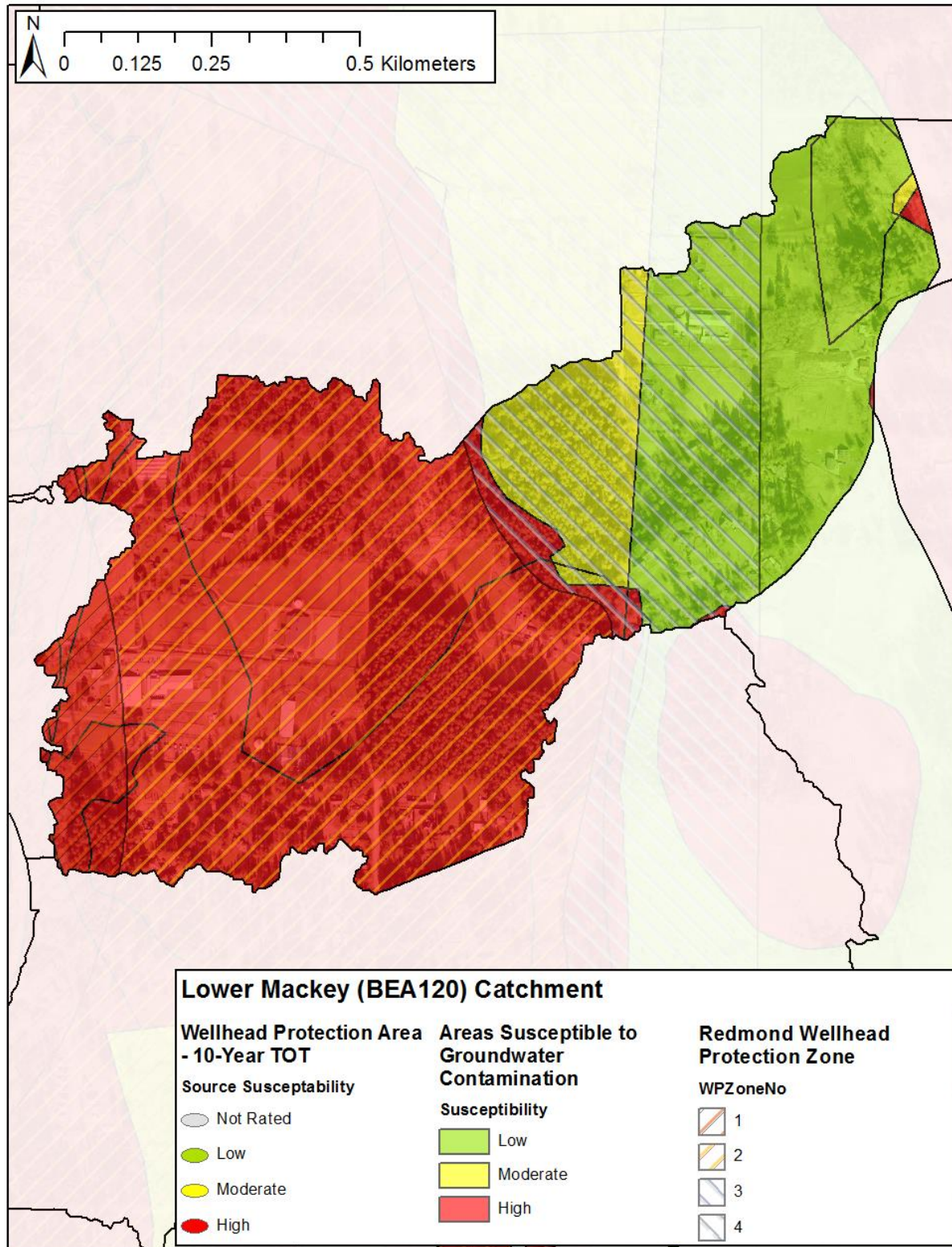


Figure 5. Lower Mackey Creek (BEA120) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff. No wellhead protection 10-year TOT in catchment.

3.2 BEA230/240/245/250 – English Hill (Score: 88)

The English Hill catchments (BEA230/240/245/250) all drain to Bear Creek downstream of the confluence with Cottage Lake Creek. These catchments were grouped because of their similar land use and the likely need to address the four in order to have measurable water quality improvement downstream. The catchments are a total of 754 acres in area. The catchments drain to a wetland near Bear Creek prior to flowing into the creek. The tributaries are not named. The catchments are low density development and farmland near Bear Creek (BEA230) (Figure 6) and medium-density residential developments further upstream in the catchment (BEA240/245/250) (Table 5). Very little is public land (3%) (Figure 8).

Much of the upper catchments are served by regional stormwater facilities built prior to 1990 (Figure 7). These facilities likely do not meet current flow control requirements and do not provide significant water quality treatment. It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment. Because the area is highly susceptible to groundwater contamination in the lower catchment, road runoff would need to be treated prior to infiltration (Figures 9).

A program to identify missing agricultural BMPs and incentive their installation is identified, with a specific focus on the parcels in this catchment (Table 6).

Table 5. Available data for English Hill catchments (BEA230/240/245/250).

Criteria	Data
Existing water quality problems	Water quality in the unnamed Bear Creek tributary was not monitored
Existing instream habitat problems	No data
B-IBI (WRIA8 Regression)	Fair (49.4) (BEA230)
Riparian land cover	Pasture: 23% Trees: 26% Shrub: 18% Impervious: 12% Other: 21% (water, bare area, grass, etc.)
Public Lands	3% public land
King County Roads	7273100123 7273100183 7273100185 7273100201 3026069046
King County WLRD	0200800560 2802200310 4188000760 4188000810 8121201040 5701700600 5701700644 6641200130

Criteria	Data
	3293200220 9578050400 9578050410 5649300590 5649300600 9288950090
City of Redmond	2526059110
Seattle Public Utilities	1326059051 (Tolt Pipeline)
Horse and Livestock Lands	6.1 acres 7273100115; 7273100116 (livestock) 2355000010 (horse) 2426059005 (horse) 1326059146 (horse) 1326059150 (horse) 1326059151 (horse)
Right-of-Ways	97 acres (including road surface) Avondale Rd
Property Value	\$1,823,378 Several low cost (<\$50,000/acre) parcels along Avondale Rd Relatively lower cost in upper catchment near Tolt Pipeline.
Untreated Impervious Area	7% of catchment is untreated impervious land • Avondale Rd • Large parking/equipment storage lots • Residential area north of NE 128th St and along 175th Ave NE • 175th Ave NE to 178th Ave NE and NE 133rd St to NE 136th St
Existing Stormwater Facilities	• RD Pond for Coconour Residence (DS0044) built in 2003 • RD Pond for Sunrise Division Tract D (D90766) built in 1980 • RD Pond for Sunrise Division Tract F (D90810) built in 1980 • RD Pond for Langtree Estates (D91119) built in 1983 • RD Pond for Amerley on English Hill (D90942) built in 1981 • RD Pond for Mount Clare Estates (D90327) built in 1978 • RD Pond for Park Ave Ridge (D92054) built in 1990 • RD Pond for Wyndham Knoll (D91747) built in 1988 • RD Pond for Hollymor III (D90963) built in 1982 • RD Pond for Highgrove (D91277) built in 1987 • RD Pond (D92054) built in 1988 • RD Pond for English Hill Estates (D92094) built in 1992 • RD Vault for Kempin Meadows (D99142) built in 2009 • RD Pond for Morning Meadows (D91783) built in 1977 • RD Pond for Westbrook Estates (D92812) built in 1993
Easements	None
Groundwater	• Western portion of catchment in Redmond Wellhead Protection Zone 3 • Catchment is highly susceptible to groundwater contamination.
Stream Shade	66% of the stream has less than 50% shading Hot spots of low shade: • Western tributary • Bear Creek above western tributary

Table 6. Summary of Identified Strategies for English Hill catchments (BEA230/240/245/250).

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for pastureland			X	X	
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

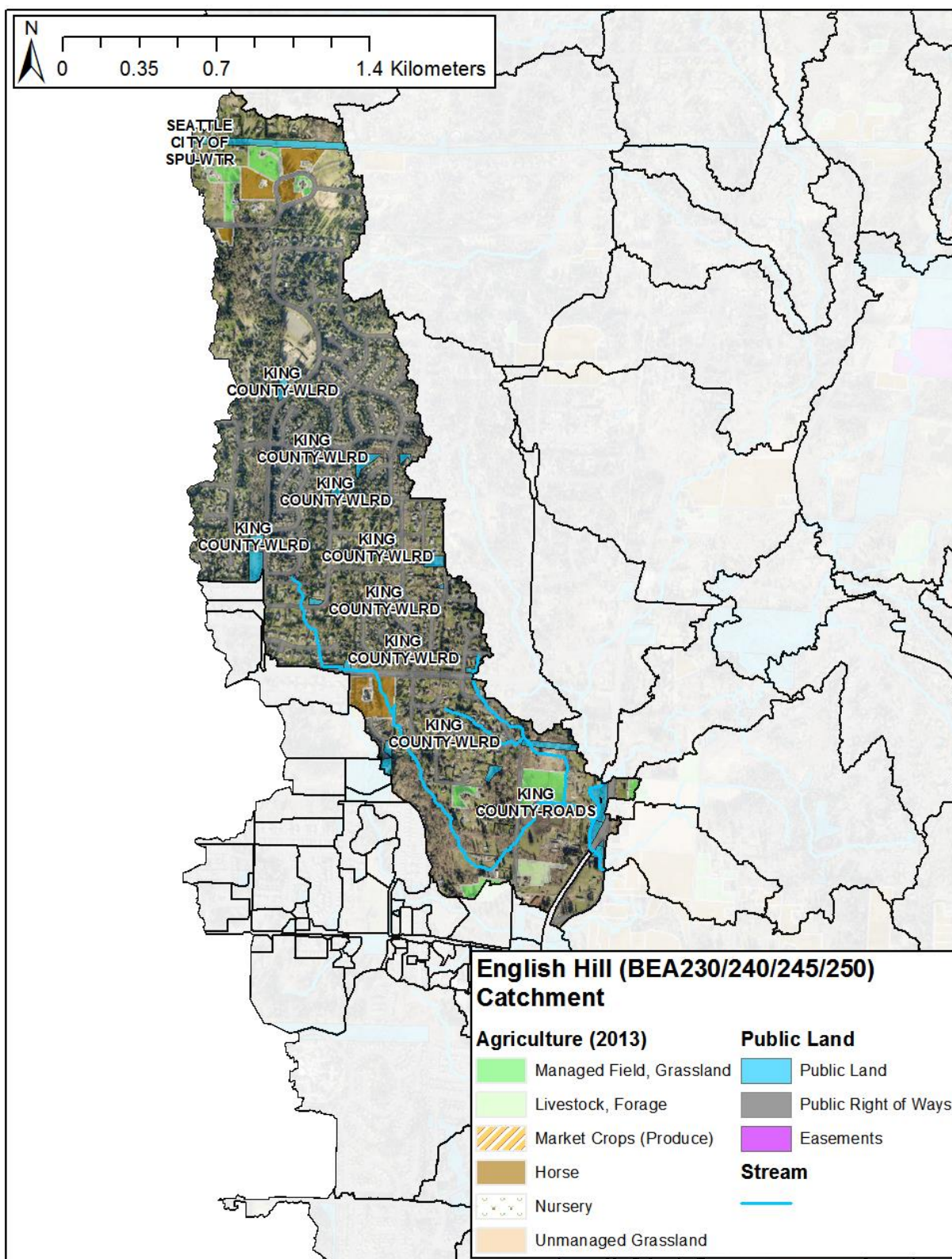


Figure 6. English Hill (BEA230/240/245/250) catchment agricultural and public land.

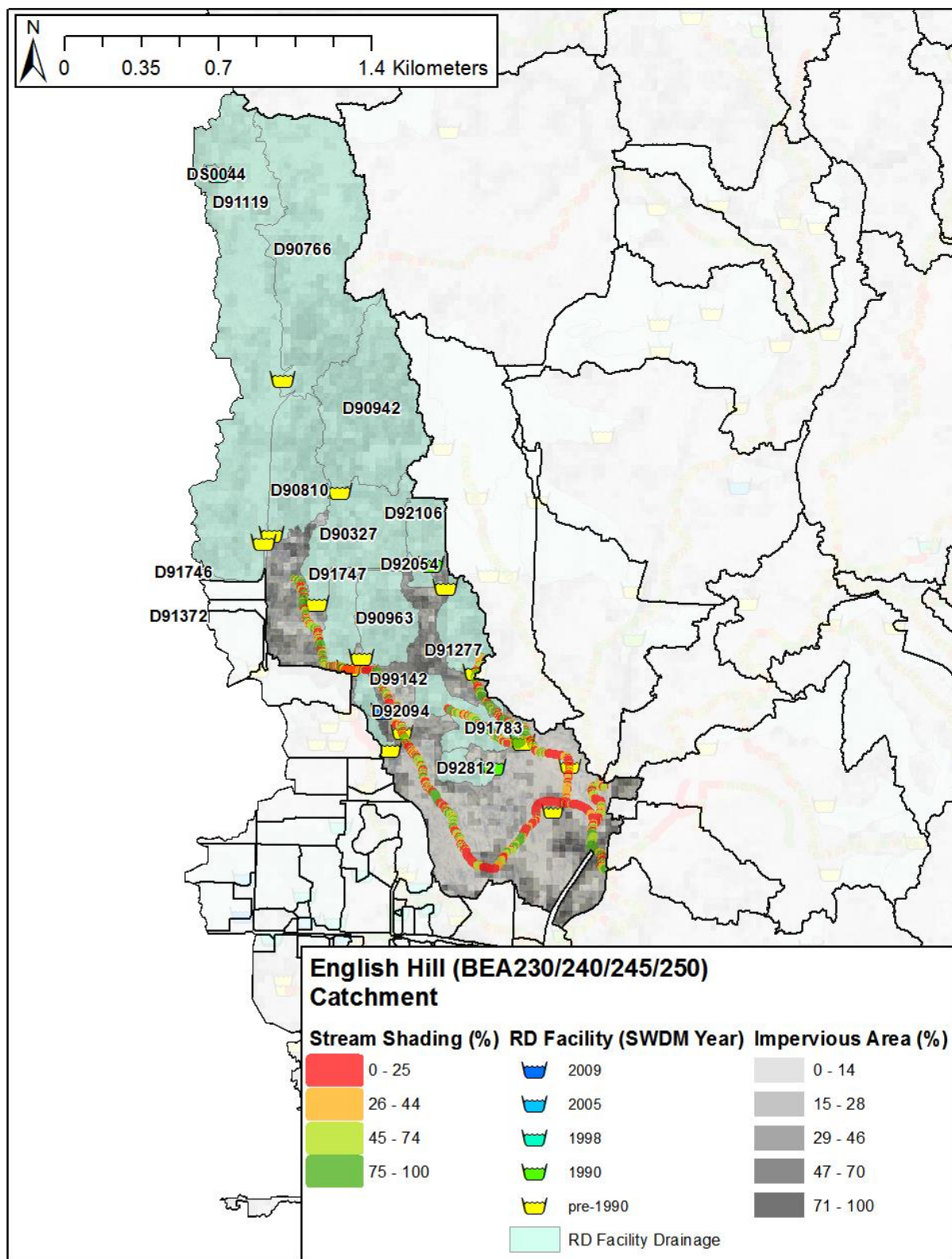


Figure 7. English Hill (BEA230/240/245/250) catchment stream shading, impervious area, and RD facilities and their drainage area.

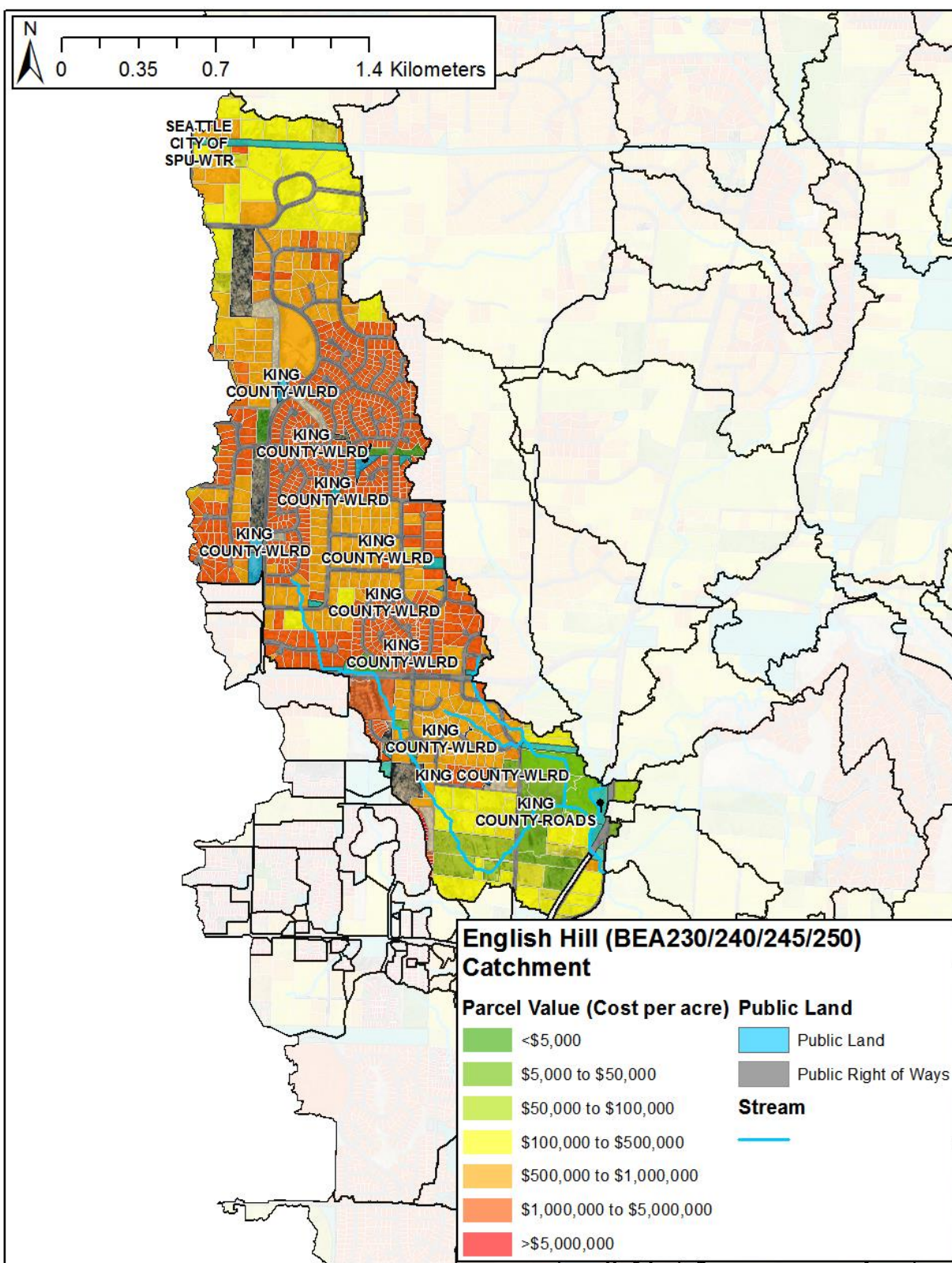


Figure 8. English Hill (BEA230/240/245/250) catchment parcel values and public lands.

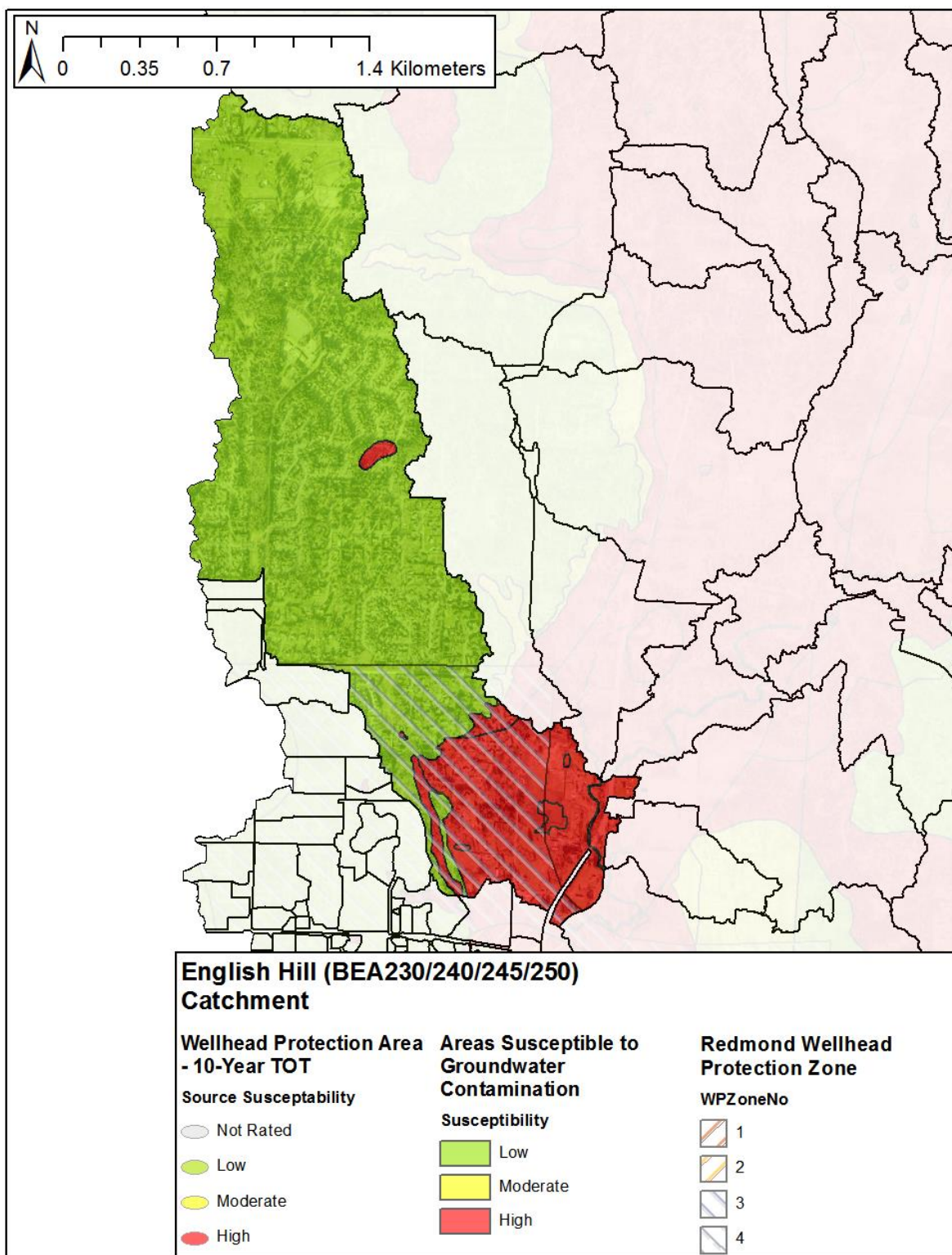


Figure 9. English Hill (BEA230/240/245/250) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff. No wellhead protection 10-year TOT in catchment.

3.3 BEA200 – Avondale and 116th (Score: 83)

The Avondale and 116th St (BEA200) catchment is along Lower Bear Creek. The catchment is 320 acres in area. The catchment contains mainstem Lower Bear Creek, as well as several unnamed tributaries (Table 7). The land use in the catchment varies from medium-density commercial and residential development along Avondale Road to the west to horse pasture land throughout the eastern catchment (Figure 10). The existing horse pasture may or may not have agricultural BMPs in place. A program to identify missing agricultural BMPs and incentive their installation is identified, with a specific focus on the parcels in this catchment (Table 8). Less than 20% is public lands (Figure 12).

Several of the RD facilities were both constructed prior to 1990 and likely do not meet current design standards (Figure 11). It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment. It is also identified that the Avon Villa Mobile Home Park be targeted for stormwater BMP facilities. Because some of the catchment is highly susceptible to groundwater contamination, road runoff may need to be treated prior to infiltration (Figure 13).

Table 7. Available data for BEA200 (Avondale and 116th St) catchment.

Criteria	Data
Existing water quality problems (Lower Bear Creek)	• Temperature (91% of summer 7-DADMax temperatures exceed water quality standards) • Dissolved Oxygen (2 of 3 summer samples did not meet water quality standards) • Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria) • Total Suspended Solids (wet-weather samples are five-times that of baseflow samples)
Existing instream habitat problems (Lower Bear Creek)	• Lower habitat quality (King County et al., 1989) • Bank Erosion/Instability and Lack of Instream Habitat Diversity (Entranco, 1994) • Loss of vegetation and instream large organic debris (King County et al., 1994)
B-IBI (WRIA8 Regression)	Fair (54.5)
Riparian land cover	Pasture: 12% Trees: 26% Shrub: 25% Impervious: 15% Non-forested wetland: 0% Other: 16%
Public Lands	16% public land
King County Roads	7273100085
King County Property Services	3126069157

Criteria	Data
City of Redmond	3126069002 (Juel Community Park) 3126069004 (Farrel-McWhirter Park) 3126069156 3126069160
Horse and Livestock Lands	30 acres 7273100008; 7273100040; 7273100055; 7273100056; 7273100065; 7273100067; 7273100238; 7273100239; 7273100226; 7273100229; 7273100231; 3126069001; 3126069011; 3126069114; 3126069119; 3126069120; 1243100005; 1243100010; 1243100016; 1243100025; 1243100033; 1243100040; 2926069011; 2926069061; 2926069075; 2926069081
Right-of-Ways	15 acres (including road surface) Avondale NE 116 th St Several residential streets
Property Value	\$1,077,084 per acre Lower costs along outside of Redmond city limits along NE 116 th St
Untreated Impervious Area	20% of catchment is untreated impervious land (drainages are not mapped for Redmond stormwater facilities) - Residences near 196th AVE NE and NE 113th St - Avon Villa Mobile Home Park
Existing Stormwater Facilities	- RD Pond for Glosten (DS0086) – built 2008 - RD Pond for DOT (DT0050) – built 1993 - Redmond Vault (03-3125) – built 2003 (Texaco) - Redmond Pond (95-0980) – build date unknown - Redmond Vault (96-2370) – built 1996 (Bear Creek Overlook) - Redmond Pond/Vault (91-1140) – built 1991 (Essex Park Townhouses) - Redmond Vault (04-0700) – built 2005 (Avondale Retail=
Easements	None
Groundwater	Much of the catchment is in Redmond Wellhead Protection Zone 3. The SE region near Avondale and 116 th St is Zone 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff. The catchment has low to high susceptibility to groundwater contamination.
Stream Shade	49% of the stream has less than 50% shading Hot spots of low shade: Low canopy cover through Bear Creek Natural Area; invasive grass present

Table 8. Summary of Identified Strategies for BEA200 (Avondale and 116th St) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for pastureland			X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X

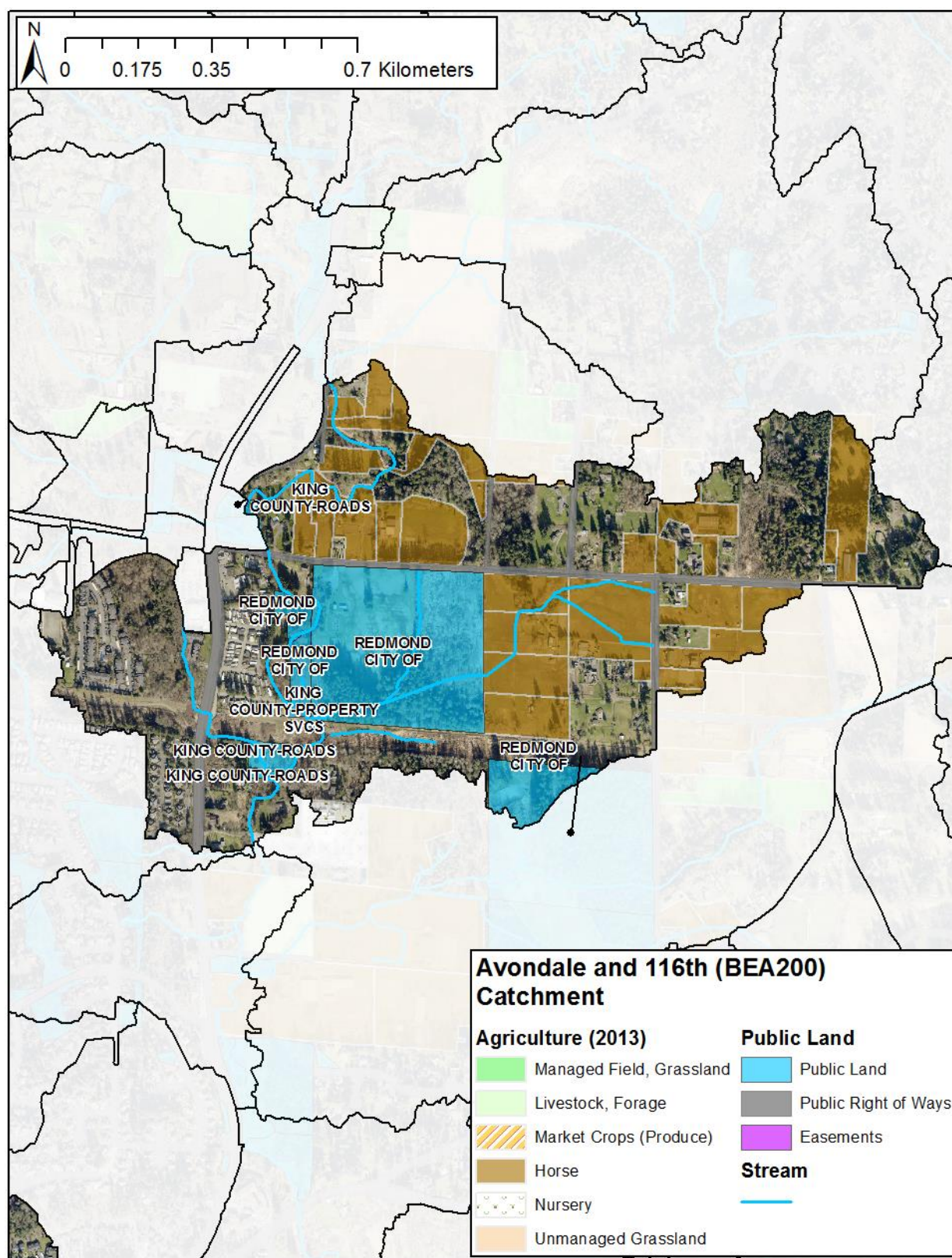


Figure 10. Avondale and 116th (BEA200) catchment agricultural and public land.

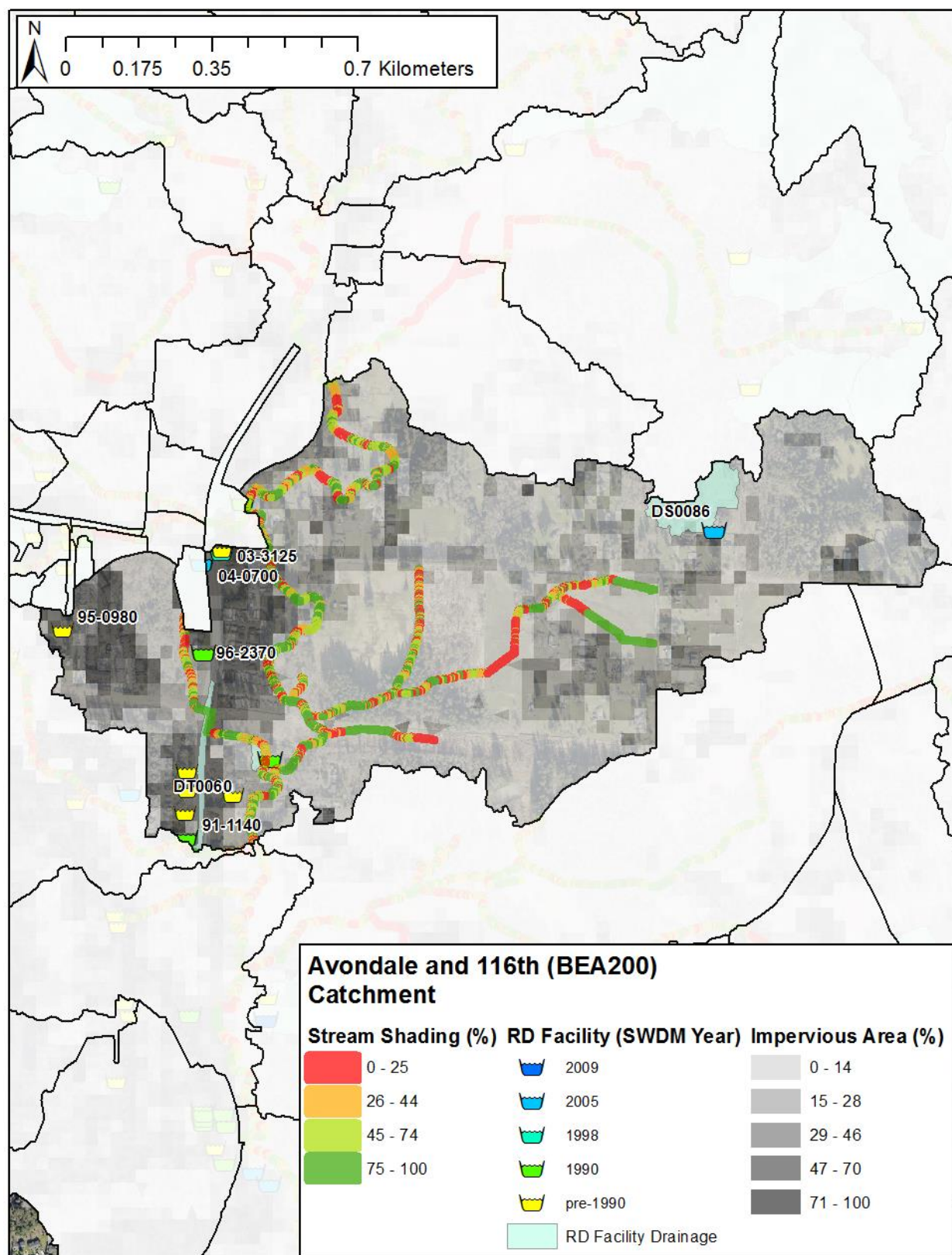


Figure 11. Avondale and 116th (BEA200) catchment stream shading, impervious area, and RD facilities and their drainage area.

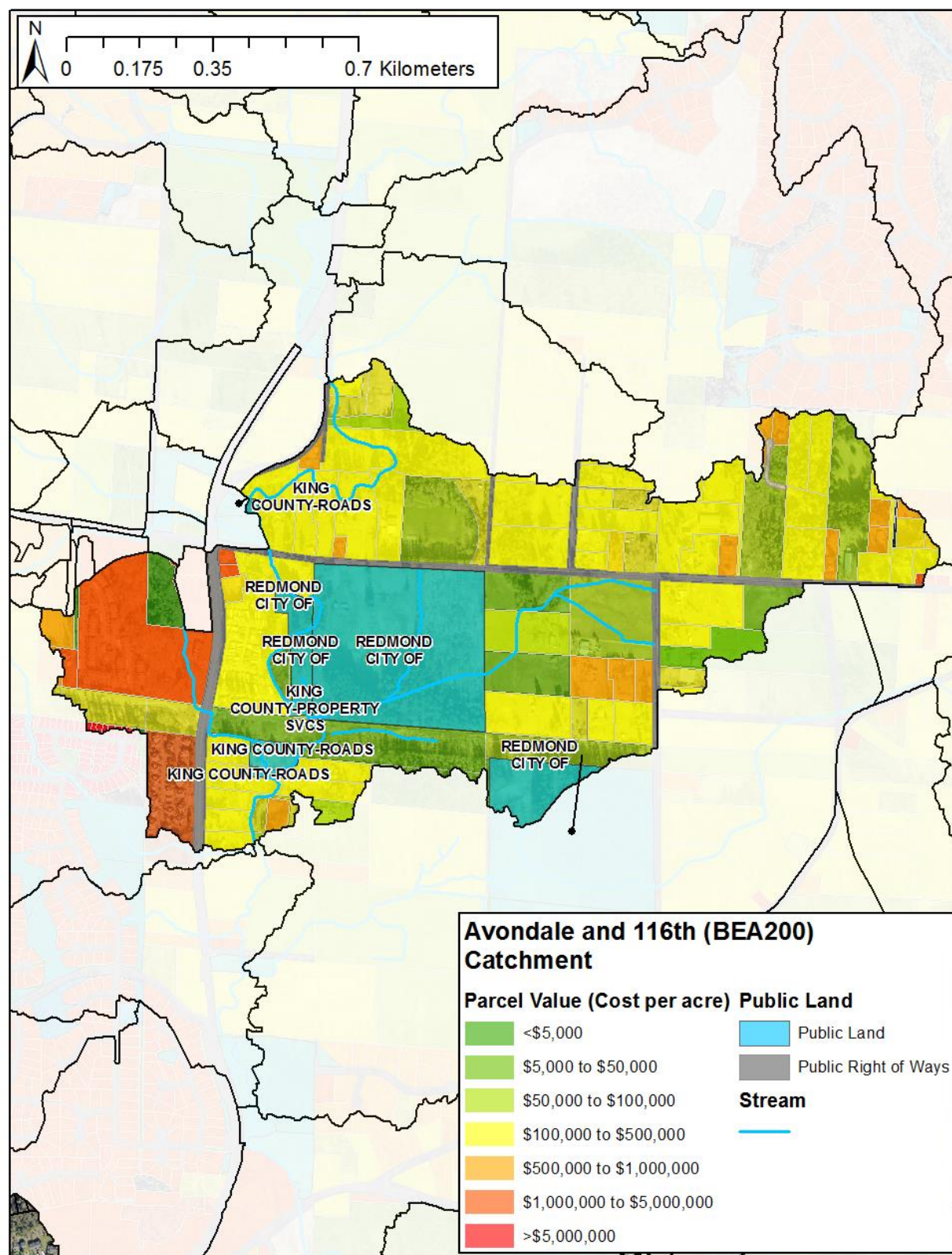


Figure 12. Avondale and 116th (BEA200) catchment parcel values and public lands.

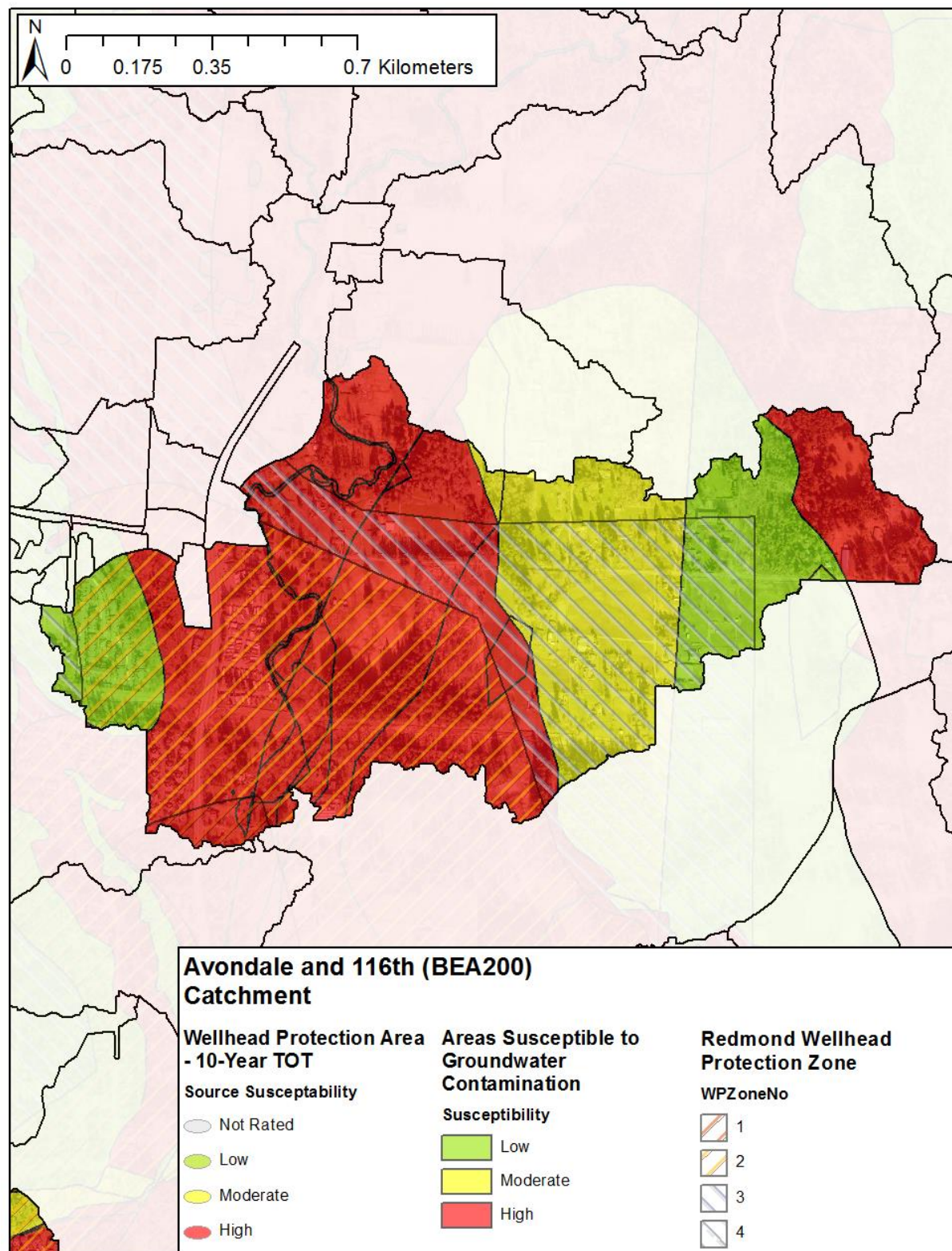


Figure 14. Avondale and 116th (BEA200) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff. No wellhead protection 10-year TOT in catchment.

3.4 BEA740 – Avondale and 165th St (Score 83)

The Avondale and 165th St (BEA740) catchment is a tributary to Cottage Lake Creek. The catchment is 160 acres in area. The catchment is predominately low-density residential development, with some medium-density residential and commercial development towards the northern end. Avondale Road is major arterial. Installation of roadside bioretention facilities is identified in the Avondale right-of-way. Because the area is highly susceptible to groundwater contamination, road runoff would need to be treated prior to infiltration.

Table 9. Available data for BEA740 (Avondale and 165th St) catchment.

Criteria	Data
Existing water quality problems (Cottage Lake Creek)	• Temperature (72% of summer 7-DADMax temperatures exceed water quality standards) • Dissolved Oxygen (2 of 3 summer samples did not meet water quality standards) • Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria) • Total Suspended Solids (wet-weather samples are more than twice that of baseflow samples)
Existing instream habitat problems	No data for tributary
B-IBI	Poor (23.2)
Riparian land cover	Pasture: 0% Trees: 27% Shrub: 0% Impervious: 18 % Non-forested wetland: 0% Other: 55%
Public Lands	1.3 percent public lands
King County Roads	1628700110; 1628700114; 1628700130; 1774500095
King County Property Services	6139800660
Horse and Livestock Lands	None
Right-of-Ways	22 acres (including road surface) Avondale Several residential streets
Property Value	\$927,793
Untreated Impervious Area	20% of catchment is untreated impervious land • Commercial/residential area along Avondale Rd • Congregation Kol Ami (16530 Avondale Rd NE)
Existing Stormwater Facilities	• Vault for Cottage Lake Elementary School (D98524) – built 2004 • Vault for Cottage Lake Elementary School (D98525) – built 2004

Criteria	Data
Easements	None
Groundwater	Low to high susceptibility to groundwater contamination
Stream Shade	81% of the stream has less than 50% shading

Table 10. Summary of Identified Strategies for BEA740 (Avondale and 165th St) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

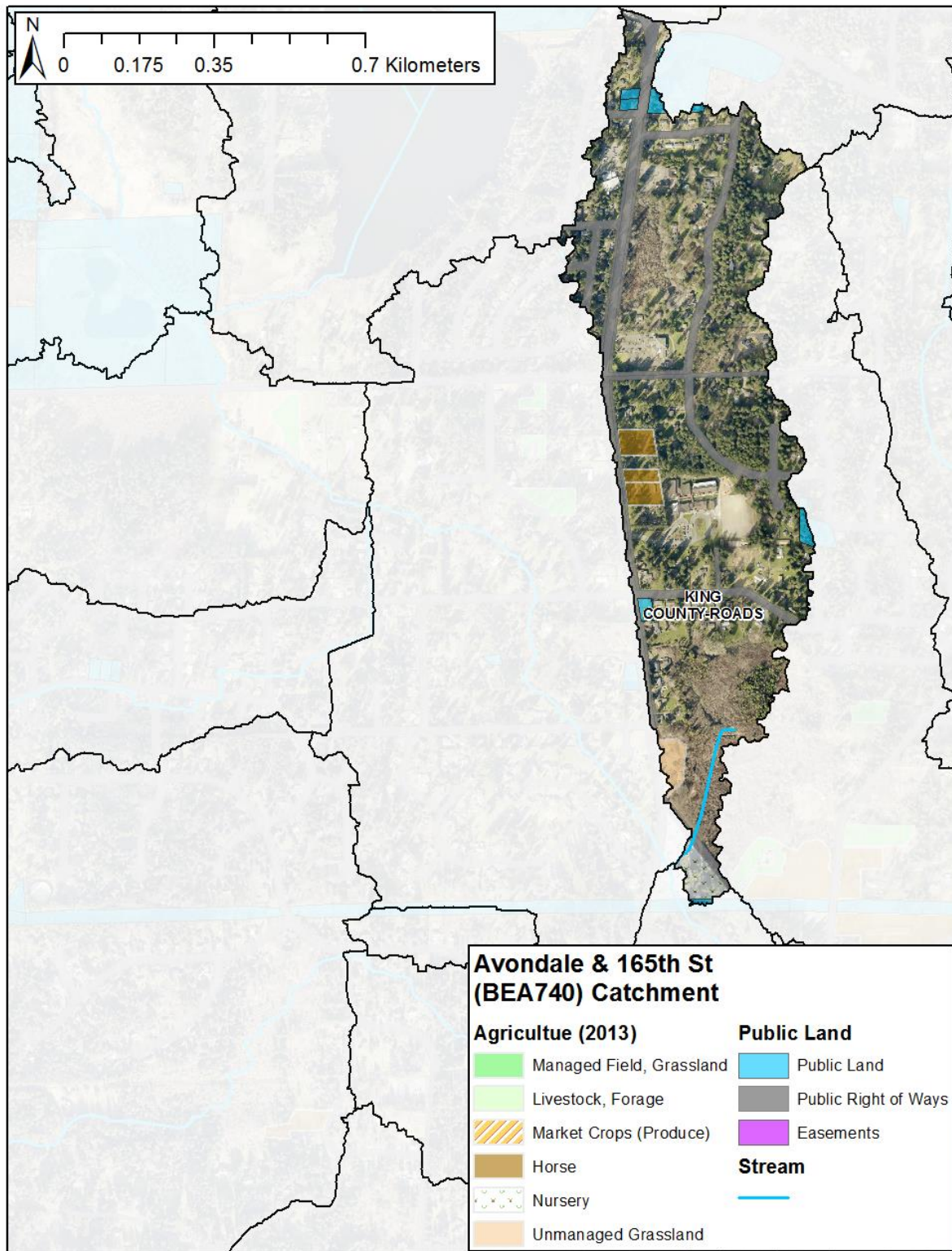


Figure 15. Avondale and 165th St (BEA740) catchment agricultural and public lands.

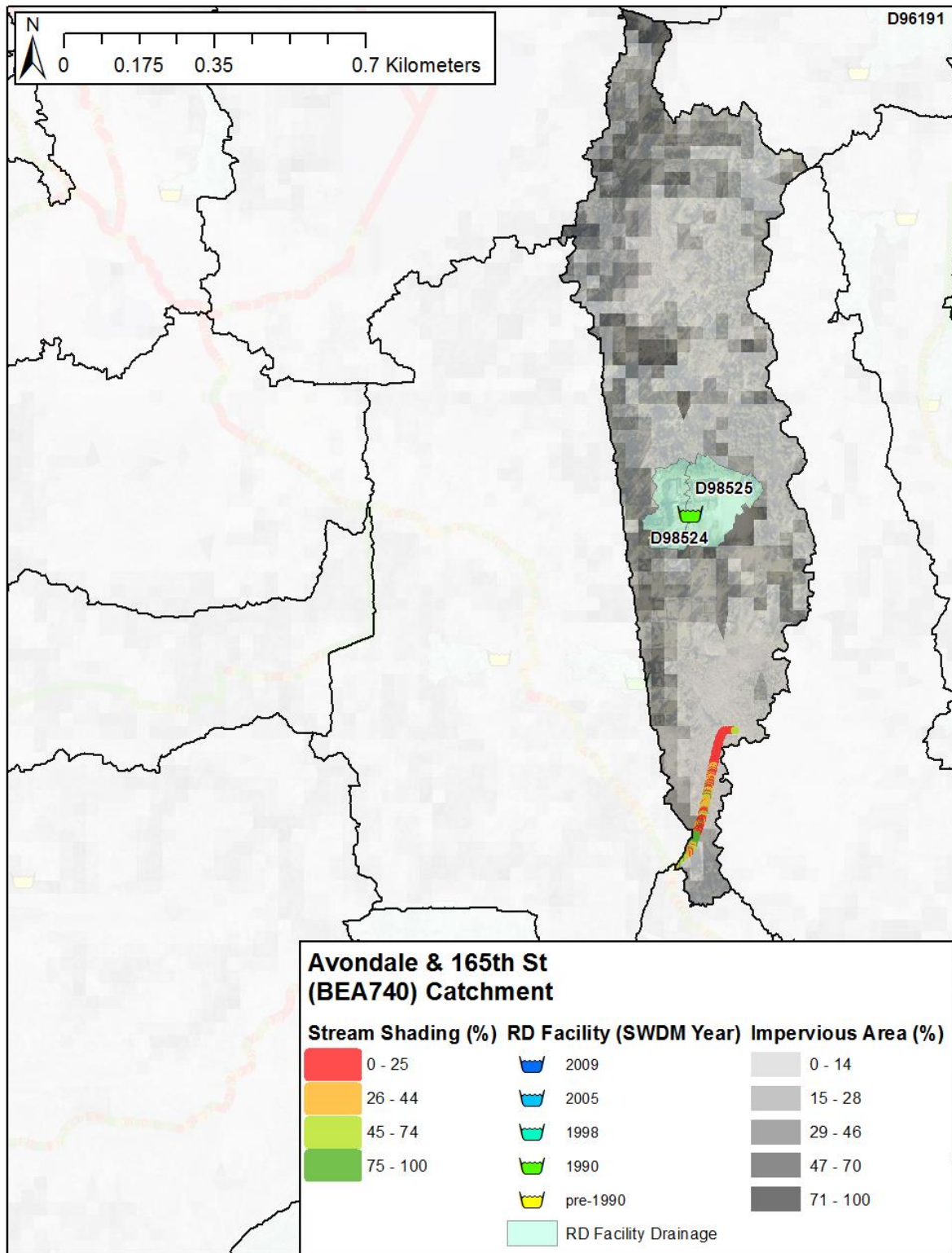


Figure 16. Avondale and 165th St (BEA740) catchment stream shading, impervious area, and RD facilities and their drainage area.

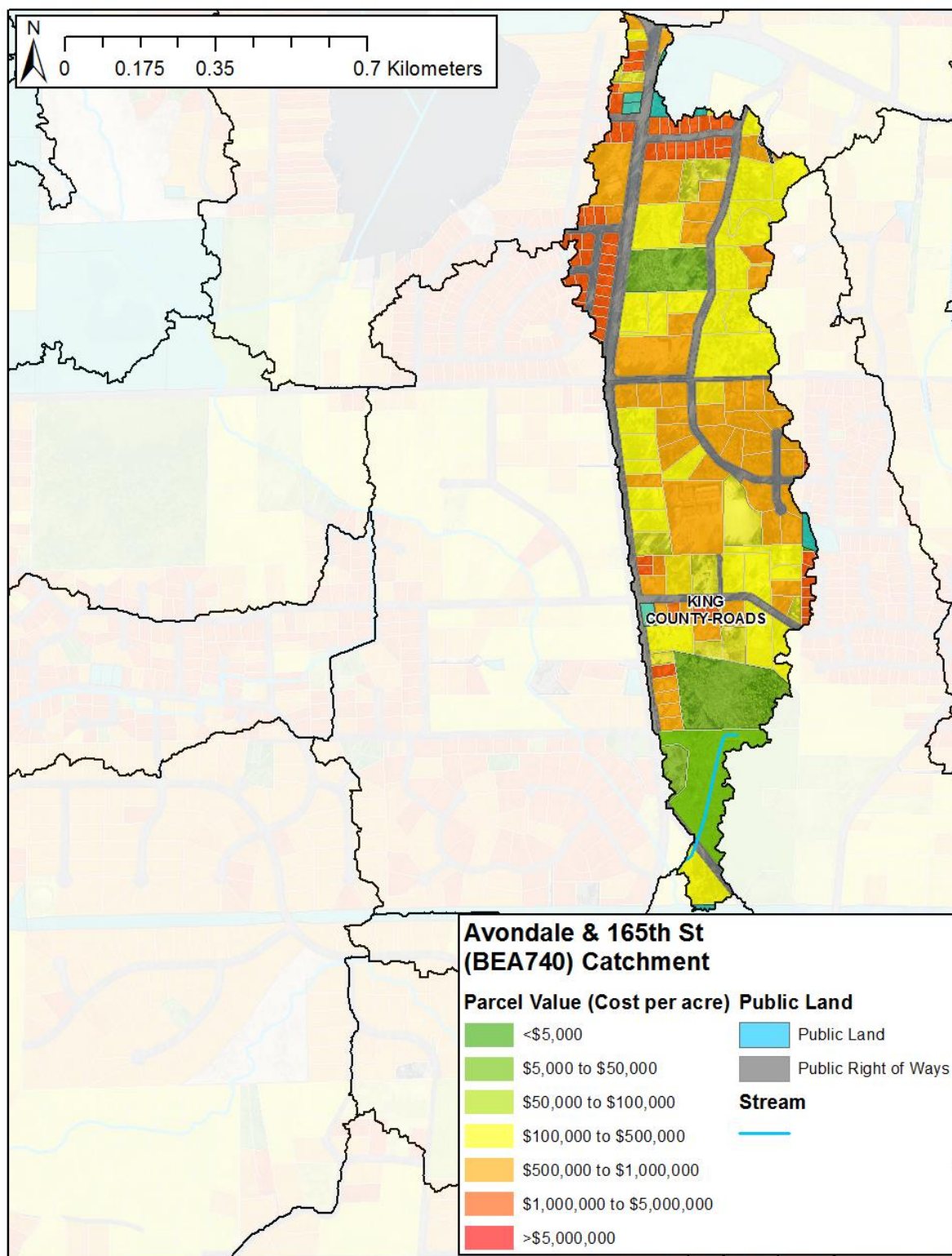


Figure 17. Avondale and 165th St (BEA740) catchment parcel values and public lands.

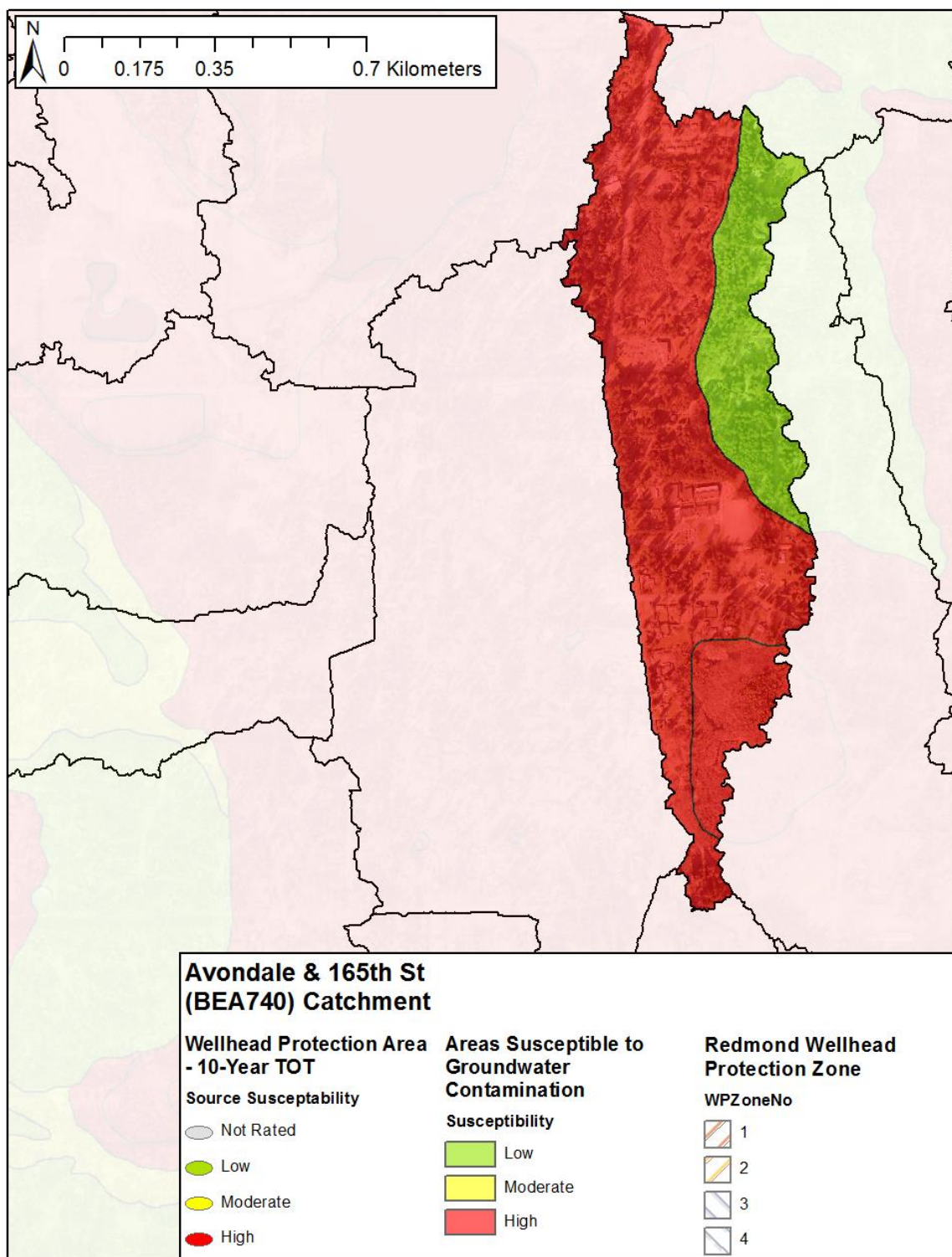


Figure 18. Avondale and 165th St (BEA740) catchment groundwater protection areas. No wellhead protection 10-year TOT in catchment.

3.5 BEA300 – Mid Bear Creek Natural Area (Score: 75)

The Mid Bear Creek Natural Area (BEA300) is approximately 1.2 km upstream of the confluence of Bear and Cottage Lake creeks. The catchment is 63 acres in area. While much of the catchment is forested, the immediate stream area is often unshaded with the presence of reed canarygrass, an invasive plant. Riparian restoration and tree planting is identified within the County-owned Bear Creek Natural Area.

The RD facility serving Fire Station #33 was constructed prior to 1990 and likely does not meet current design standards (Figure 19). It identified that the facility be inspected and, if needed, updated to provide better storage and water quality treatment. Because the area is highly susceptible to groundwater contamination, road runoff would need to be treated prior to infiltration.

Table 11. Available data for Mid Bear Creek Natural Area (BEA300) catchment.

Criteria	Data
Existing water quality problems (Middle Bear Creek)	• Temperature (87% of summer 7-DADMax temperatures exceed water quality standards) • Dissolved Oxygen (3 of 3 summer samples did not meet water quality standards) • Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria) • Total Suspended Solids (wet-weather samples are twice that of baseflow samples)
Existing instream habitat problems (Middle Bear Creek)	Not properly functioning: Pool quantity, large wood debris At risk: pool quality (Parametrix, 2002)
B-IBI (WRIA8 Regression)	Fair (55.7)
Riparian land cover	Pasture: 28% Trees: 45% Shrub: 32% Impervious: 5% Non-forested wetland: 8% Other: 11%
Public Lands	44% public land
King County Roads	0625100020; 0625100021
King County Parks	7701961400; 3026069103; 0625100116 (Middle Bear Creek Natural Area)
Horse and Livestock Lands	None
Right-of-Ways	5 acres (including road surface) Bear Creek Road NE NE 133rd St

Criteria	Data
Property Value	\$441,281 Lower costs along either side of NE 133rd St
Untreated Impervious Area	4% of catchment is untreated impervious land - NE 133rd St and 198th Dr NE - Generally forested
Existing Stormwater Facilities	RD Pond for Fire Station #33 (D96906) – built 1986
Easements	None
Groundwater	High Susceptibility to Groundwater Contamination
Stream Shade	56% of the stream has less than 50% shading Hot spots of low shade: Low canopy cover through Bear Creek Natural Area; invasive grass present

Table 12. Summary of Identified Strategies for Mid Bear Creek Natural Area (BEA300) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Remove invasive reed canarygrass and plant riparian trees on County-owned land		X		X	
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X

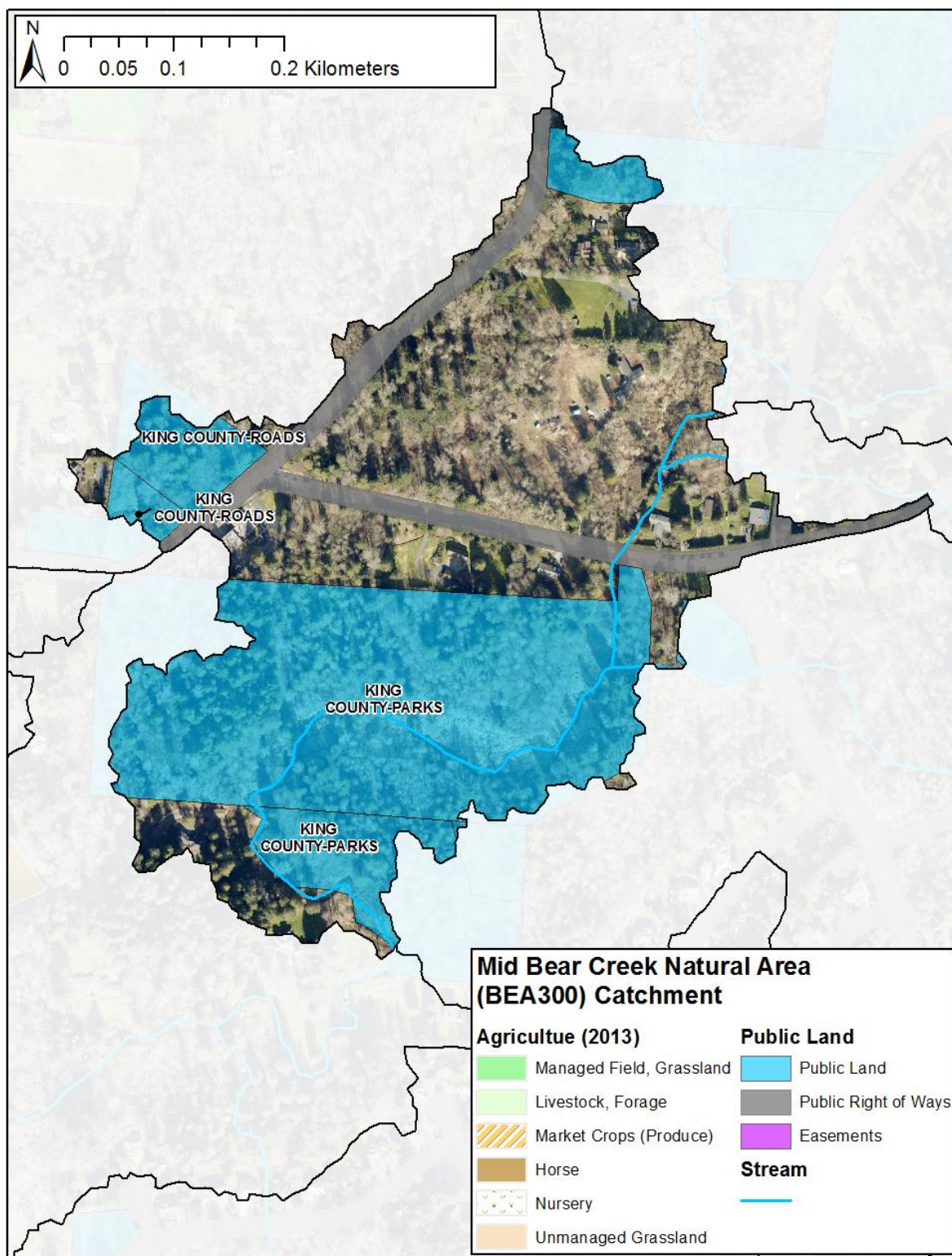


Figure 19. Mid Bear Creek Natural Area (BEA300) catchment agricultural and public land.

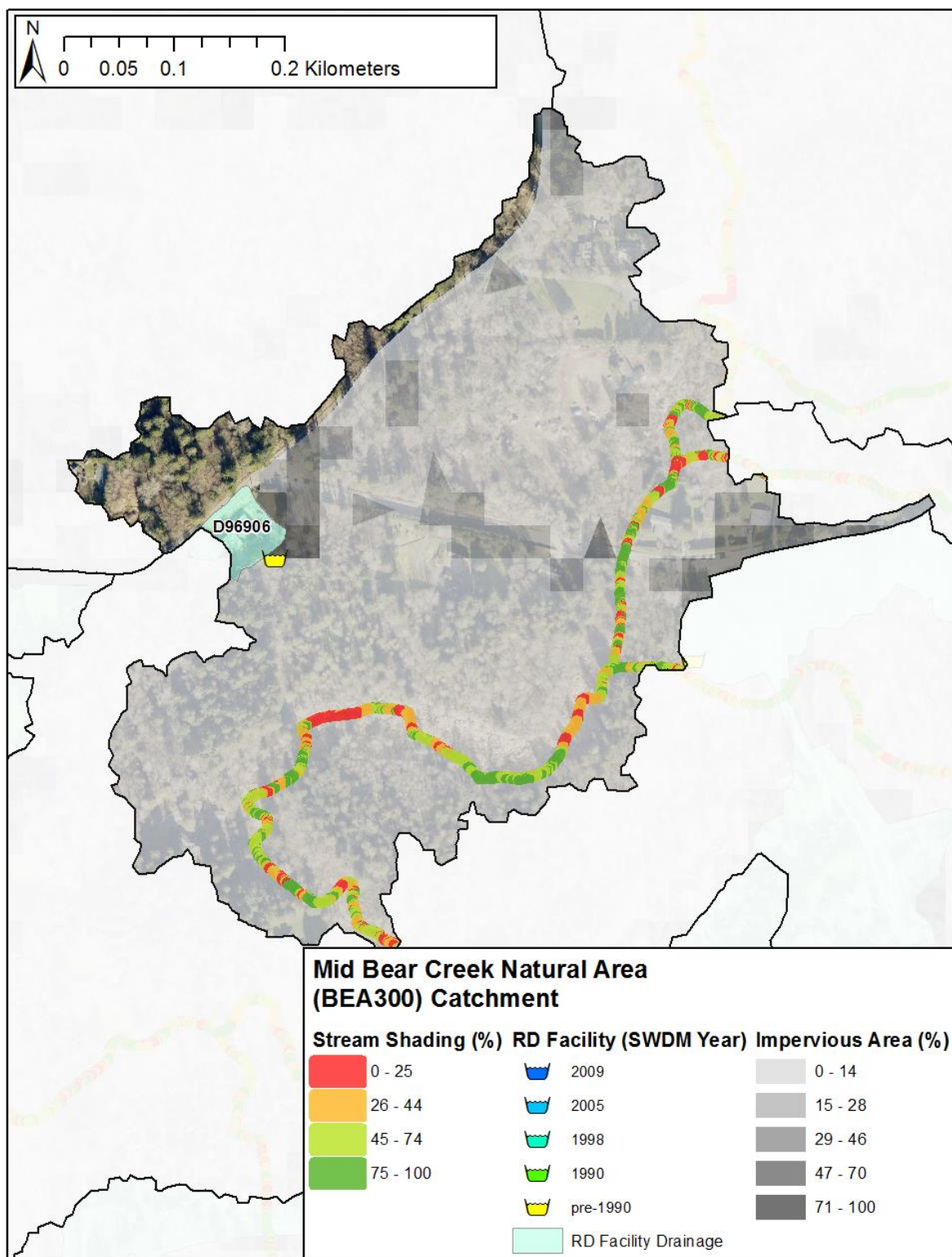


Figure 20. Mid Bear Creek Natural Area (BEA300) catchment stream shading, impervious area, and RD facilities and their drainage area.

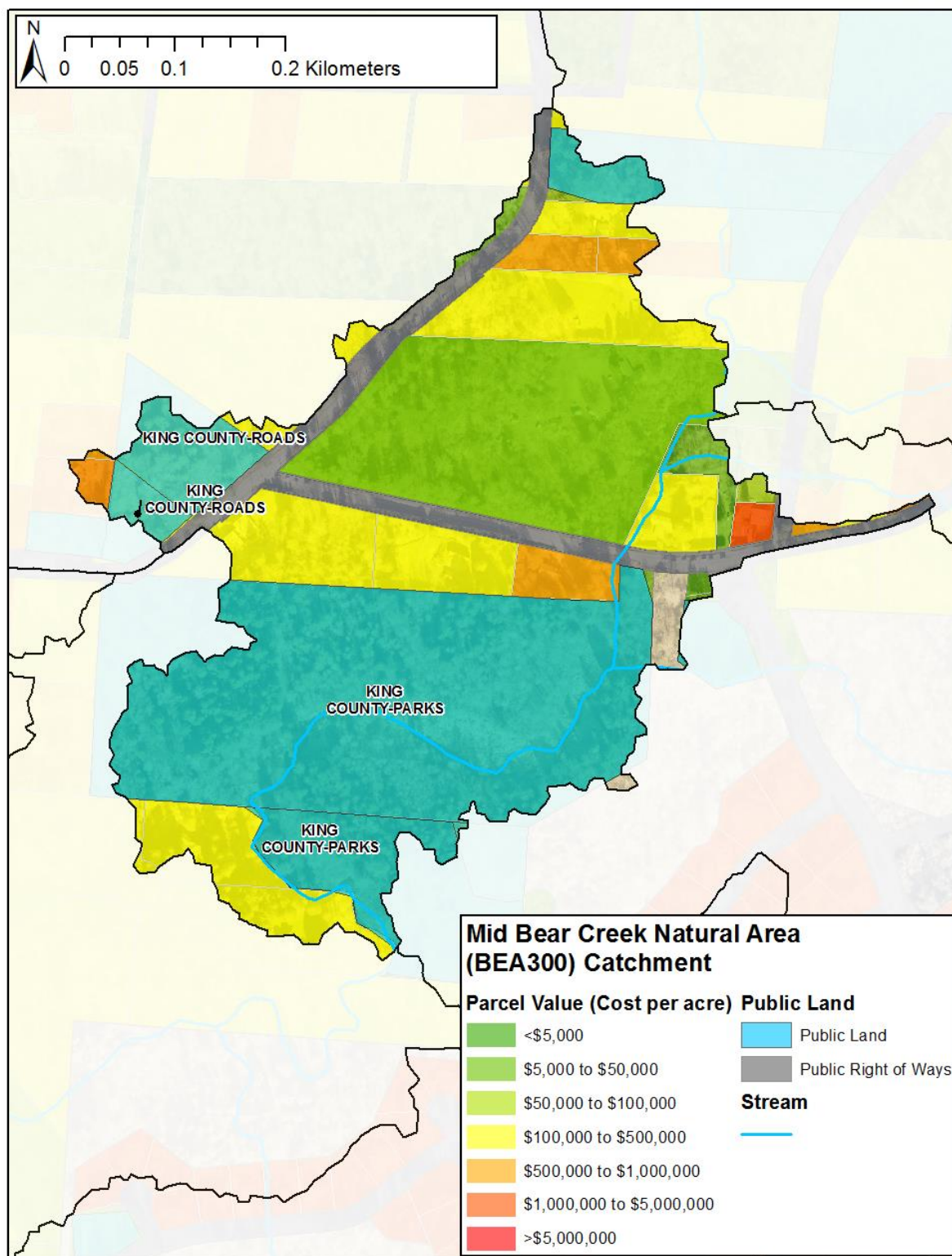


Figure 21. Mid Bear Creek Natural Area (BEA300) catchment parcel values and public lands.

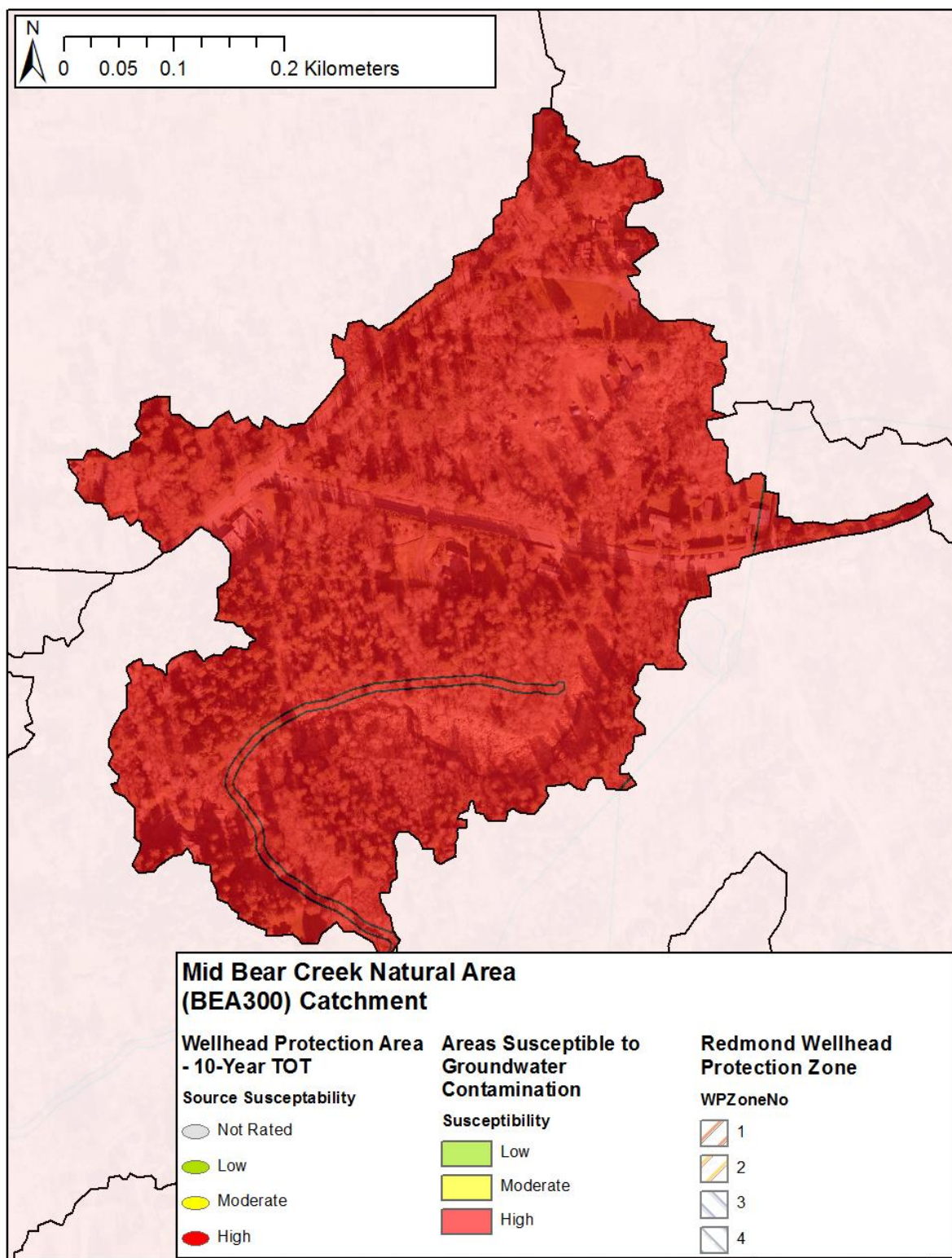


Figure 22. Mid Bear Creek Natural Area (BEA300) catchment groundwater protection areas. No wellhead protection 10-year TOT in catchment.

4.0 PRIORITY SNOHOMISH COUNTY CATCHMENTS

For catchments located primarily within unincorporated Snohomish County, The data input to the prioritization metric and the resulting final score are displayed in Table 13 with the catchments ranked. The following sections detail the five top-ranked catchments and discuss potential projects and actions to improve water quality and hydrology.

In addition to the three priority catchments identified in the Bear Creek study area, the Maltby catchment (BEA970) and Paradise Lake Conservation Area (BEA920) were identified as priority catchments. The catchments are not within the Bear Creek study area, draining to Cottage Lake. However, the BEA970 catchment and the northern and southern sections of BEA920 are highly impervious, which has negative consequences on the hydrology and water quality in Daniels Creek and eventually Cottage Lake.

Table 13. Ranked catchments located primarily in Snohomish County and prioritization metric input data. Grouped catchments highlighted with the same color, except catchment outside study area shaded in grey.

Catchment	Scoring Metrics									Total Score
	Water Quality	B-IBI	Untreated Impervious	Storm-water Facility	Forage Live-stock	Property Cost	Public Land	Right-of-way	Roof	
BEA970	15	30	30	0	0	15	10	8	5	118
BEA920	15	10	5	0	0	10	20	0	5	65
BEA960	15	10	5	0	0	10	20	0	5	65
BEA625	15	10	0	0	0	15	20	0	5	65
BEA660	15	10	0	0	0	15	20	0	5	65
BEA630	15	10	10	0	0	15	0	8	5	63
BEA620	15	10	5	0	0	15	10	0	5	60
BEA640	15	10	0	0	0	15	10	0	5	55
BEA670	15	0	10	0	0	15	0	0	10	50
BEA665	15	10	5	0	0	15	0	0	5	50
BEA650	15	10	0	0	0	15	0	0	5	45

4.1 BEA620/625/630 – NE Paradise Lake (Score: 65)

The NE Paradise Lake (BEA620/625/630) catchments drain to Paradise Lake. The catchments are 318 acres in area. The catchments are a mix of low-density, rural residential and forested land use. It is identified that the existing stormwater detention and treatment infrastructure be inspected and their drainage area assessed. If undersized or not meeting current standards, it is identified the detention facilities be upgraded. Gaps in the current stormwater infrastructure should be identified and new facilities constructed or flows rerouted to existing facilities. Tree plantings suitable for the wetland environment along the waterway are also identified.

Table 14. Available data for NE Paradise Lake (BEA620/625/630) catchments.

Criteria	Data
Existing water quality problems	- Bear Creek above Paradise Lake water quality was not assessed - Downstream Paradise Lake is highly productive and on the 303(d) of impaired waters for total phosphorus.
Existing instream habitat problems	Highest quality habitat (King County et al., 1989)
B-IBI (WRIA8 Regression)	Fair (51.7, 48.9, and 42.5)
Riparian land cover	2% impervious 80% forested 8% shrub 7% other 3% pasture
Public Lands	20% public land
King County Parks	0526069001, 0526069028
Snohomish County	00793000099700 (retention pond)
Cross Valley Water District	27063300400800
Horse and Livestock Lands	4 acres 27063300300700
Right-of-Ways	27 acres (including road surface) Several residential streets and connectors Siler Logging Company Railroad
Property Value	\$226,572 Western catchment is generally lower cost per acre
Untreated Impervious Area	6% of catchment is untreated impervious land
Existing Stormwater Facilities	There is one stormwater facility mapped by Snohomish County along 234th St SE
Easements	None
Groundwater	- Critical Aquifer Recharge Areas are not mapped in Snohomish County - King County portion of catchment is low susceptibility to groundwater contamination - A 10-year TOT wellhead protection area in the eastern catchment with low susceptibility to contamination
Stream Shade	43% of the stream has less than 50% shading

Table 15. Summary of Identified Strategies for NE Paradise Lake (BEA620/625/630) catchments.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

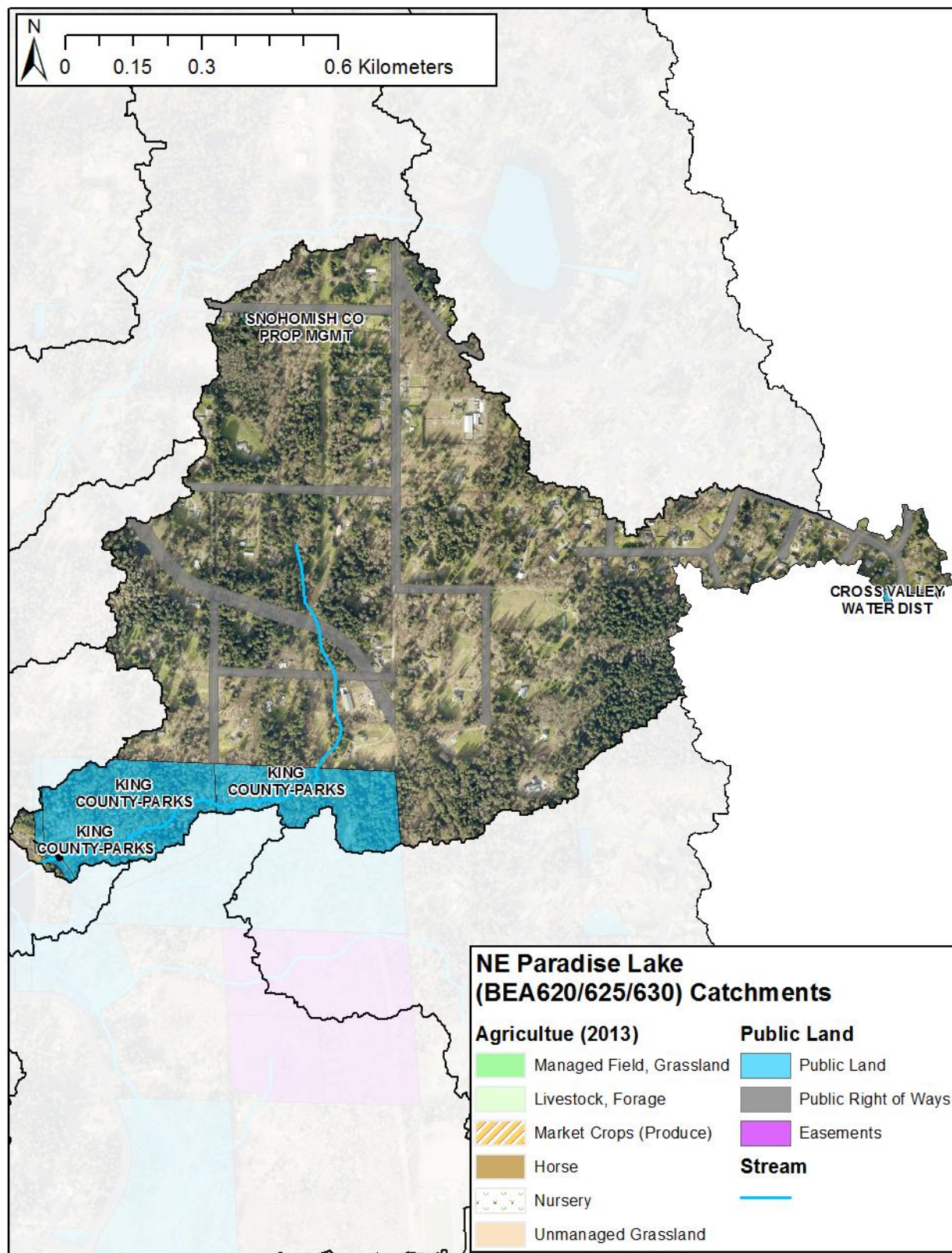


Figure 23. NE Paradise Lake (BEA620/625/630) catchment agricultural and public land.

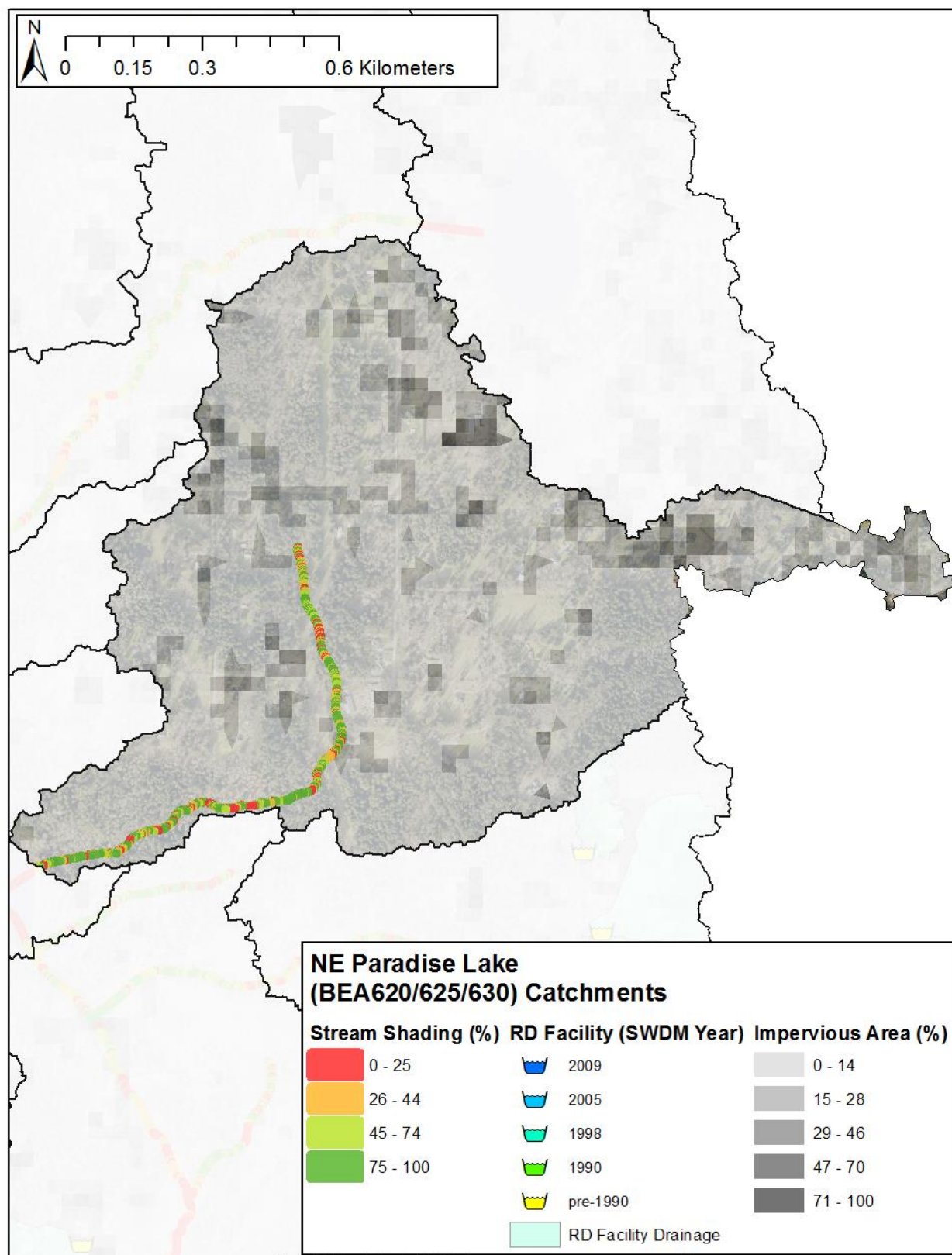


Figure 24. NE Paradise Lake (BEA620/625/630) catchment stream shading, impervious area, and RD facilities and their drainage area.

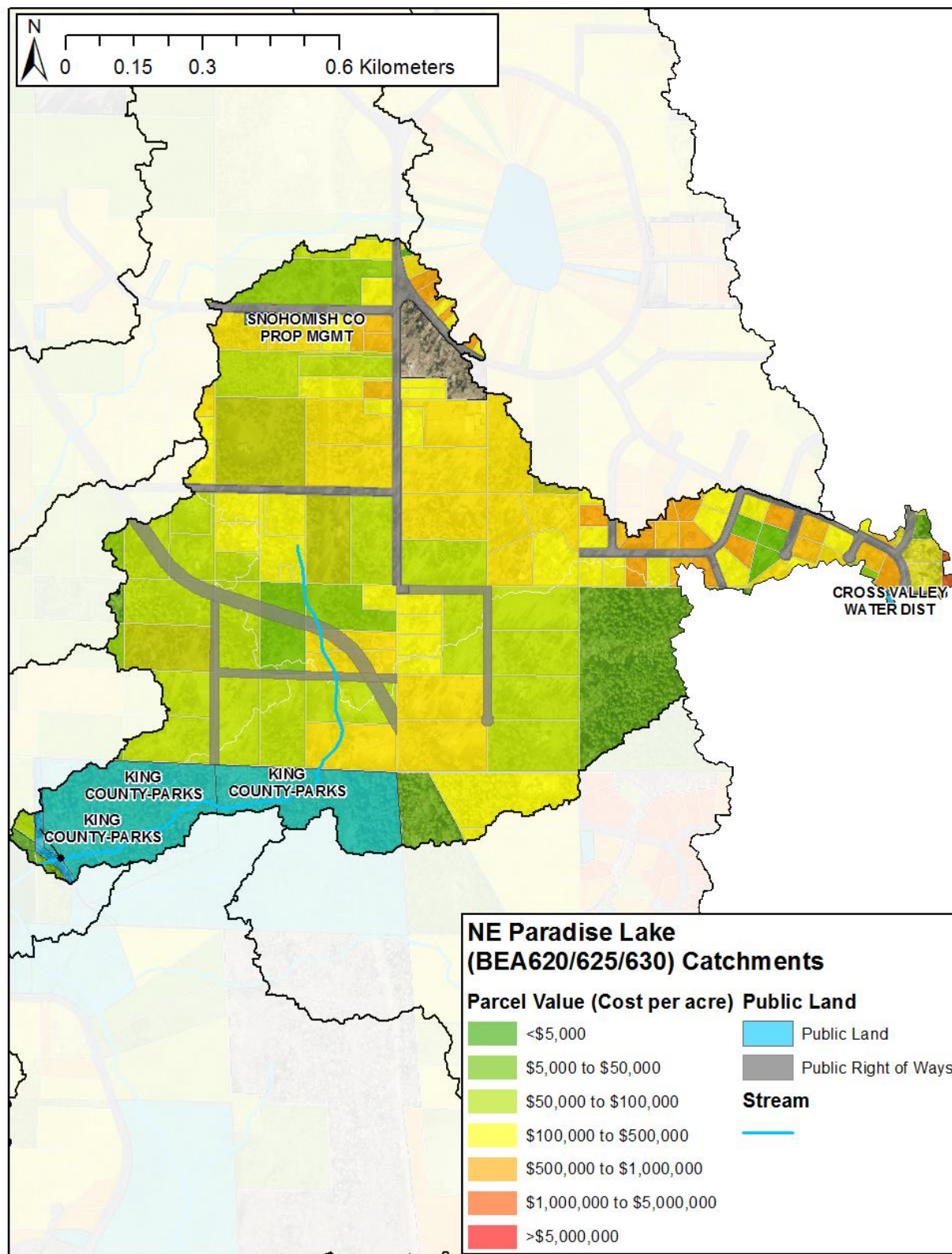


Figure 25. NE Paradise Lake (BEA620/625/630) catchment parcel values and public lands.

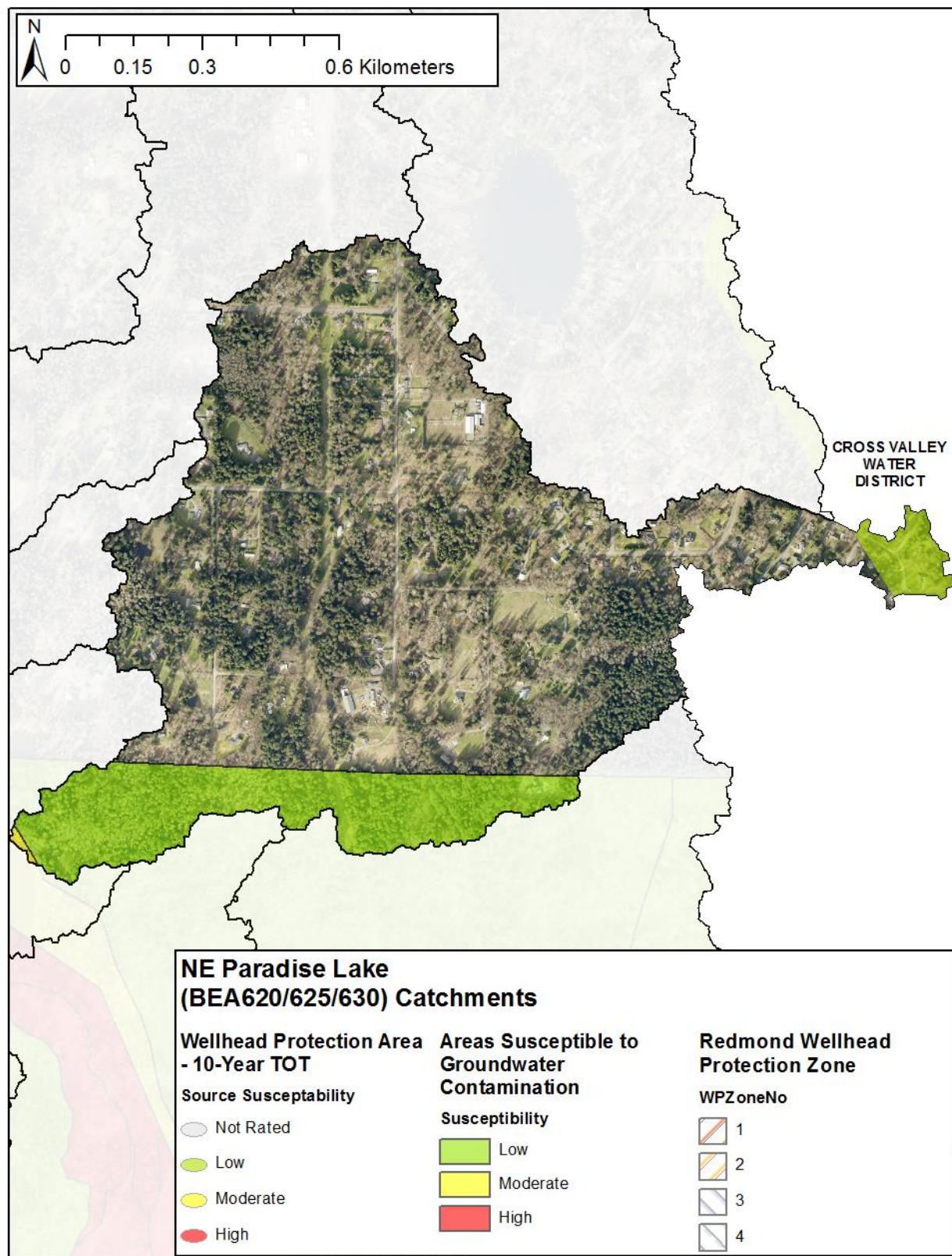


Figure 26. NE Paradise Lake (BEA620/625/630) catchment groundwater protection areas.

4.2 BEA640/660 – Bear Above Paradise Lake (Score: 65)

The Bear Above Paradise Lake (BEA640 and 660) catchments drain to Paradise Lake. The catchment is 1220 acres in area. Much of the catchments are owned by Snohomish County as part of the Paradise Valley Conservation Area, which is composed of forest and wetlands.

Low-density residential development is also present in the eastern and northwestern portions of the catchments. The installation of LID features in developed areas and along roadways is identified. An incentive program may be used for LID installation for existing development.

It is identified that the existing stormwater detention and treatment infrastructure be inspected and their drainage area assessed. If undersized or not meeting current standards, it is identified the detention facilities be upgraded. Gaps in the current stormwater infrastructure should be identified and new facilities constructed or flows rerouted to existing facilities. Tree plantings suitable for the wetland environment along the waterway are also identified.

Table 16. Available data for Bear Above Paradise Lake (BEA640/660) catchments.

Criteria	Data
Existing water quality problems	- Bear Creek above Paradise Lake water quality was not assessed - Downstream Paradise Lake is highly productive and on the 303(d) of impaired waters for total phosphorus.
Existing instream habitat problems	No data
B-IBI (WRIA8 Regression)	Fair (58.5 and 58.2)
Riparian land cover	2% impervious 45% trees 8% shrubs 30% non-forested wetland 11% other 4% pasture
Public Lands	34% public land - Paradise Valley Conservation Area
Snohomish County Property Management	27063100100100; 27063000302000; 27063100100200; 27063200200200; 27063100200300
Snohomish County Public Utility District 1	27062900401600
Horse and Livestock Lands	None
Right-of-Ways	60 acres (including road surface) Paradise Lake Rd Echo Lake Rd Siler Logging Company Railroad

Criteria	Data
Property Value	\$202,953/acre Residential parcels are generally lower cost per acre
Untreated Impervious Area	4% of catchment is untreated impervious land There are several stormwater detention and treatment facilities in the catchment, but their drainage areas have not yet been mapped.
Existing Stormwater Facilities	There are several stormwater detention and treatment facilities in the catchment, but their drainage areas have not yet been mapped.
Easements	None
Groundwater	• Critical Aquifer Recharge Areas are not mapped in Snohomish County • Several 10-year TOT wellhead protection areas in catchment with low to high susceptibility to contamination operated by the Cross Valley Water District.
Stream Shade	65% of the stream has less than 50% shading Hot spots of low shade: ○ Bear Creek flows through a largely unshaded wetland

Table 17. Summary of Identified Strategies for Bear Above Paradise Lake (BEA640/660) catchments.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

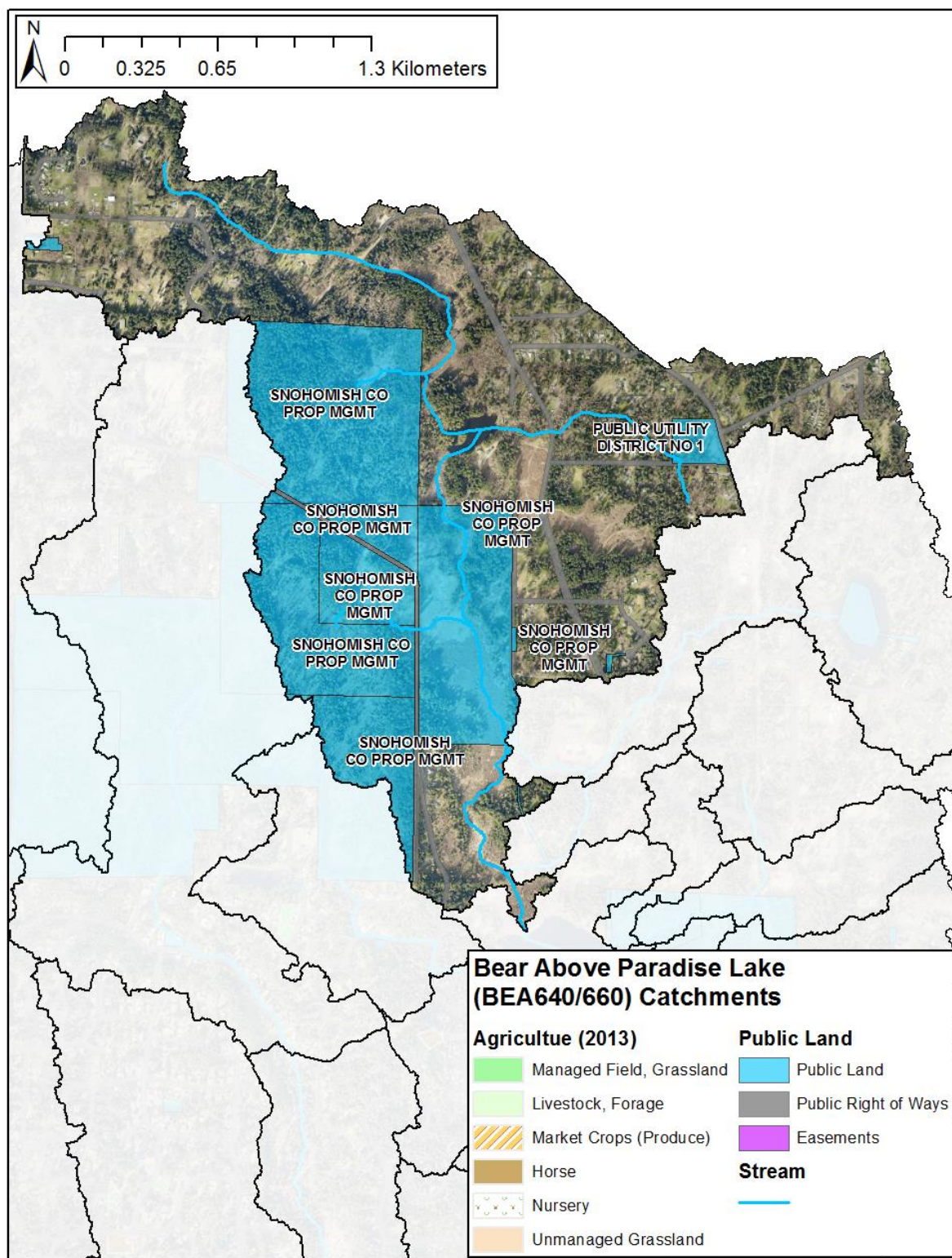


Figure 27. Bear Above Paradise Lake (BEA640/660) catchment agricultural and public land.

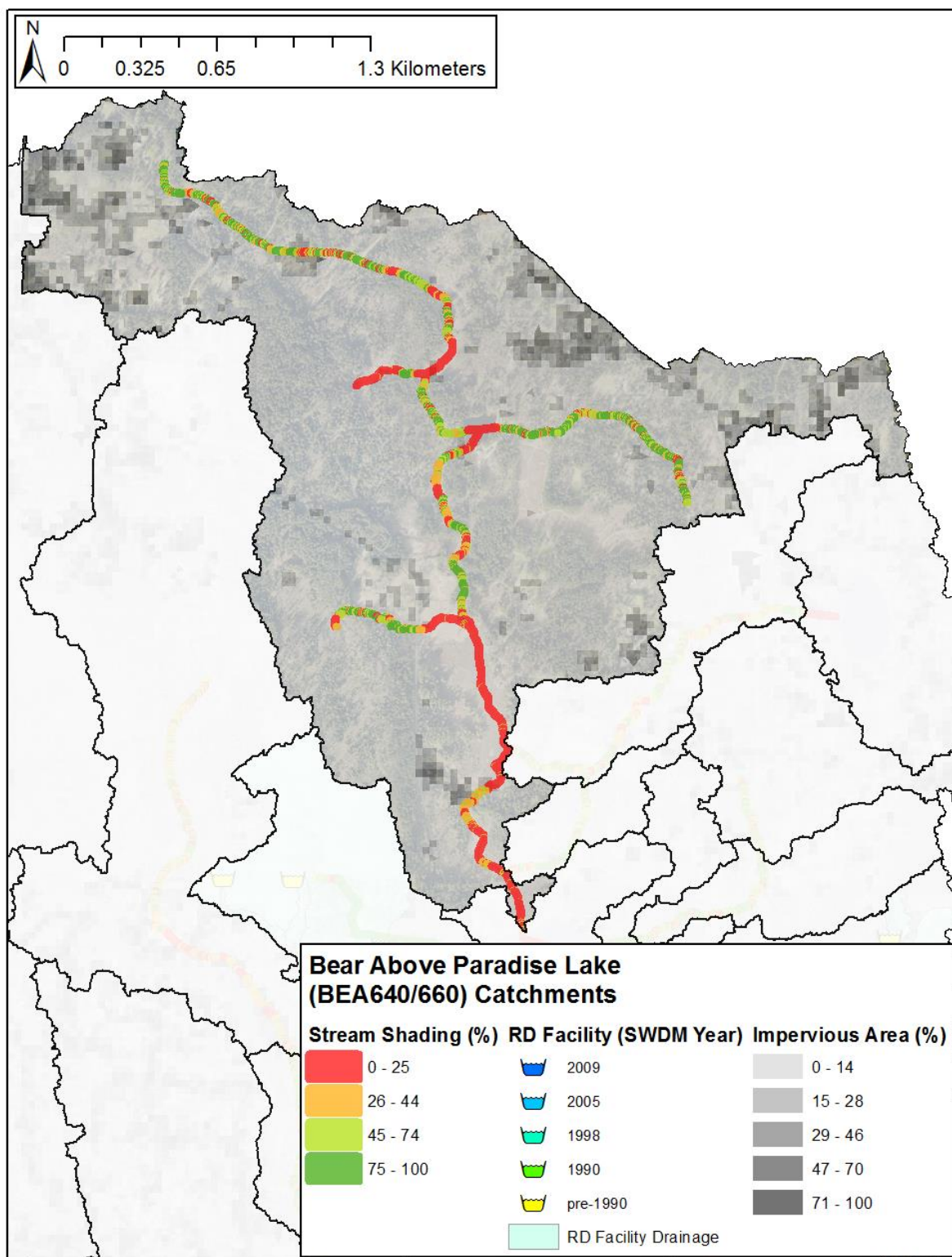


Figure 28. Bear Above Paradise Lake (BEA640/660) catchment stream shading, impervious area, and RD facilities and their drainage area.

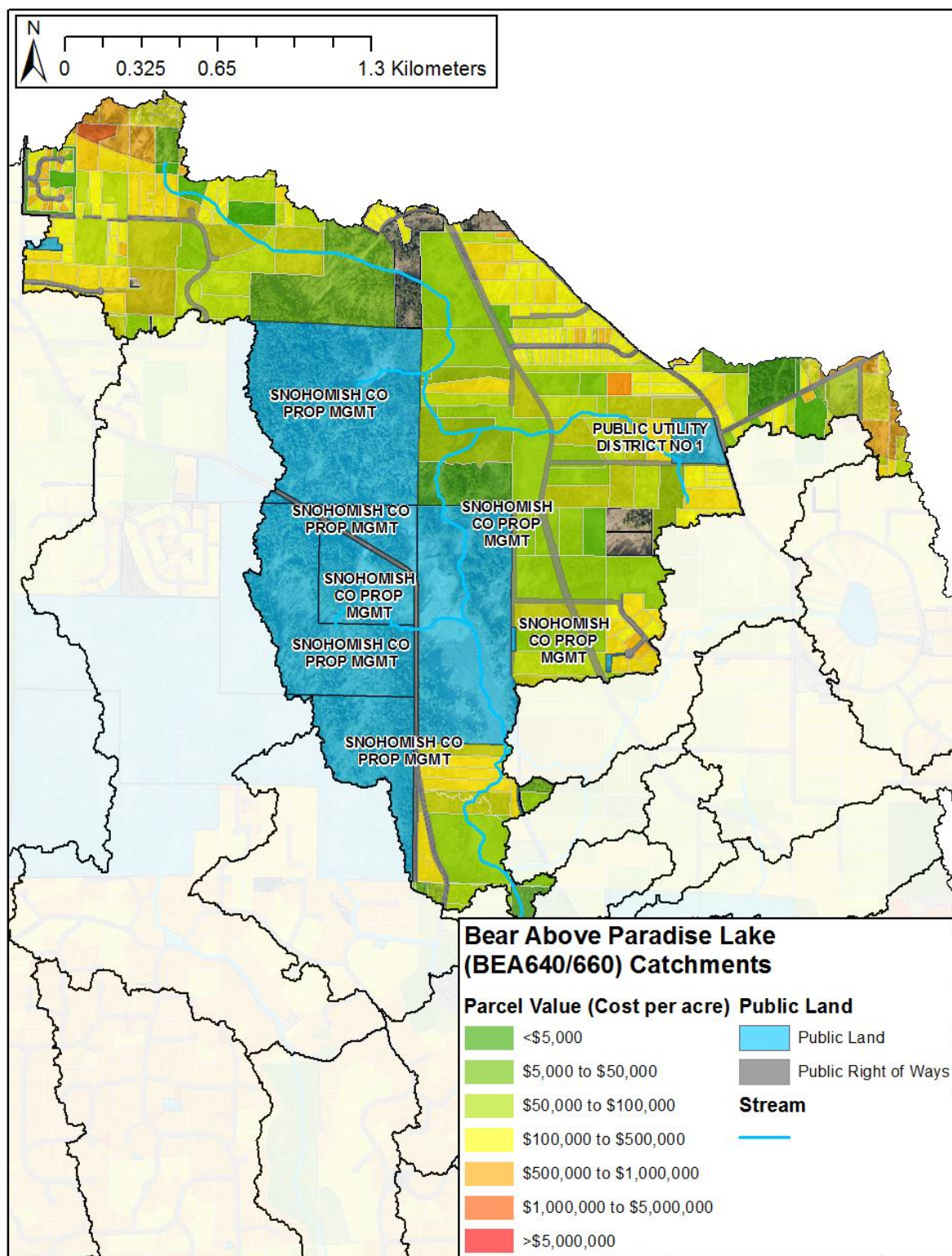


Figure 29. Bear Above Paradise Lake (BEA640/660) catchment parcel values and public lands.

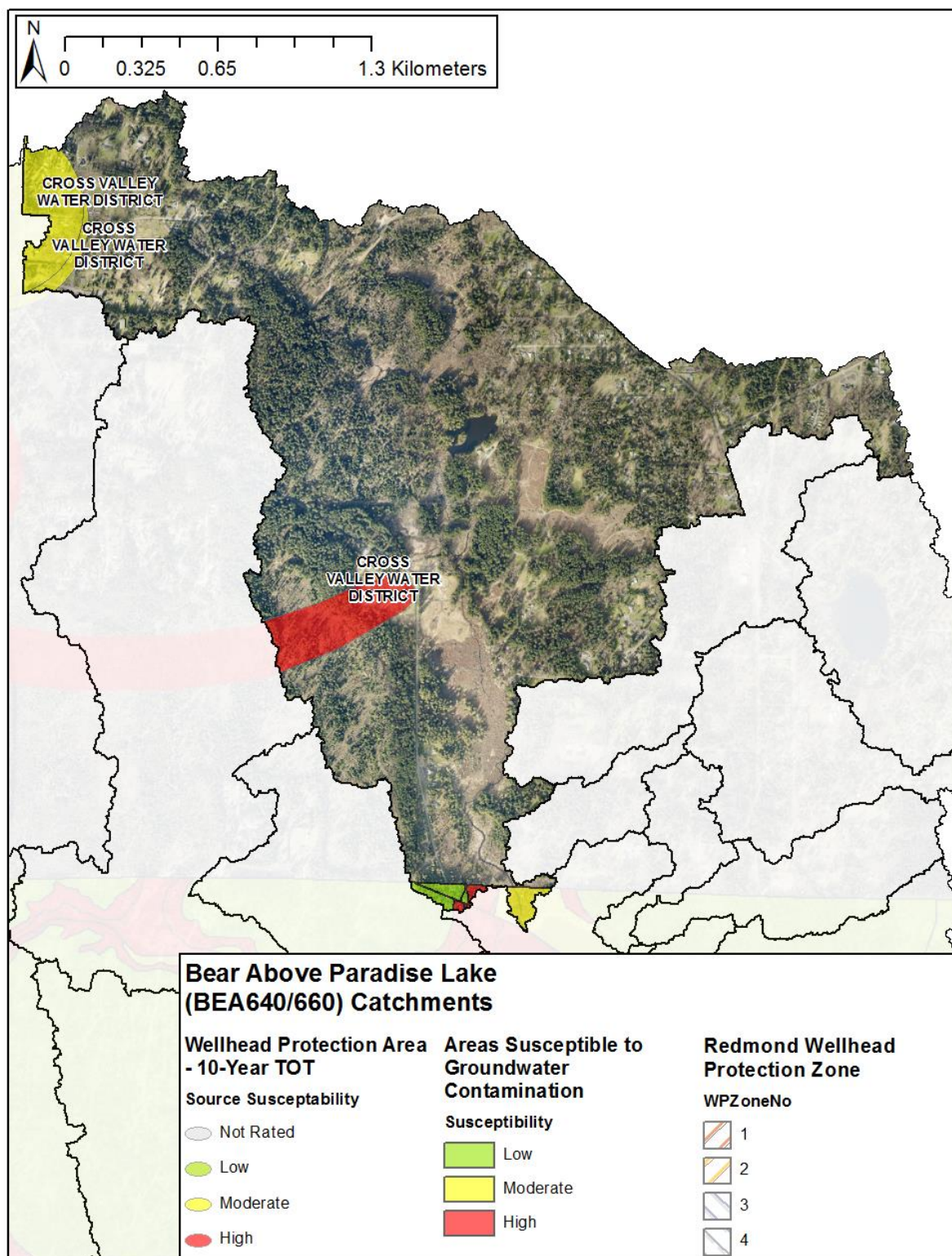


Figure 30. Bear Above Paradise Lake (BEA640/660) catchment groundwater protection areas.

4.3 BEA670 – Echo Lake (Score: 55)

The Echo Lake (BEA670) catchment drains to Bear Creek Above Paradise Lake (BEA640/660). The catchment is 185 acres in area. The catchment is mostly low-density residential with Echo Lake receiving its runoff.

It is identified that the existing stormwater detention and treatment infrastructure be inspected and their drainage area assessed. If undersized or not meeting current standards, it is identified the detention facilities be upgraded. Gaps in the current stormwater infrastructure should be identified and new facilities constructed or flows rerouted to existing facilities. Tree plantings along the waterway are also identified.

Snohomish County is identified to continue encouraging shoreline restoration along Echo Lake, to support septic inspection, and to support lawn and garden lakeside best management practices (e.g., P-free fertilizers, dog waste pickup).

Table 18. Available data for Echo Lake (BEA670) catchment.

Criteria	Data
Existing water quality problems (Echo Lake)	- Not assessed as part of water quality assessment. - Echo Lake is on the 303(d) of impaired water for total phosphorus.
Existing instream habitat problems	No data
B-IBI (WRIA8 Regression)	Good (63.2)
Riparian land cover	5% impervious 3% trees 7% non-forested wetland 84% other (water)
Public Lands	5% public land
State Department of Game	00433100006300 (Echo Lake); 00433100003800
Horse and Livestock Lands	None
Right-of-Ways	14 acres (including road surface) Echo Lake Rd Several residential streets
Property Value	\$439,093 Residential parcels are generally lower cost per acre
Untreated Impervious Area	8% of catchment is untreated impervious land
Existing Stormwater Facilities	There are three stormwater facilities mapped by Snohomish County along E Echo Lake Rd.
Easements	None
Groundwater	- Critical Aquifer Recharge Areas are not mapped in Snohomish County - A 10-year TOT wellhead protection area in the eastern catchment with low susceptibility to contamination
Stream Shade	97% of the stream has less than 50% shading Hot spots of low shade: Echo Lake outlet is not well-shaded

Table 19. Summary of Identified Strategies for Echo Lake (BEA670) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Shoreline restoration/stewardship along Echo Lake		X	X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

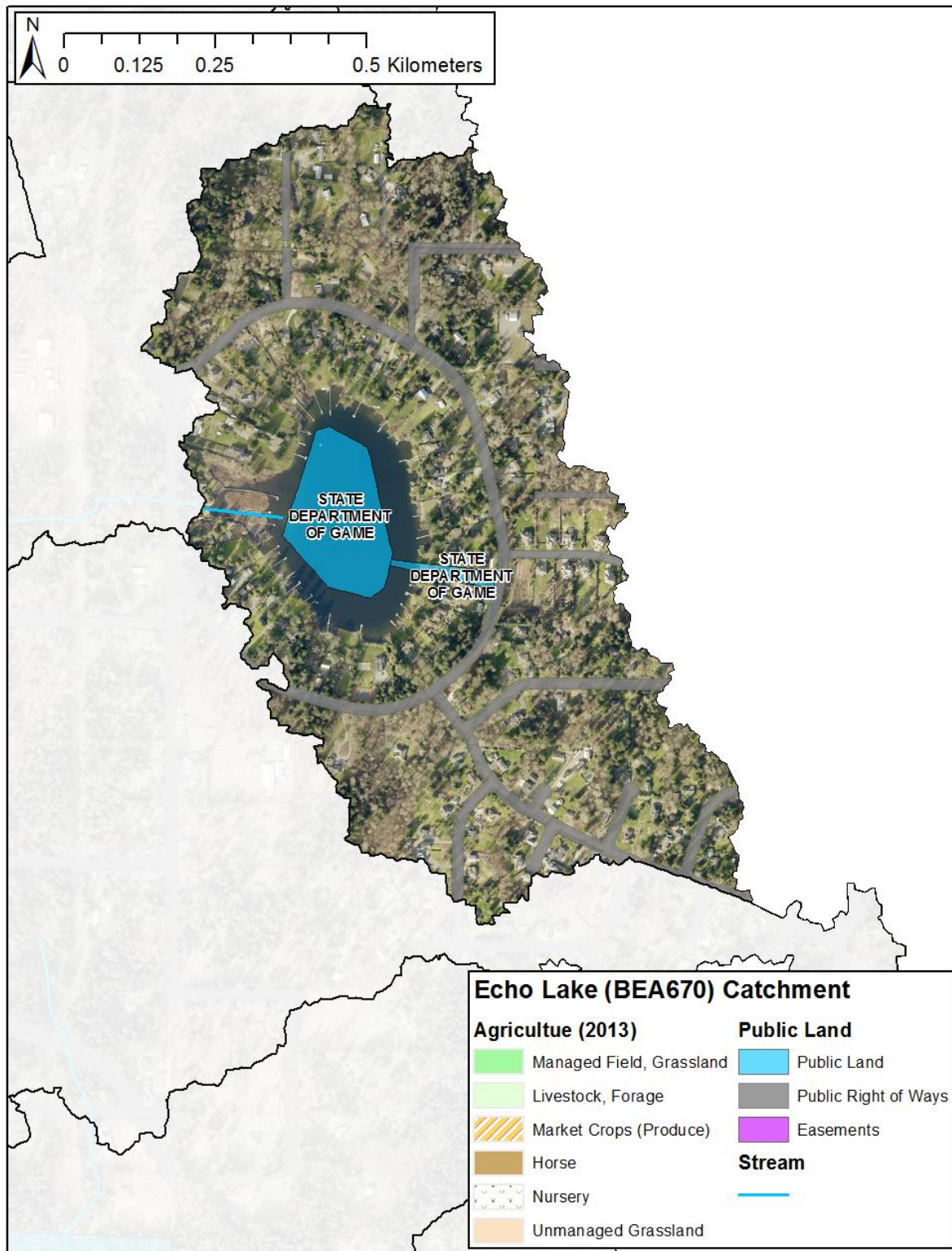


Figure 31. Echo Lake (BEA670) catchment agricultural and public land.

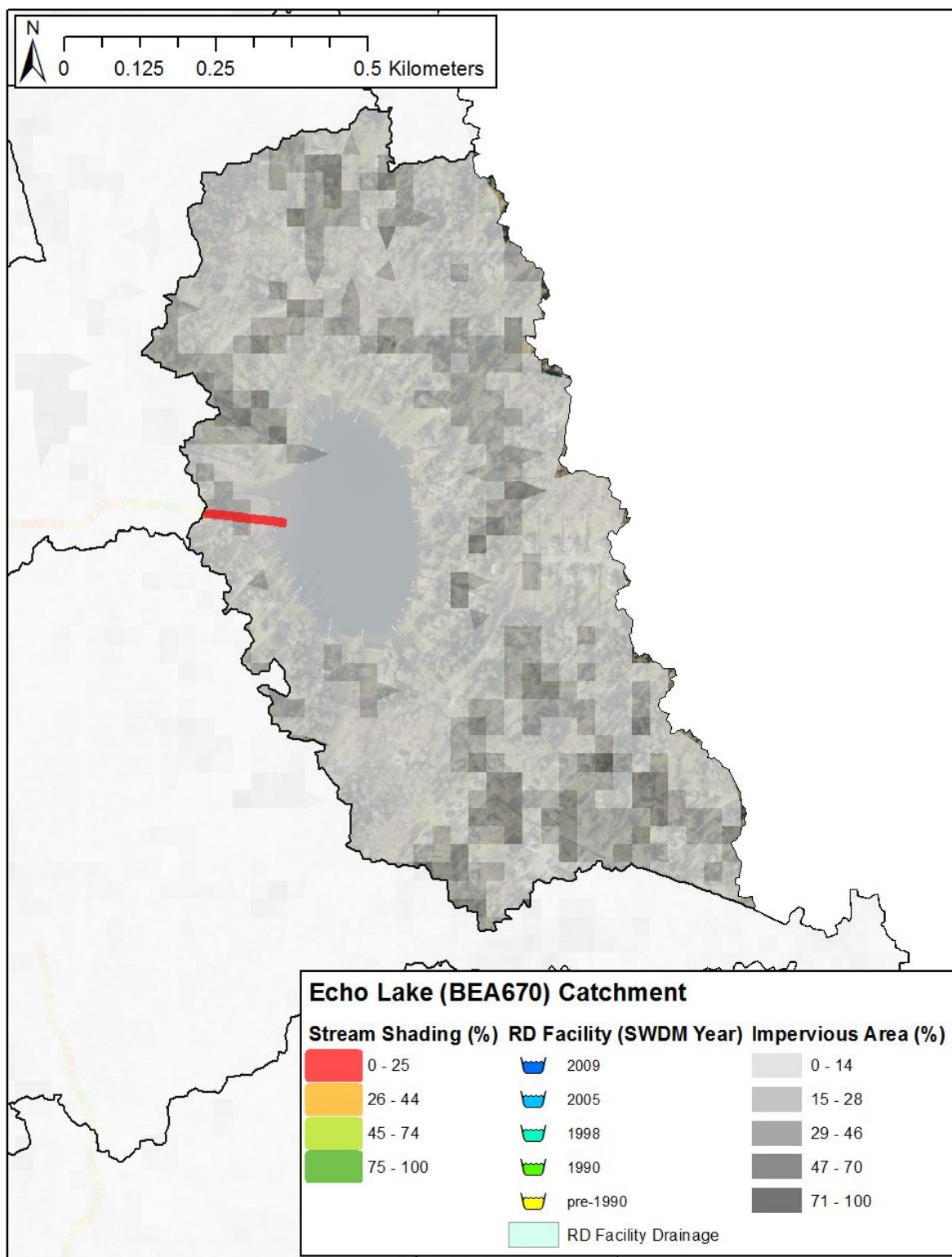


Figure 32. Echo Lake (BEA670) catchment stream shading, impervious area, and stormwater (RD) facilities and their drainage area.

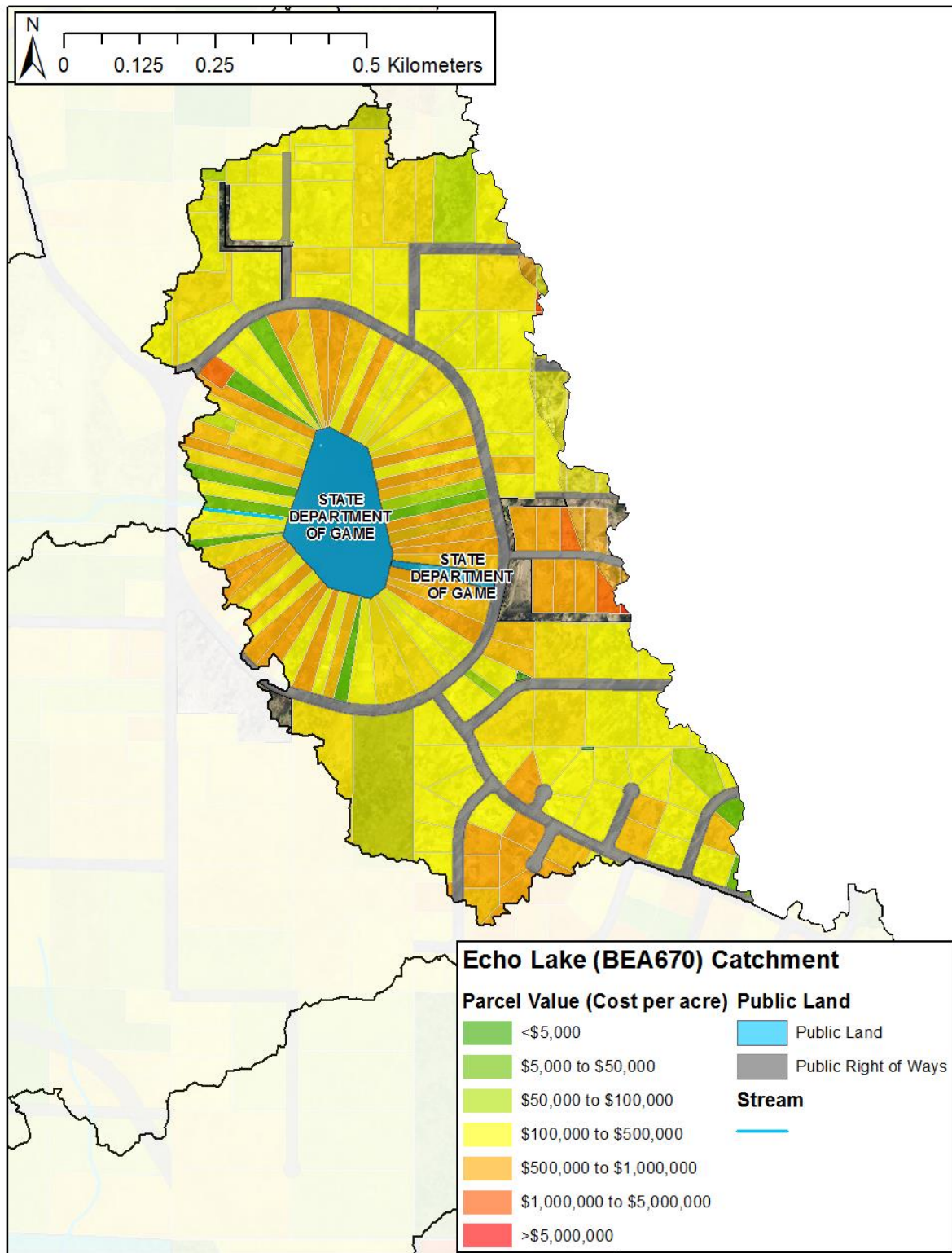


Figure 33. Echo Lake (BEA670) catchment parcel values and public lands.

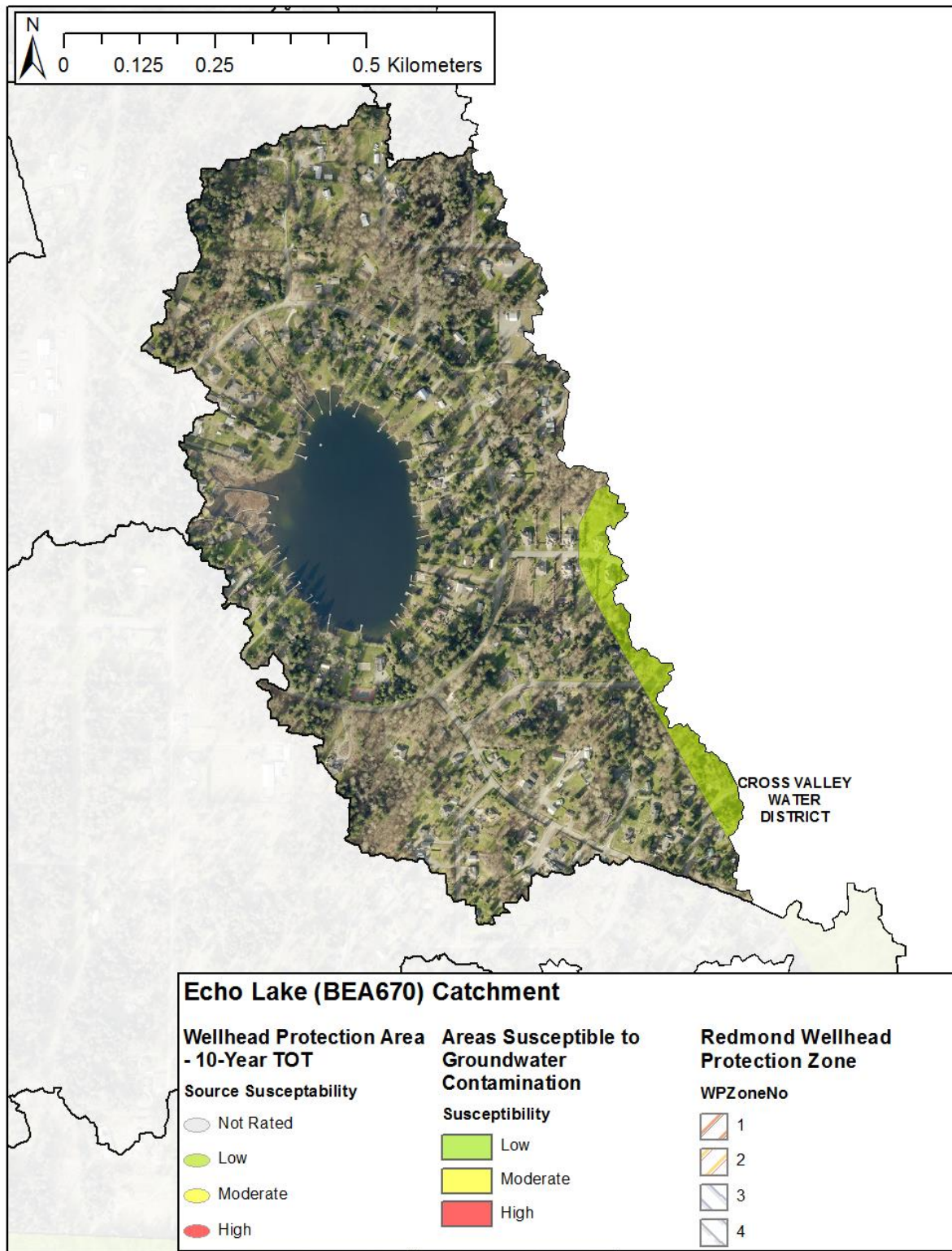


Figure 34. Echo Lake (BEA670) catchment groundwater protection areas

4.4 BEA970 – Maltby (Score: 118) (outside study area – drains to Cottage Lake)

The Maltby (BEA970) catchment drains to Crystal Lake, whose outlet is Daniels Creek that drains to Cottage Lake. The catchment is 693 acres in area. The catchment is a mixture of industrial and residential land use. It is identified that the existing stormwater detention and treatment infrastructure be inspected and their drainage area assessed. If undersized or not meeting current standards, it is identified the detention facilities be upgraded. Gaps in the current stormwater infrastructure should be identified and new facilities constructed or flows rerouted to existing facilities. Tree plantings along the waterway are also identified.

Table 20. Available data for Maltby (BEA970) catchment.

Criteria	Data
Existing water quality problems (Crystal Lake -> Daniels Creek -> Cottage Lake)	- Not assessed as part of water quality assessment. - Downstream Crystal Lake is moderately productive and phosphorus limited. - Downstream Cottage Lake has a TMDL for phosphorus.
Existing instream habitat problems	No data
B-IBI (WRIA8 Regression)	Very poor (6.1)
Riparian land cover	No data
Public Lands	13% public land
Monroe School District	27052500100300 27052500102400
University of Washington	27051400400100 27052400200500
East County Park and Recreation	27052400205000 27052400202100
Cross Valley Water District	27052400300900 00427200002100 27052500102500
Snohomish County	27052400308800
Port of Seattle	27052400404800 27052500204400
WSDOT	27052400300500 00619304600003 27052400300300 27052500200100 27052500101500 27052500105100 27052500101900
Horse and Livestock Lands	None
Right-of-Ways	142 acres (including road surface) - SR 522 - SR 524 - Yew Way

Criteria	Data
	- Paradise Lake Road - Several residential streets
Property Value	\$419,197
Untreated Impervious Area	33% of catchment is untreated impervious land Much of the southwest and northwest industrial areas are highly impervious
Existing Stormwater Facilities	There are several stormwater detention and treatment facilities in the catchment, but their drainage areas have not yet been mapped.
Easements	None
Groundwater	Several 10-year TOT wellhead protection areas in catchment with moderate susceptibility to contamination
Stream Shade	66% of the stream has less than 50% shading - Hot spots of low shade: - Along Yew Way

Table 21. Summary of Identified Strategies for Maltby (BEA970) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

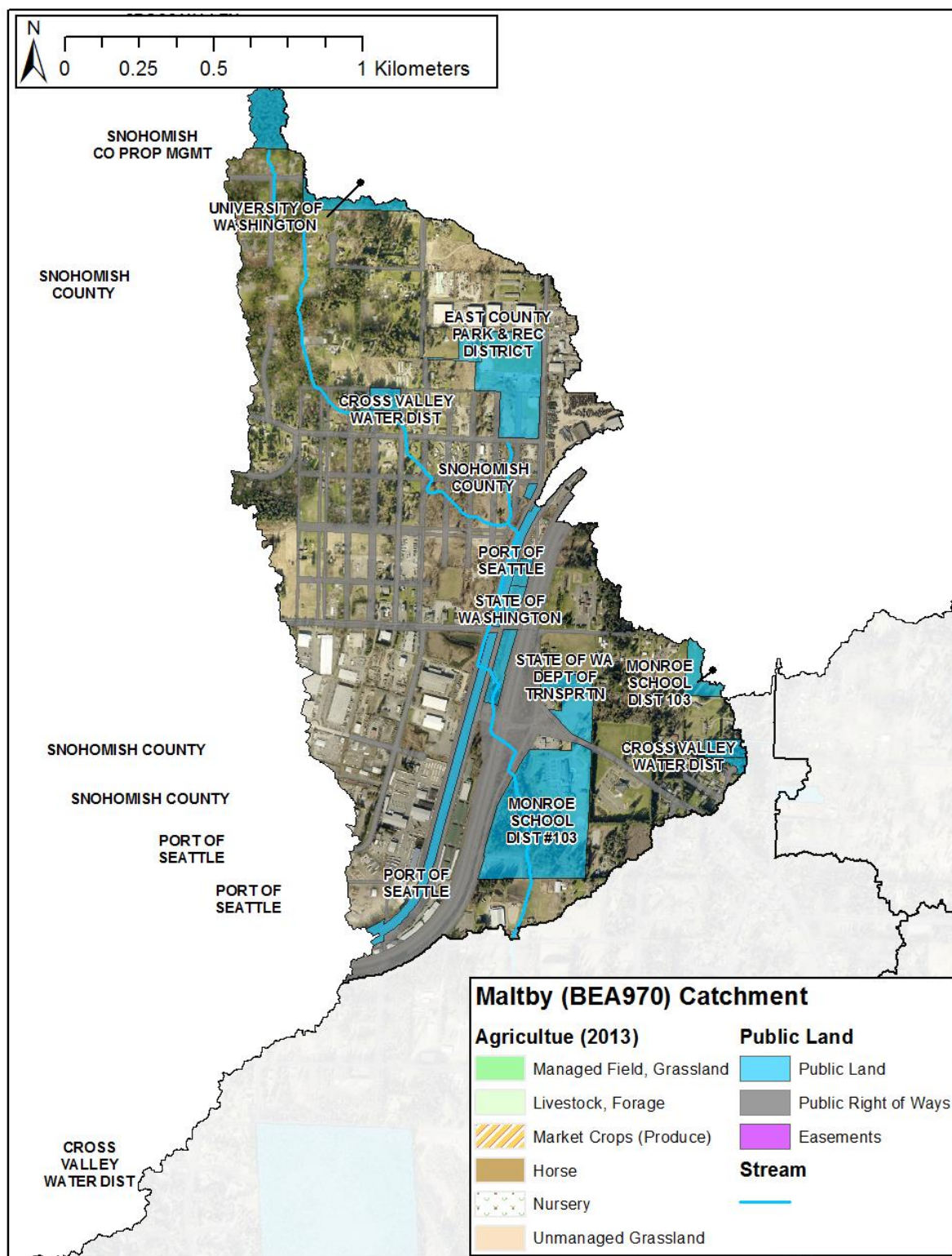


Figure 35. Maltby (BEA970) catchment agricultural and public land.

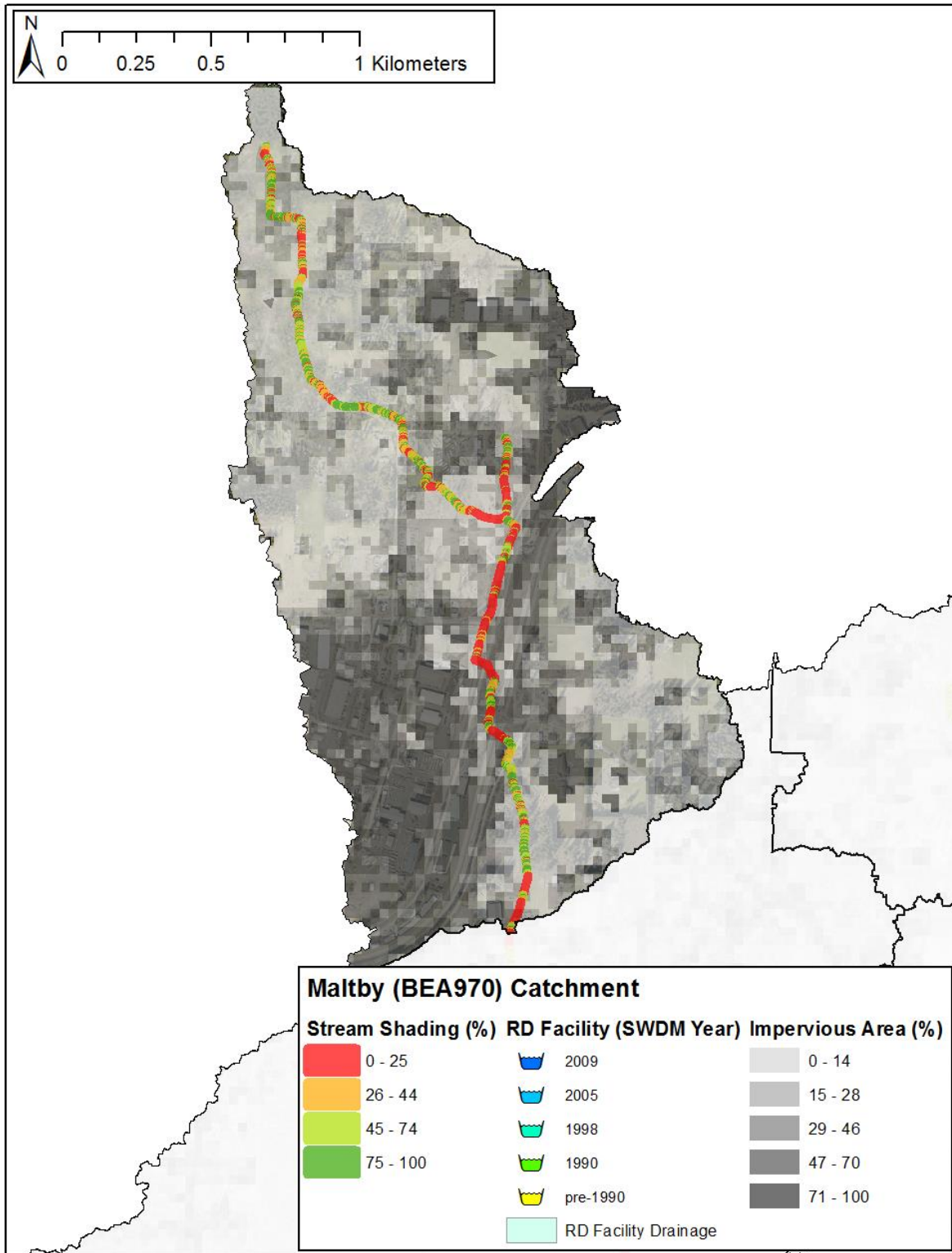


Figure 36. Maltby (BEA970) catchment stream shading, impervious area, and RD facilities and their drainage area.

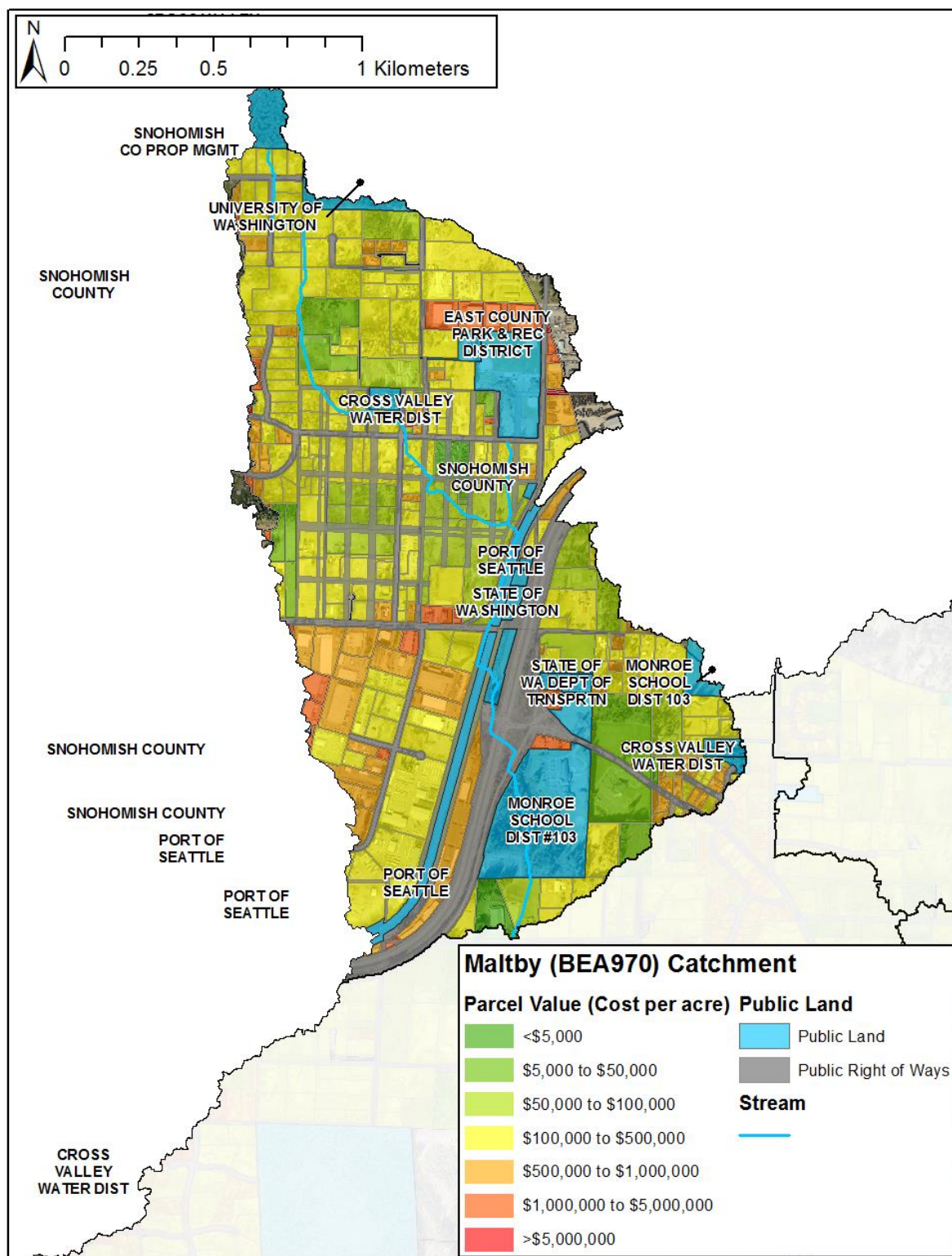


Figure 37. Maltby (BEA970) catchment parcel values and public lands.

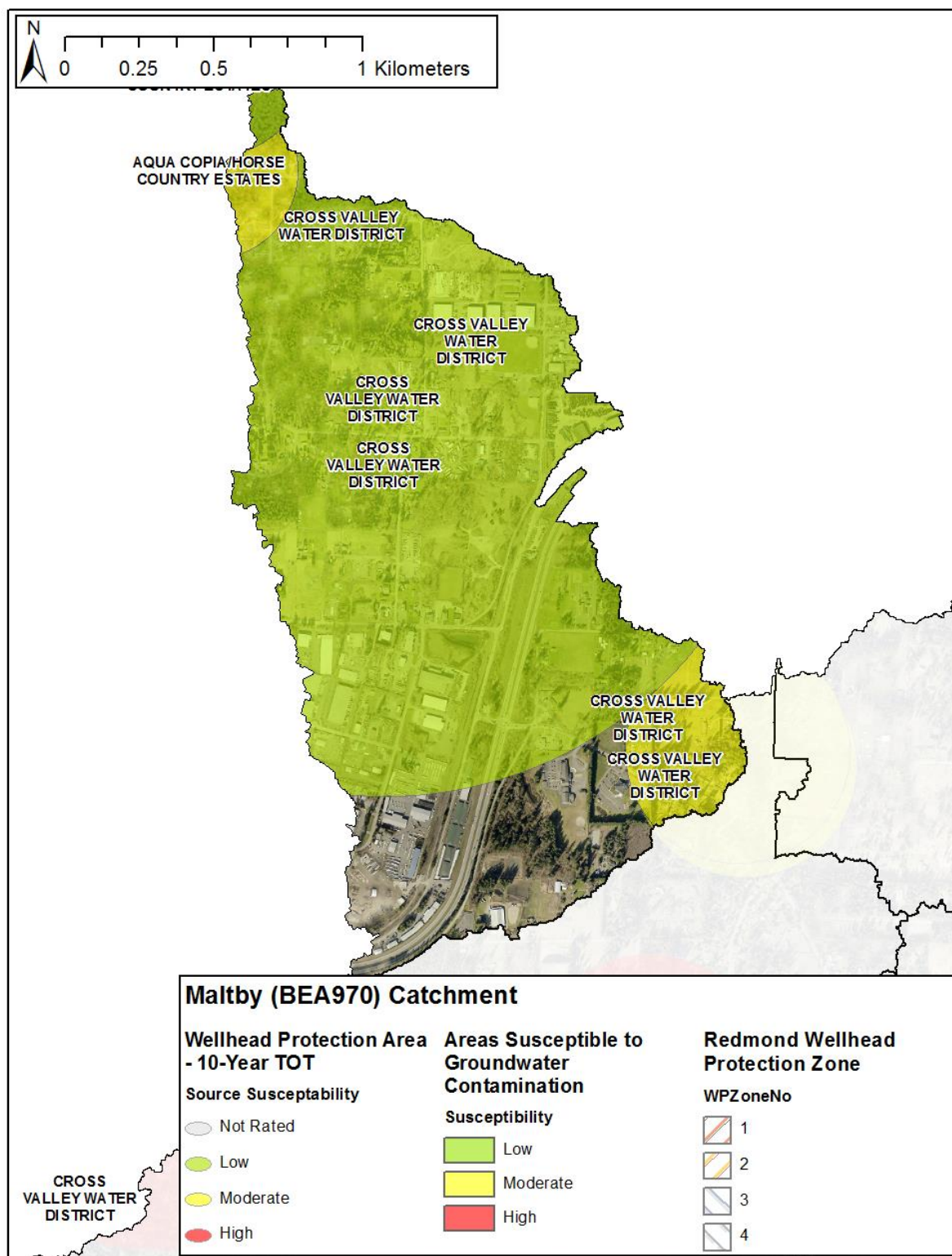


Figure 38. Maltby (BEA970) catchment groundwater protection areas.

4.5 BEA920 – Paradise Valley Conservation Area (Score: 65) (outside study area – drains to Cottage Lake)

The Paradise Valley Conservation Area (BEA920) catchment drains to Cottage Lake. The catchment is 593 acres in area. The catchment is a mixture of residential land use and conserved natural areas (Paradise Valley Conservation Area owned by Snohomish County). The catchment includes both King and Snohomish counties, including the residential development along NE 201st Dr in King County. It is identified that the existing stormwater detention and treatment infrastructure be inspected and their drainage area assessed. If undersized or not meeting current standards, it is identified the detention facilities be upgraded. Gaps in the current stormwater infrastructure should be identified and new facilities constructed or flows rerouted to existing facilities. Tree plantings along the waterway are also identified.

Table 22. Available data for Paradise Valley Conservation Area (BEA920) catchment.

Criteria	Data
Existing water quality problems	- Not assessed as part of water quality assessment. - Downstream Cottage Lake has a TMDL for phosphorus.
Existing instream habitat problems	No data
B-IBI (WRIA8 Regression)	Fair (52.9)
Riparian land cover	No data
Public Lands	43% public land
King County WLRD	9359300710
Snohomish County	27063100300100 27063100100200 27063100200300 00422800003400 27063000302000
Horse and Livestock Lands	no
Right-of-Ways	36 acres (including road surface) Paradise Lake Road Several residential streets in King and Snohomish counties
Property Value	\$635,043 per acre
Untreated Impervious Area	8% of catchment is untreated impervious land
Existing Stormwater Facilities	Snohomish County detention pond (MA0339RMDP) Snohomish County detention pond (MA0334RMDP)
Easements	None
Groundwater	- King County portion of catchment is low susceptibility to groundwater contamination - A 10-year TOT wellhead protection area in the eastern catchment with low susceptibility to contamination
Stream Shade	73% of the stream has less than 50% shading

Table 23. Summary of Identified Strategies for Paradise Valley Conservation Area (BEA920) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

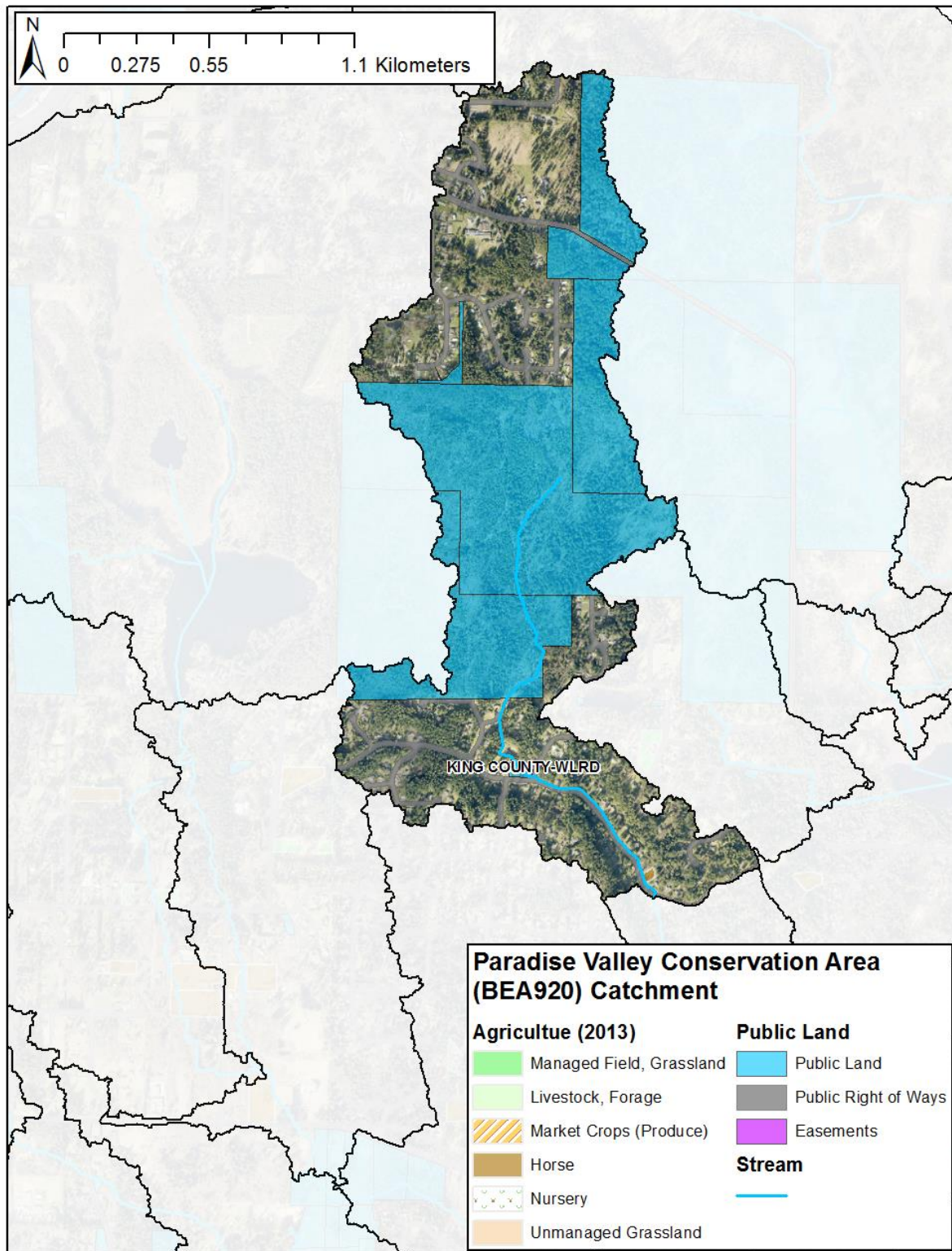


Figure 39. Paradise Valley Conservation Area (BEA920) catchment agricultural and public land.

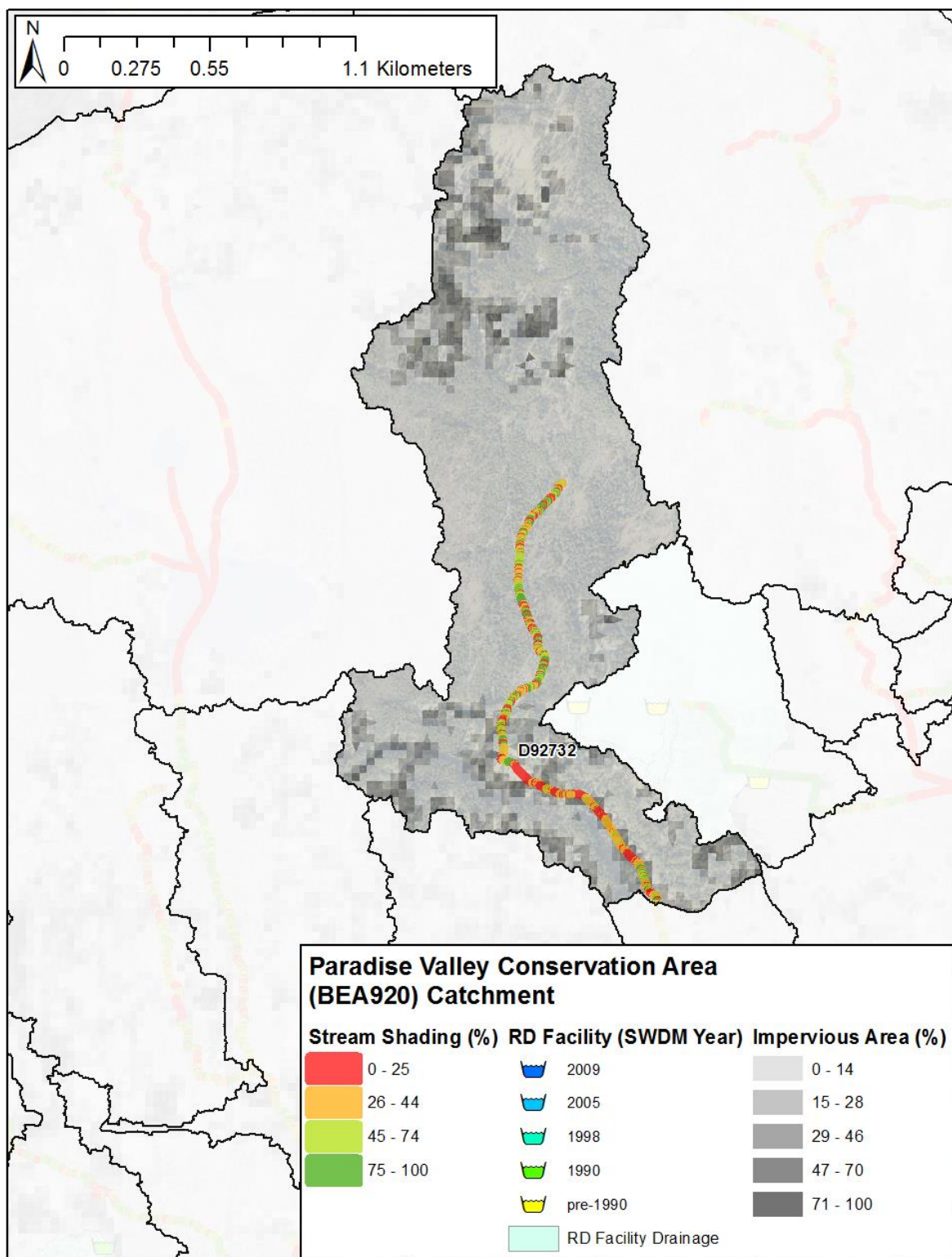


Figure 40. Paradise Valley Conservation Area (BEA920) catchment stream shading, impervious area, and stormwater (RD) facilities and their drainage area.

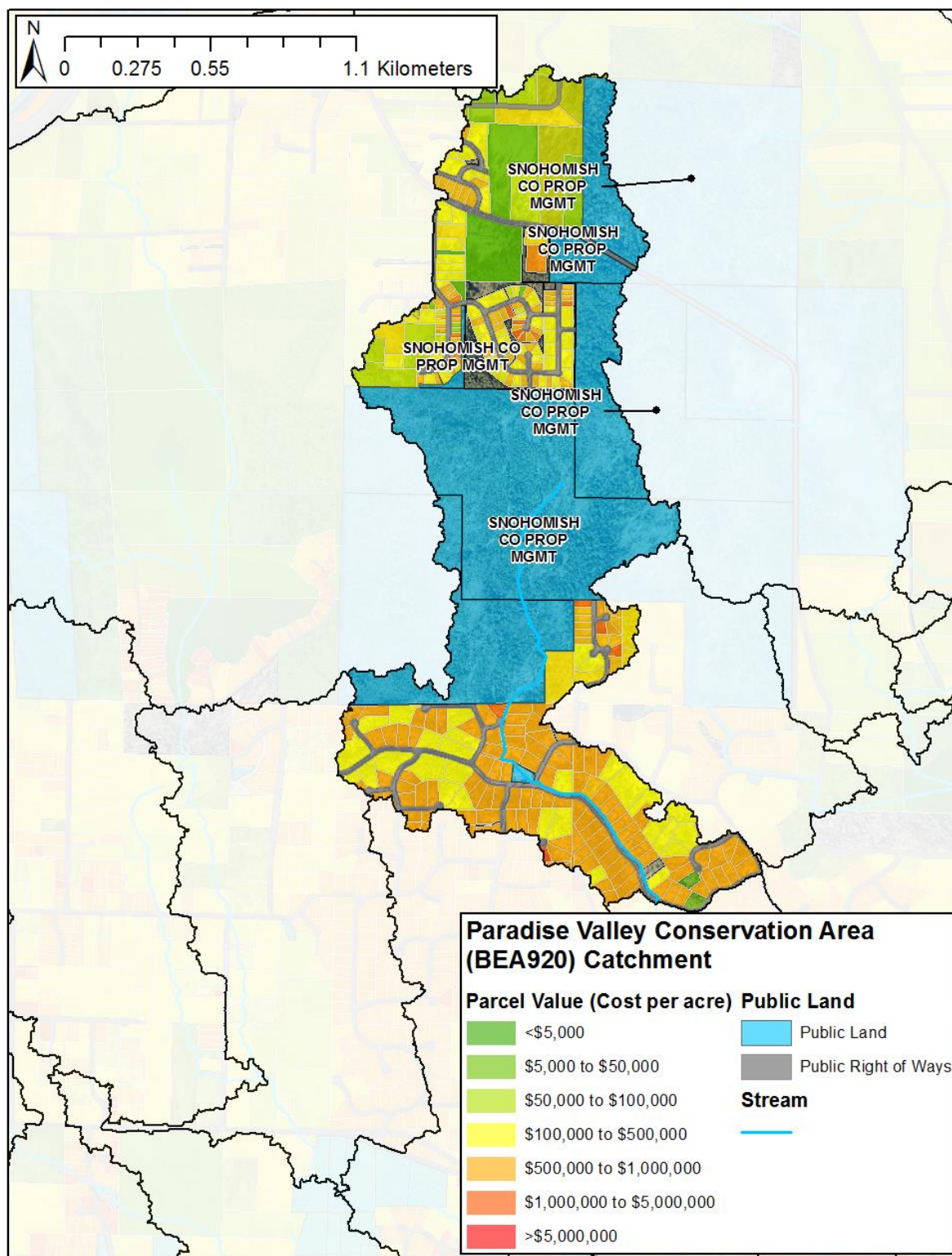


Figure 41. Paradise Valley Conservation Area (BEA920) catchment parcel values and public lands.

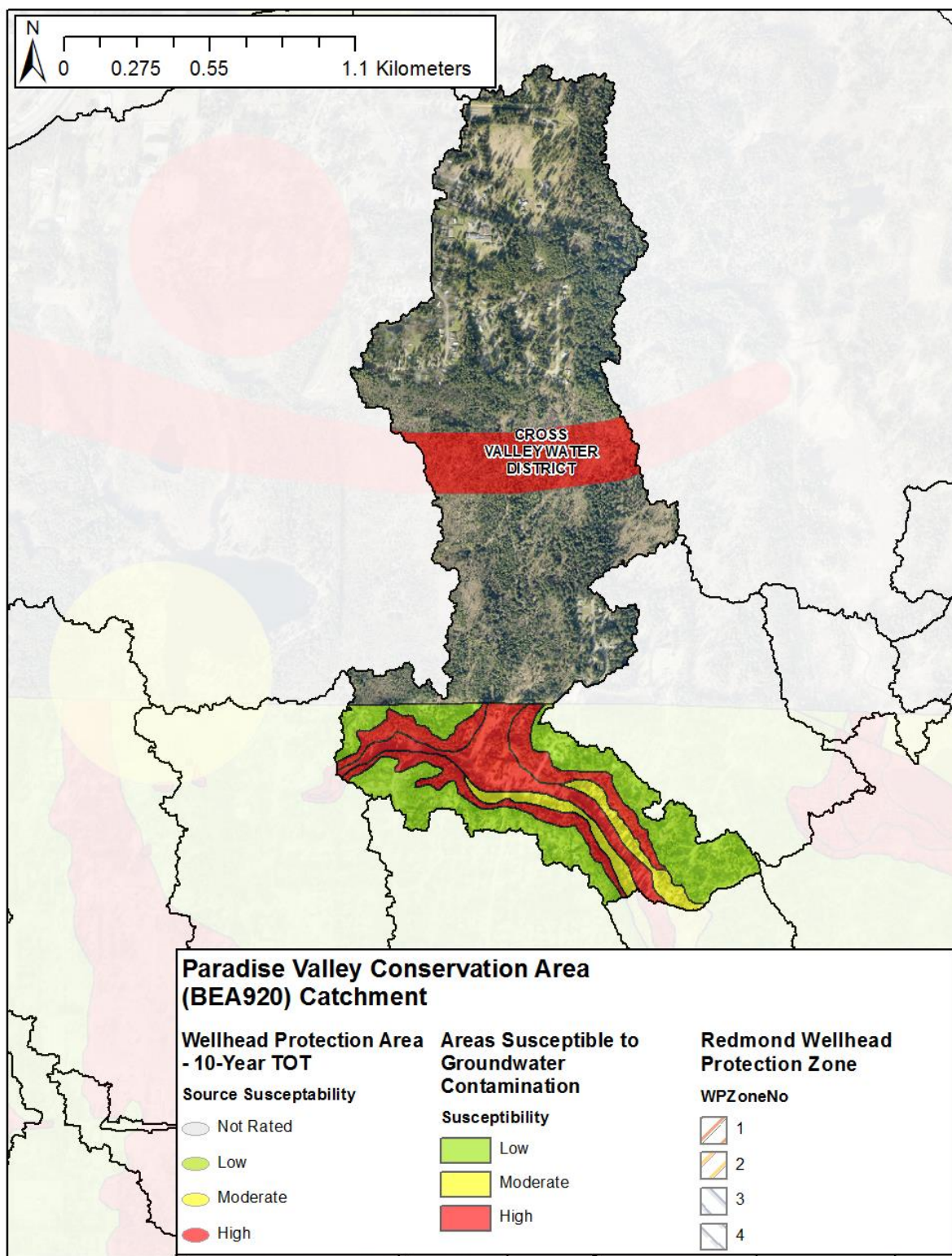


Figure 42. Paradise Valley Conservation Area (BEA920) catchment groundwater protection areas.

5.0 PRIORITY CITY OF REDMOND CATCHMENTS

For catchments located primarily within the City of Redmond, The data input to the prioritization metric and the resulting final score are displayed in Table 24 with the catchments ranked. The following sections detail the five top-ranked catchments and discuss potential projects and actions to improve water quality and hydrology.

Table 24. Ranked catchments located primarily in City of Redmond and prioritization metric input data.

Catchment	Scoring Metrics									Total Score
	Water Quality	B-IBI	Untreated Impervious	Storm-water Facility	Forage Live-stock	Property Cost	Public Land	Right - of-way	Roof	
BEA190	15	20	30	0	0	5	10	8	15	103
MON	25	30	10	10	0	5	0	8	15	103
BEA110	15	20	30	0	0	5	0	15	15	100
BEA100	15	10	30	0	10	5	10	8	10	98
BEA010	25	10	30	0	0	10	0	0	15	90
BEA080	15	20	30	0	0	5	0	8	10	88

5.1 BEA190 – Tyler’s Creek (Score: 103)

The Tyler’s Creek watershed is 168 acres, and 167 acres are located in the City. Land use is predominantly single-family residential. There are large tracts of undeveloped land in the headwaters.

Most of the developed watershed needs stormwater runoff treatment facilities. In addition, replanting buffers with shade producing trees would help lower water temperature, especially during low flow periods. Last, retrofitting the NE 116th Street with stormwater treatment facilities would significantly reduce the untreated stormwater runoff entering Tyler’s Creek.

The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development.

Table 25. Available data for Tyler's Creek (BEA190) catchment.

Criteria	Data
Existing water quality problems	Not assessed as part of water quality assessment.
Existing instream habitat problems	Known fish passage barriers
B-IBI (WRIA8 Regression)	Very poor (13)
Riparian land cover	18% impervious 32% trees 35% shrub 15% other (water, bare area, grass, etc.)
Public Lands	10% public land
City of Redmond	3626059137(Utility ROW) 2193320520 2193320530 2193310720 2193320540
Horse and Livestock Lands	none
Right-of-Ways	24 acres (including road surface) Several residential streets
Property Value	\$4,583,834 per acre
Untreated Impervious Area	36% of catchment is untreated impervious area based on mapped facility drainage area Emerald Heights Retirement Community Residential streets
Existing Stormwater Facilities	- Several ponds near Emerald Heights built before 1990 - Redmond Vault 890104002 - Redmond Vault 08-0840 - Redmond Pond 06-0200 built in 2006 - Several Redmond Ponds (no recording number)
Easements	None
Groundwater	Much of the catchment is in Redmond Wellhead Protection Zone 3. The eastern region is Zone 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff. The catchment has low to high susceptibility to groundwater contamination.
Stream Shade	60% of the stream has less than 50% shading Hot spots of low shade: Near utility ROW

Table 26. Summary of Identified Strategies for Tyler's Creek (BEA190) catchment.

Strategy	Benefits
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	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

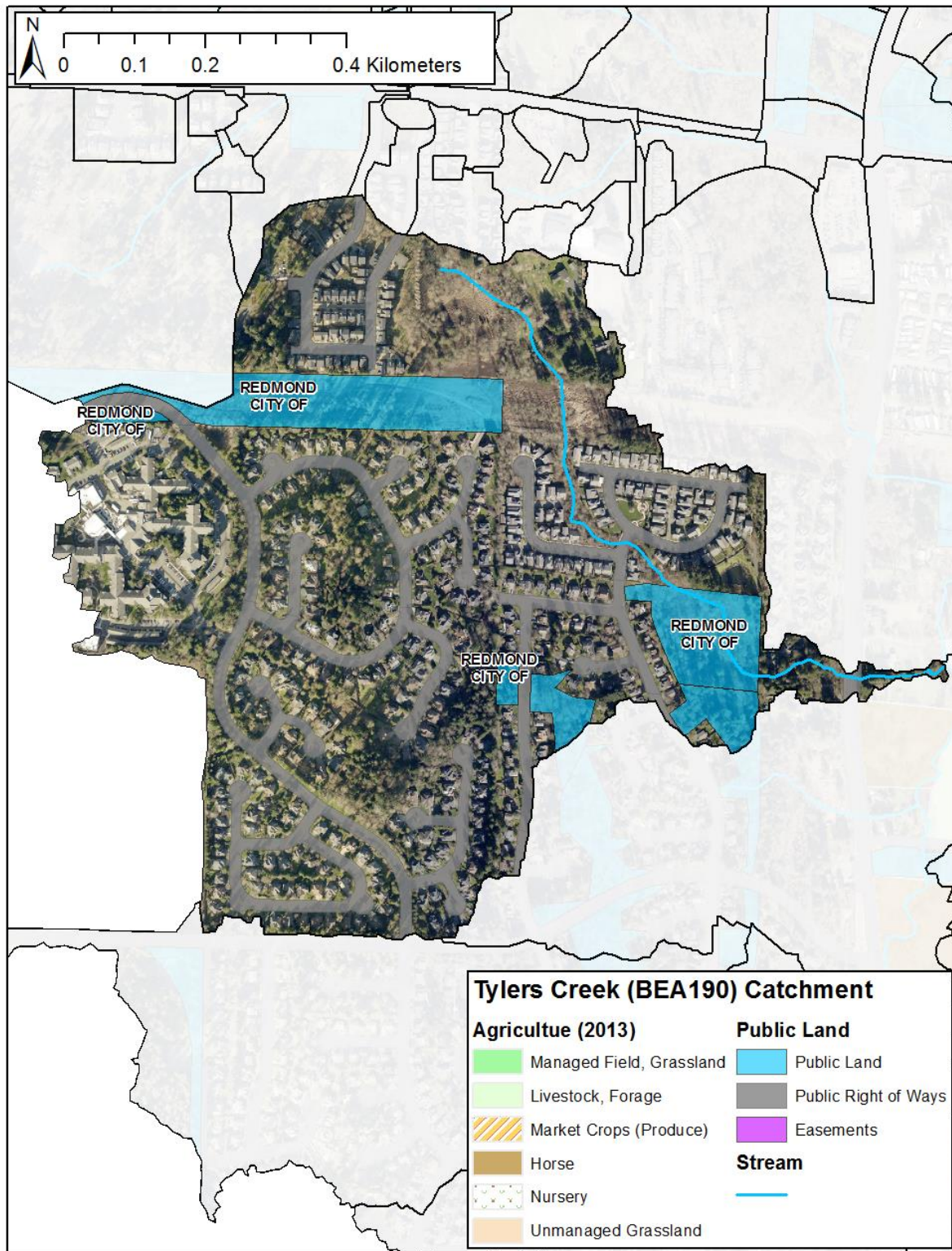


Figure 43. Tyler's Creek (BEA190) catchment agricultural and public land.

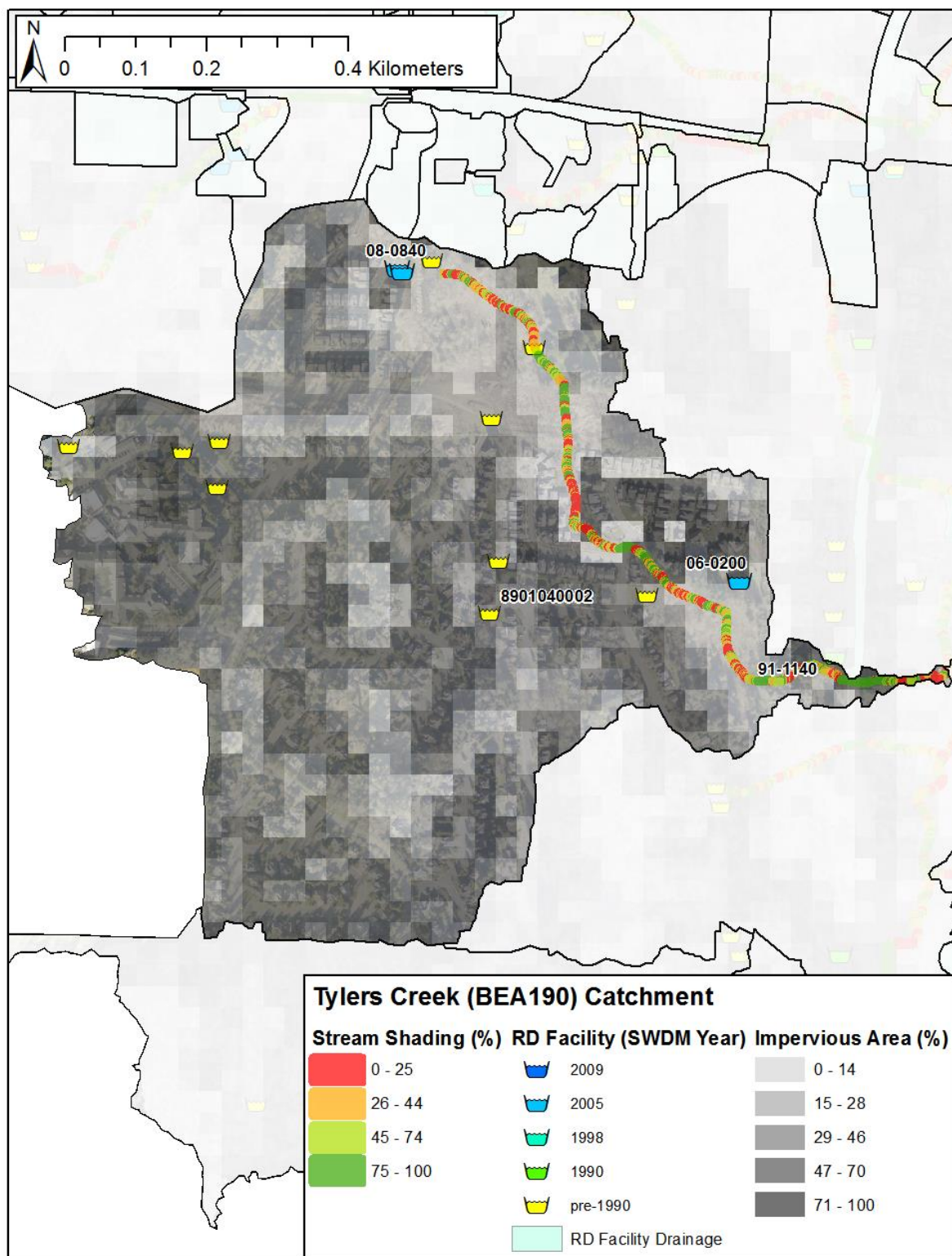


Figure 44. Tyler's Creek (BEA190) catchment stream shading, impervious area, and RD facilities and their drainage area.

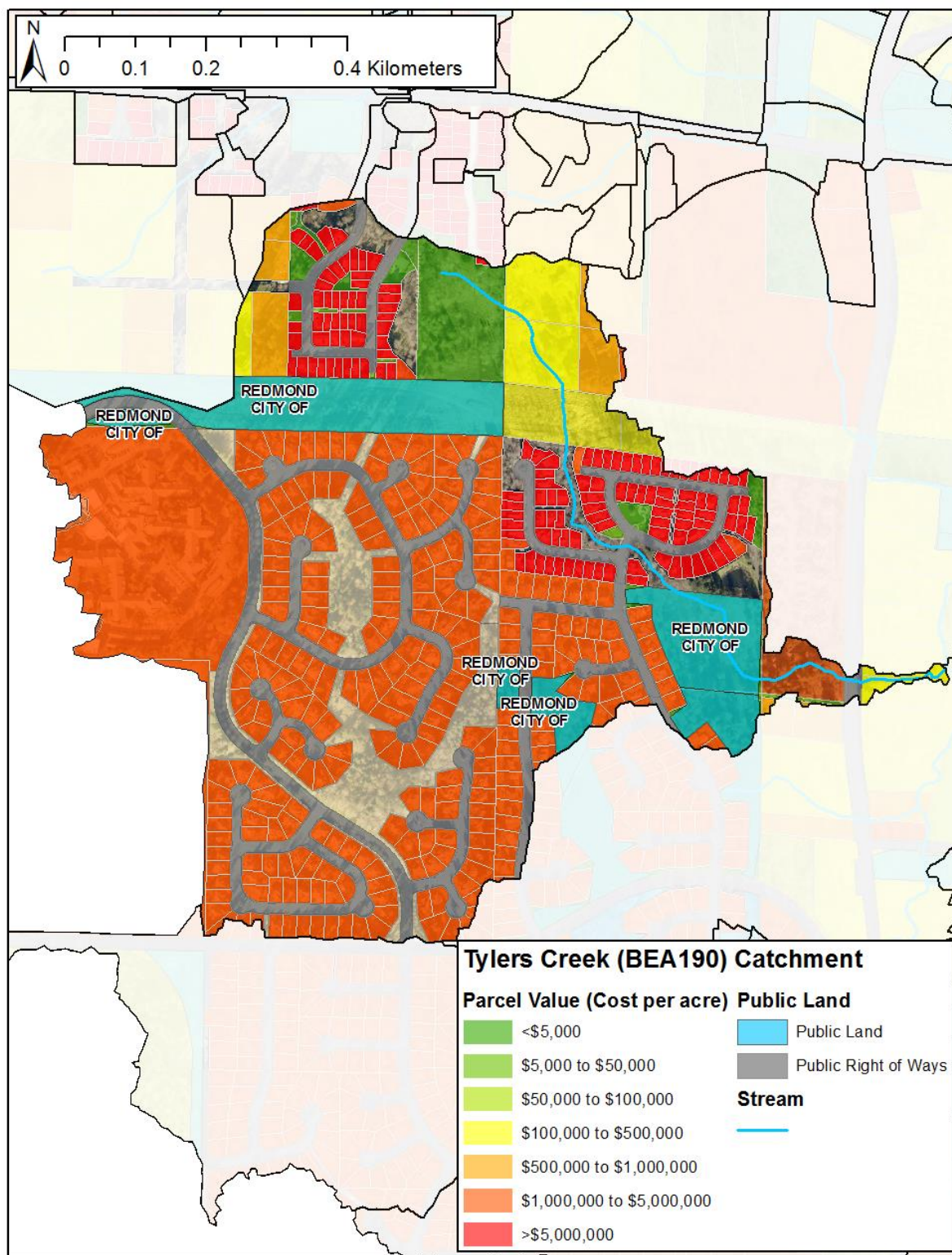


Figure 45. Tyler's Creek (BEA190) catchment parcel values and public lands.

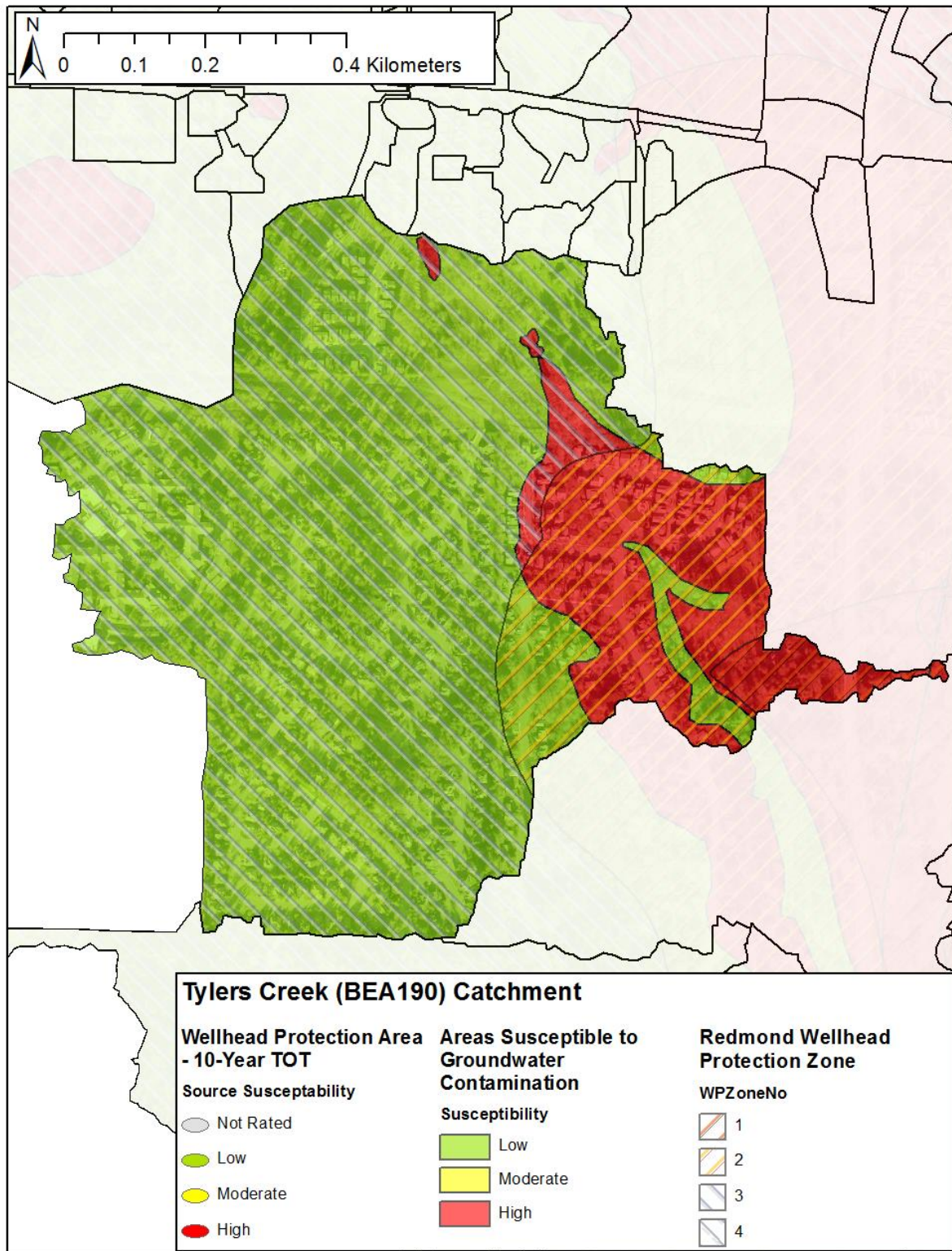


Figure 46. Tyler's Creek (BEA190) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff.

5.2 MON – Monticello Creek (Score: 103)

The Monticello Creek (MON) catchment drains Monticello Creek, which is predominately located within the City of Redmond. The catchment is 359 acres in area. The catchment is urbanized; near the mouth of Monticello Creek, commercial development is present and the remainder of the watershed is low- to mid-density residential. The installation of a regional facility that treats runoff from the commercial land at Avondale and 116th St is identified; the facility could also treat runoff along the length of 116th St.

The RD facilities D91746 and D91372 were both constructed prior to 1990 and the DT0059 facility was constructed in 1993. It is likely they do not meet current design standards. It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment. There are several municipal and private stormwater facilities located within the City of Redmond. The inspection of these facilities is also identified.

The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development.

Table 27. Available data for Monticello Creek (MON) catchment.

Criteria	Data
Existing water quality problems	• Temperature (54% of summer 7-DADMax temperatures exceed water quality standards) • Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria) • Total Suspended Solids (wet-weather samples are 20-times that of baseflow samples)
Existing instream habitat problems	Moderate habitat quality (King County et al., 1989)
B-IBI (WRIA8 Regression)	Poor (34.3)
Riparian land cover	13% impervious 31% trees 29% shrub 12% pasture 13% other (water, bare area, grass, etc.)
Public Lands	7% public lands
City of Redmond	3626059137 (utility ROW); 3626059101; 7273100100; 2526059202 (stormwater pond); 1873100710 (Curry Drainage); 2526059224; 2526059233 (stormwater pond); 2568200960 (Fisher Village Drainage); 2568200980 (Fisher Village Drainage); 8560800220 (Taloor Aye Drainage); 9348700640 (stormwater pond); 9526600760 (Woodlands West Storm Drainage); 9578090480 (Wynstone Storm Drainage); 2526059109 (Smith

Criteria	Data
	Woods); 2526059110 (Smith Woods)
King County WLRD	1862000400; 9578050390
King County Property Services	2526059203
King County Parks	7273100080
King County Roads	7273100085 (Stormwater Pond: DT0059)
Horse and Livestock Lands	None
Right-of-Ways	52 acres (including road surface) NE 116 th St NE 128 th St Several residential streets
Property Value	\$3,470,461 Property values are generally lower outside Redmond city limits and along the south fork (however, these parcels were developed in 2017 and likely are not viable for acquisition).
Untreated Impervious Area	8% of catchment is untreated impervious land Avondale Rd and NE 116th St
Existing Stormwater Facilities	- RD Pond for Avondale Rd north of NE 116th St (DT0059) –built 1993 - RD Pond for Wyndham Knoll (D91746) – built 1988 - RD Pond for Crown Heights (D91372) – built 1986 - Redmond Pond 04-0925 – built 2004 - Redmond Pond 03-2500 – built 2003 - Redmond Pond 01-1600 – built 2002 - Redmond Pond 02-1850 – built 2002 - Redmond Pond 06-1200 – built 2006 - Redmond Pond 04-0250 – built 2004 - Redmond Pond 04-0925 – built 2004 - Redmond Pond 03-2850 – built 2003 - Redmond Pond 03-2500 – built 2003 - Redmond Pond 95-0980 – built before 1990 - Redmond Pond 02-1010 – built 2003 - Redmond Vault 00-0100 – built 1999 - Redmond Vault 95-0980 – built before 1990 (Einstein Elementary) - Redmond Vault 04-0700 – built 2005 - Redmond Vault 07-1300 – built 2007 - Redmond Vault 04-1150 – built 2004 - Redmond Vault 06-1850 – built 2006 - Redmond Vault 96-2370 – built 1996 - Redmond Vault 12-0180 – built 2012
Easements	None
Groundwater	Much of the catchment is in Redmond Wellhead Protection Zone 3. The SE region near Avondale and 116 th St is Zone 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff.

Criteria	Data
	The catchment has low to high susceptibility to groundwater contamination.
Stream Shade	82% of the stream has less than 50% shading Hot spots of low shade: - North of the Redmond city limit along the Monticello Creek North Fork - The south fork upstream of 116th St NE.

Table 28. Summary of Identified Strategies for Monticello Creek (MON) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

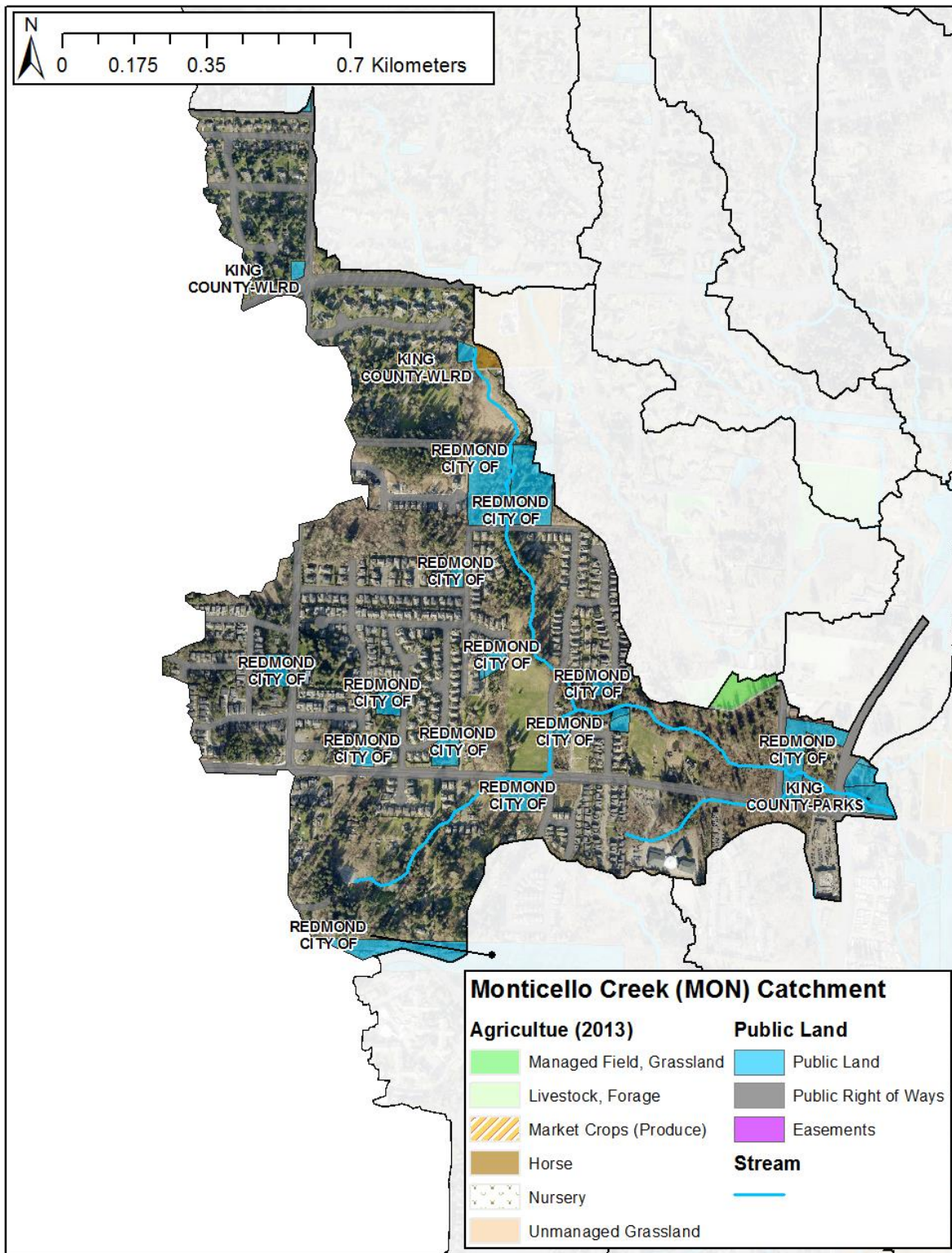


Figure 47. Monticello Creek (MON) catchment agricultural and public land.

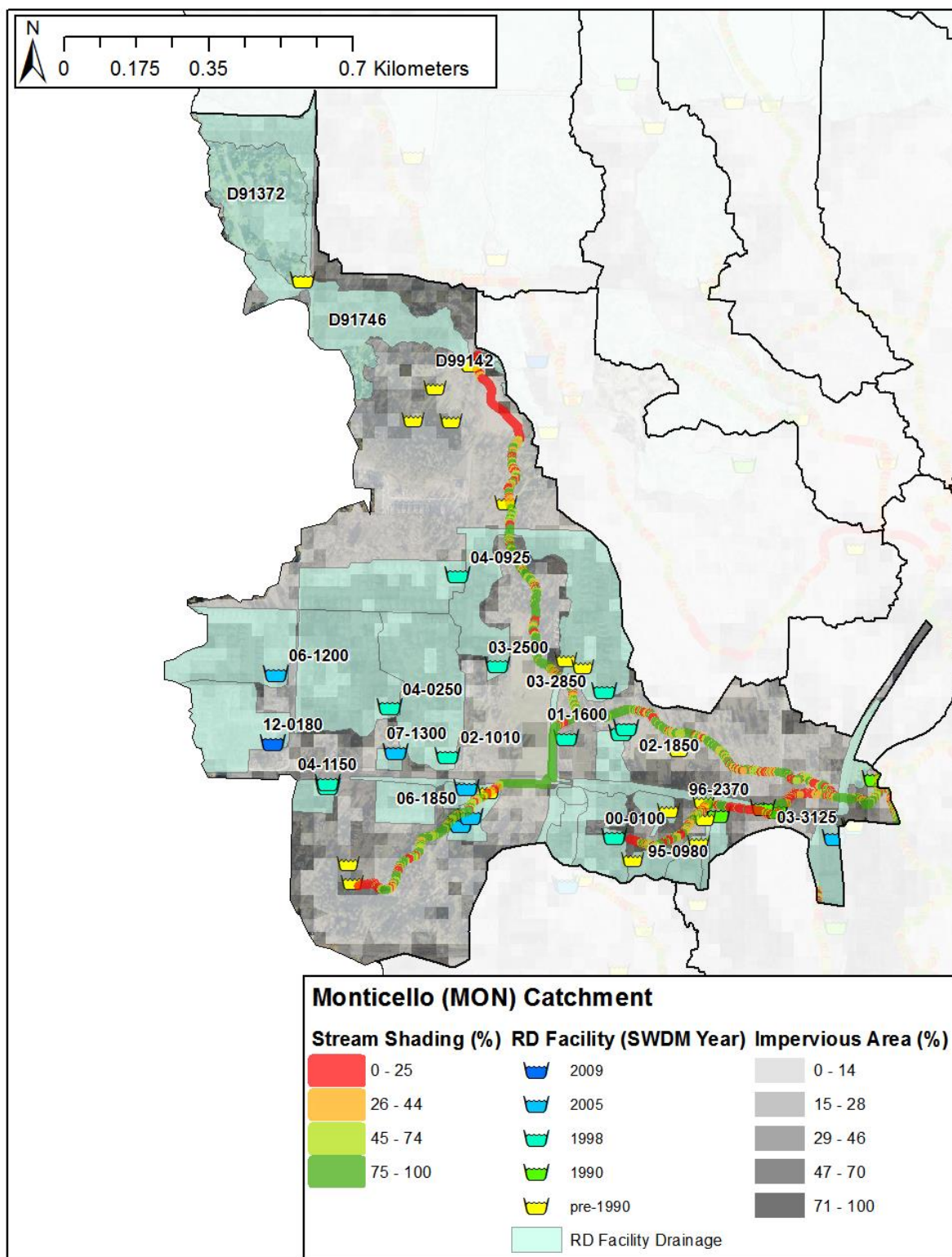


Figure 48. Monticello Creek (MON) catchment stream shading, impervious area, and RD facilities and their drainage area.

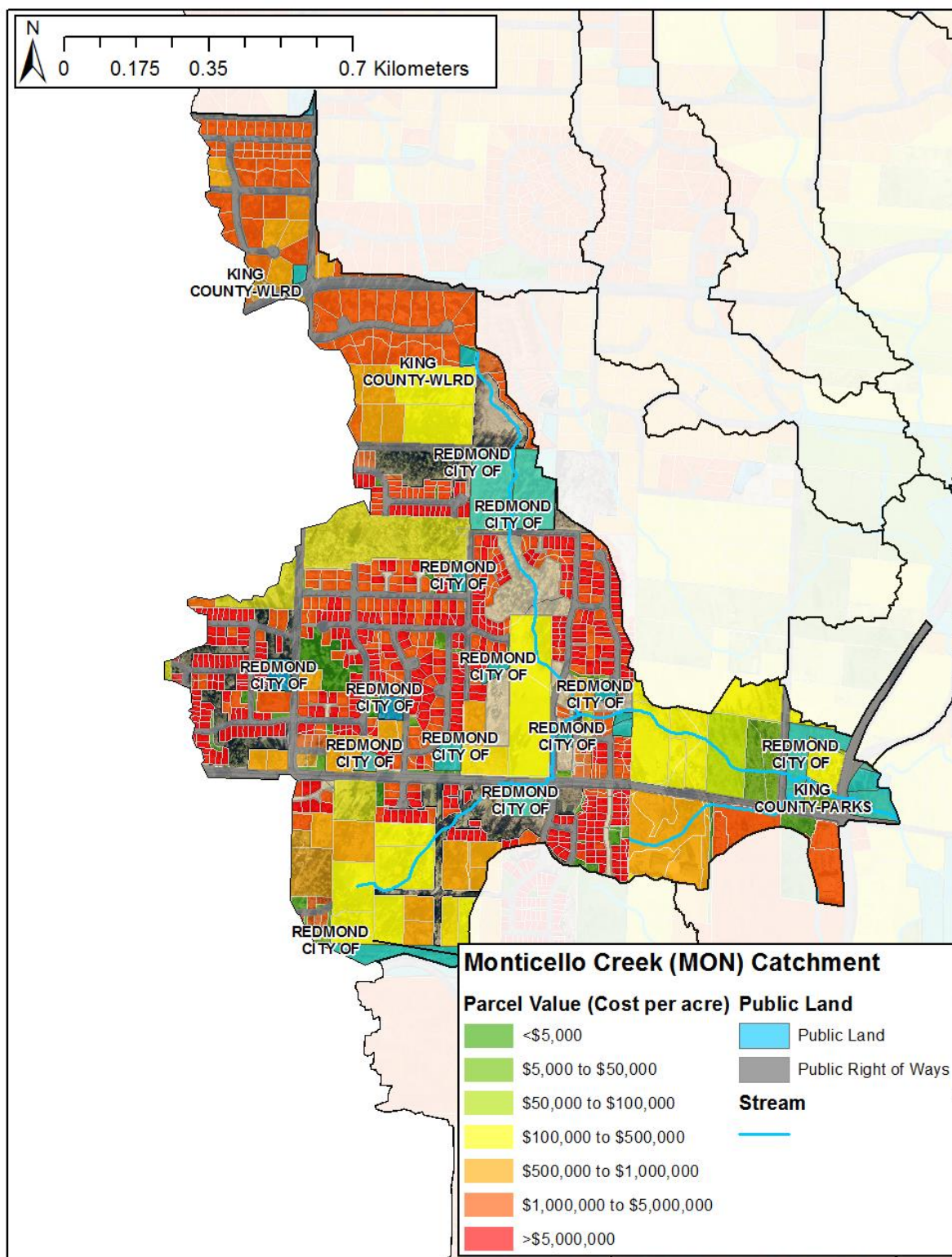


Figure 49. Monticello Creek (MON) catchment parcel values and public lands.

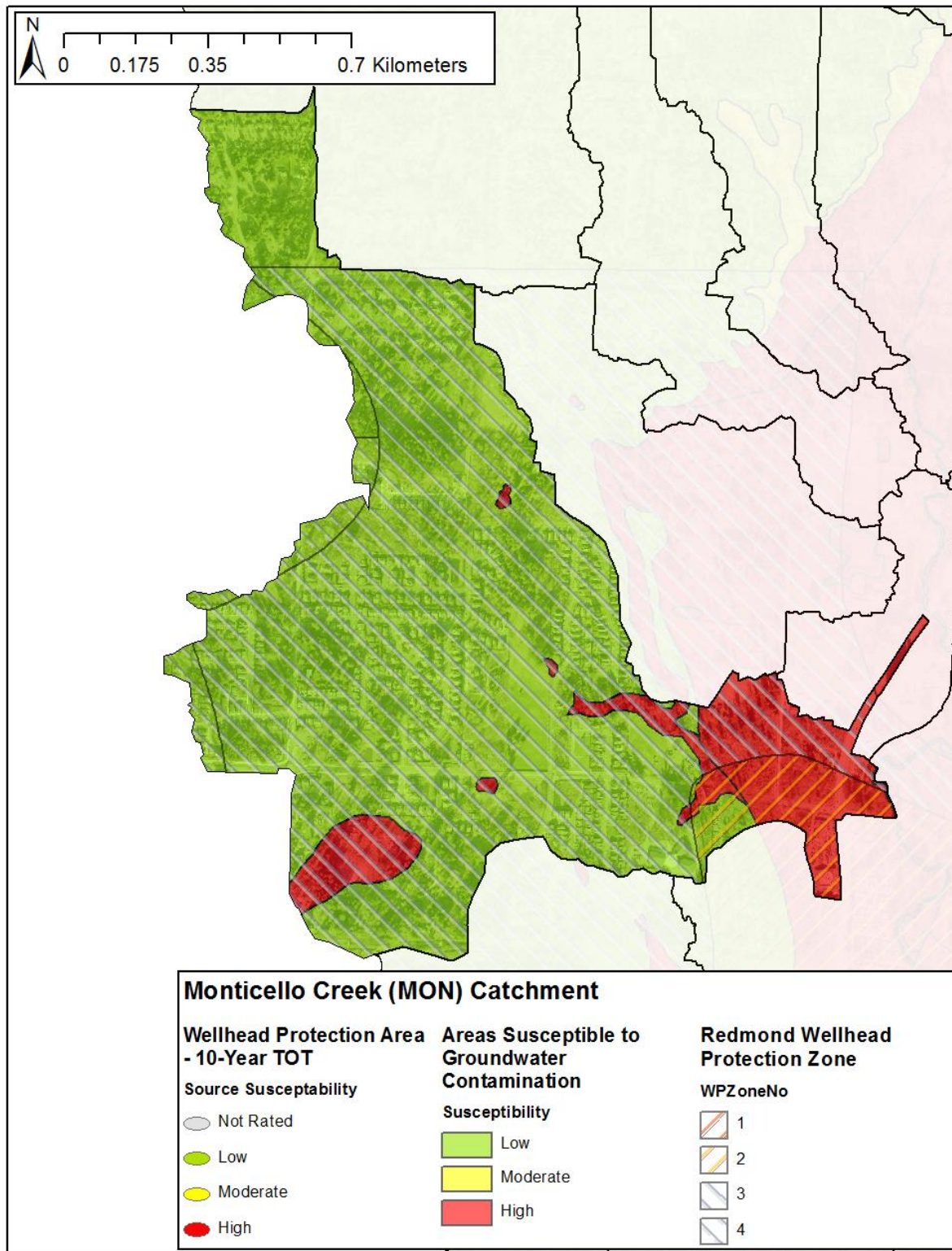


Figure 50. Monticello Creek (MON) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff.

5.3 BEA110 – 177th Ave and NE 104th St (Score: 100)

The 177th Ave and NE 104th St catchment (BEA110) is 64 acres in area. The catchment is predominately mid-density residential development with a small amount of greenspace in the western region (Hartman Park). The catchment does not have a stream. Surface water drains to BEA100 and then mainstem Bear Creek.

Three City of Redmond stormwater facilities are mapped in the catchment. Two were built prior to 1990 and the other does not have a build date. It is likely they do not meet current design standards. It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment.

Property within the catchment is expensive (averaging \$2.8 million per acre). Acquisition of private land to build stormwater facilities is not likely to be feasible. The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development. Construction of roadside bioswales is also identified along NE 104th St.

Table 29. Available data for 177th Ave and NE 104th St (BEA110) catchment.

Criteria	Data
Existing water quality problems	No stream in catchment
Existing instream habitat problems	No stream in catchment
B-IBI (WRIA8 Regression)	Very poor (9.4)
Riparian land cover	No riparian area in catchment
Public Lands	5% public land
City of Redmond	3626059015 (Hartman Park) 2193310700 2193310710
Horse and Livestock Lands	None
Right-of-Ways	14 acres (including road surface) Several residential streets
Property Value	\$2,769,998 per acre
Untreated Impervious Area	36% of catchment is untreated impervious area Residential streets
Existing Stormwater Facilities	- Redmond Vault 870526004 built in 1987 - Redmond pond (no recording number) - Redmond Vault (E-0154) built in 1987

Criteria	Data
Easements	None
Groundwater	Nearly all of the catchment is in Redmond Wellhead Protection Zone 3. The far eastern region is Zone 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff. The catchment has low susceptibility to groundwater contamination except in the far east, which is high susceptibility.
Stream Shade	No stream in catchment

Table 30. Summary of Identified Strategies for 177th Ave and NE 104th St (BEA110) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

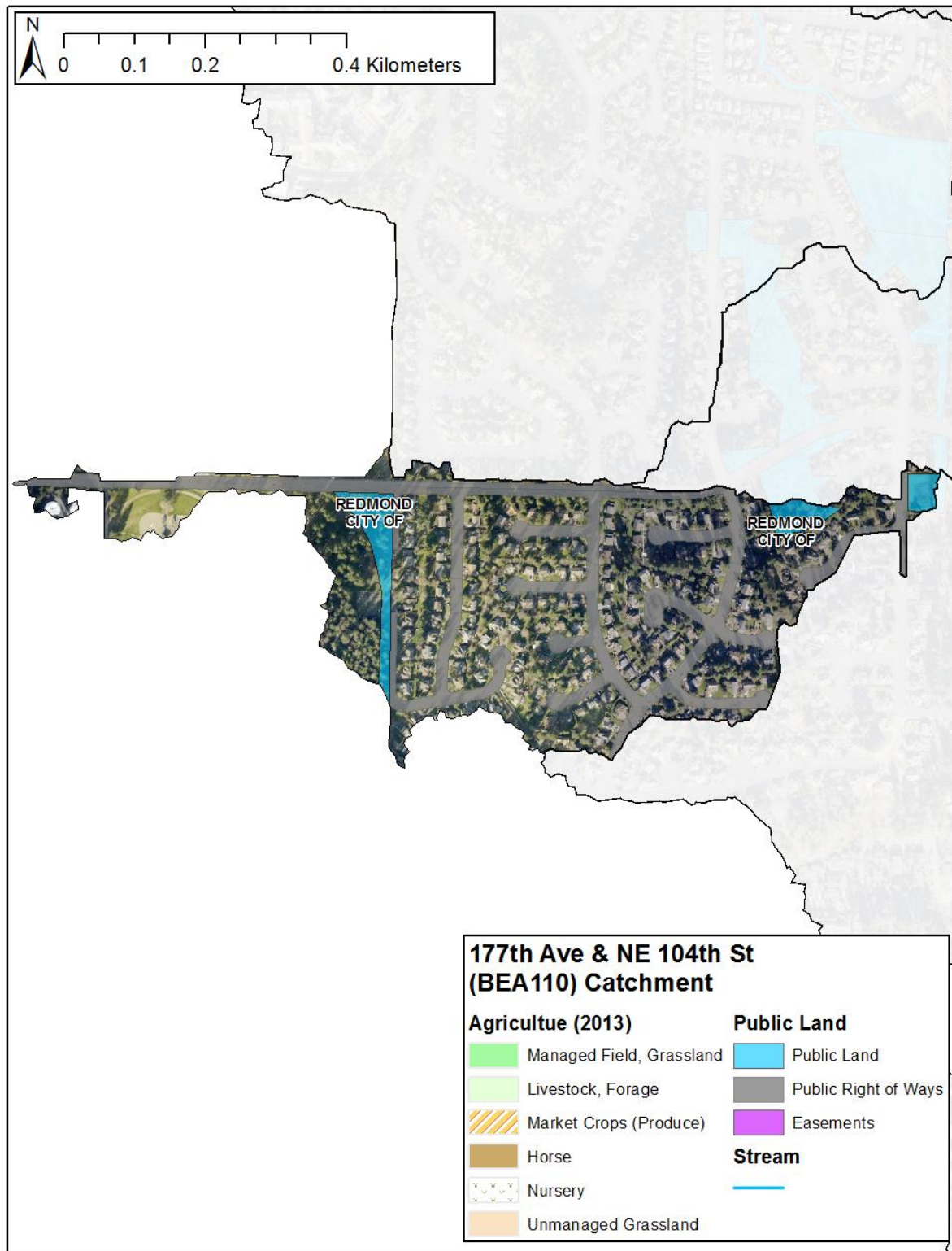


Figure 51. 177th Ave and NE 104th (BEA110) catchment agricultural and public land.

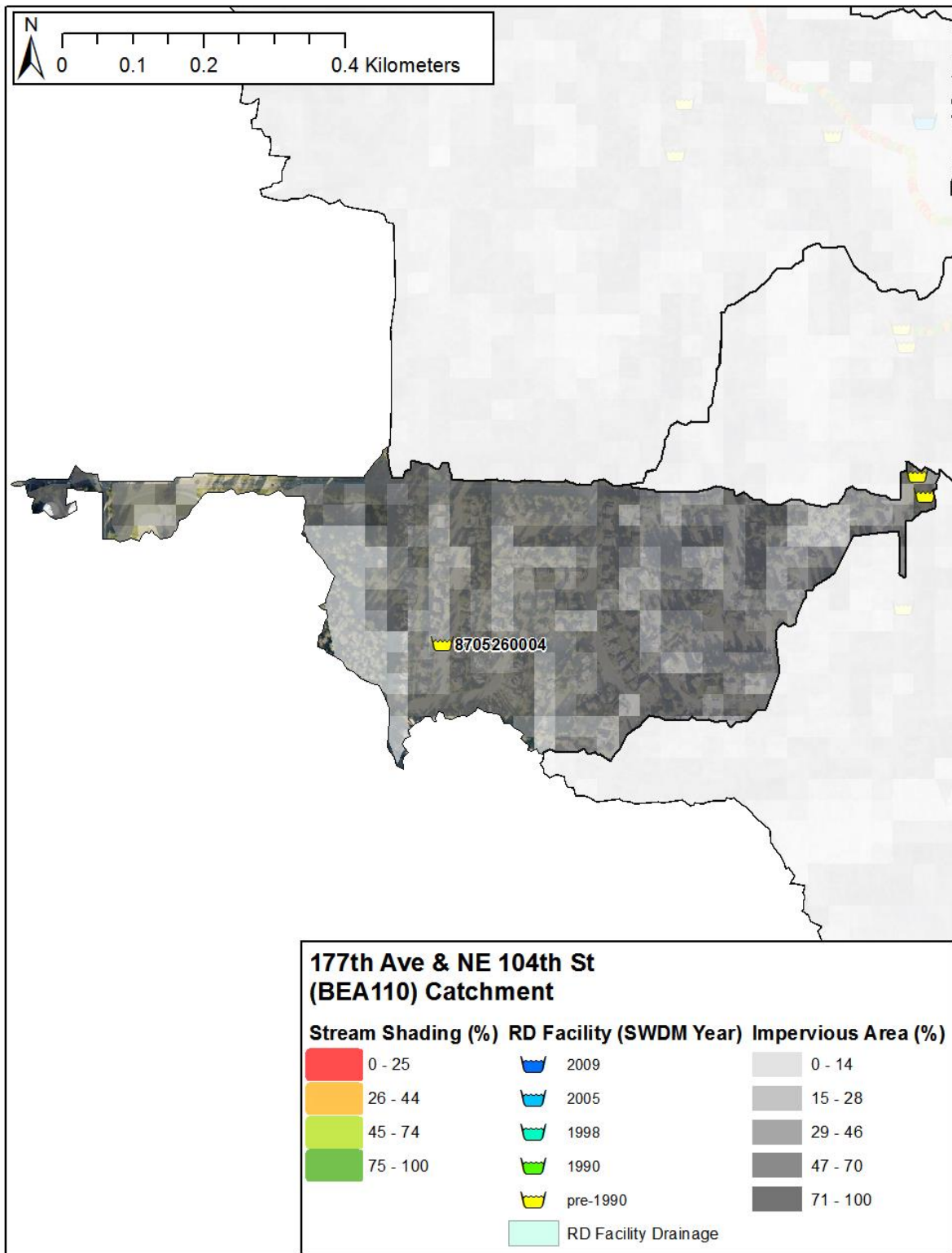


Figure 52. 177th Ave and NE 104th (BEA110) catchment stream shading, impervious area, and RD facilities and their drainage area.

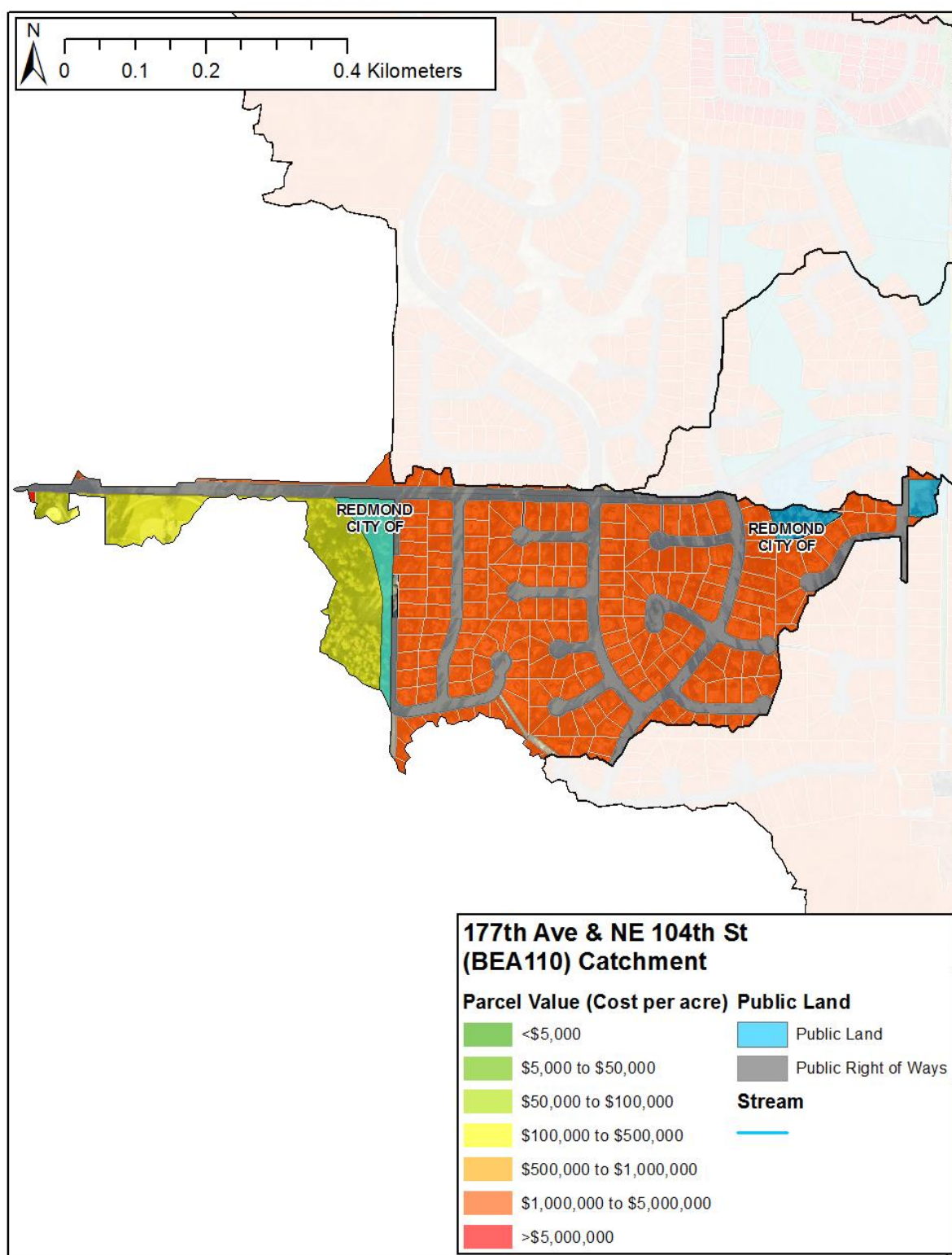


Figure 53. 177th Ave and NE 104th (BEA110) catchment parcel values and public lands.

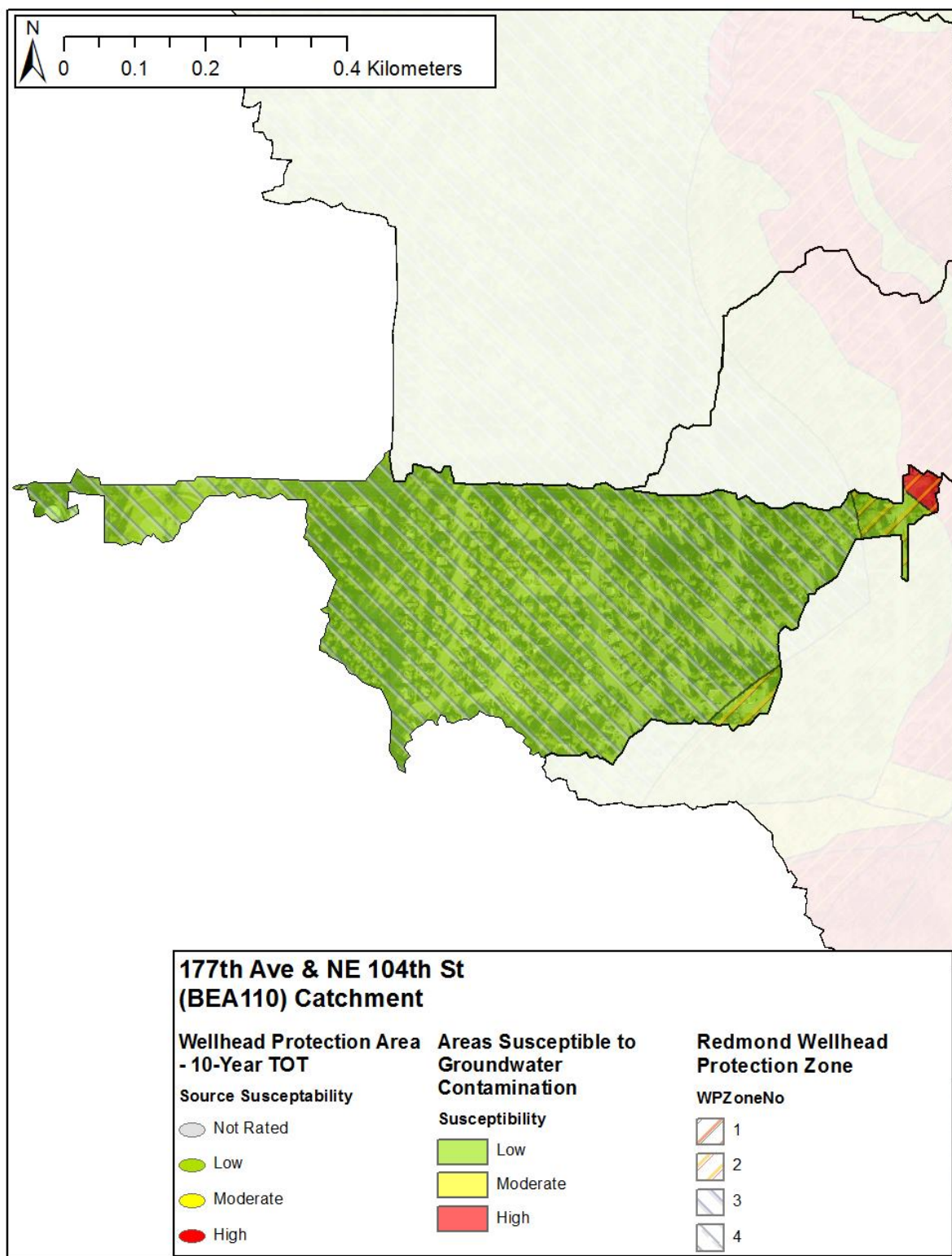


Figure 54. 177th Ave and NE 104th (BEA110) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff.

5.4 BEA100 – 184th Ave and NE 104th St (Score: 103)

The 184th Ave and NE 104th St catchment (BEA100) is 63 acres in area. The catchment is predominately mid-density residential development with a small amount of greenspace in the western region (Hartman Park). The catchment does not have a stream. Surface water drains to BEA100 and then mainstem Bear Creek.

Three City of Redmond stormwater facilities are mapped in the catchment. Two were built prior to 1990 and the other in 1995. It is likely they do not meet current design standards. It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment.

With Redmond city limits, property is expensive (>\$1 million per acre). Acquisition of private land to build stormwater facilities is not likely to be feasible. The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development. Construction of roadside bioswales is also identified along NE 104th St and Avondale Rd.

Table 31. Available data for 184th Ave and NE 104th St (BEA100) catchment.

Criteria	Data
Existing water quality problems	• Temperature (91% of summer 7-DADMax temperatures exceed water quality standards) • Dissolved Oxygen (2 of 3 summer samples did not meet water quality standards) • Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria) • Total Suspended Solids (wet-weather samples are five-times that of baseflow samples)
Existing instream habitat problems	• Lower habitat quality (King County et al., 1989) • Bank Erosion/Instability and Lack of Instream Habitat Diversity (Entranco, 1994) • Loss of vegetation and instream large organic debris (King County et al., 1994)
B-IBI (WRIA8 Regression)	Fair (53.1)
Riparian land cover	11% impervious 17% trees 35% shrub 20% pasture 18% other (water, bare area, grass, etc.)
Public Lands	16% public land
City of Redmond	2193310690 2193310700 2193320520 2193310710

Criteria	Data
	2193310720
King County Parks	3126069053 3126069052 3126069016 3126069038
Horse and Livestock Lands	9 acres 3126069011 (Little Bit Therapeutic Riding) 3126069043 (Sage Meadows) 3126069010 (Livestock)
Right-of-Ways	10 acres (including road surface) Avondale Rd NE 104 th Ave Several residential streets
Property Value	\$2,339,919 per acre
Untreated Impervious Area	27% of catchment is untreated impervious area
Existing Stormwater Facilities	- Redmond vault 99-2030 built in 1995 - Two Redmond vaults (no recording numbers) built in 1983 on 2193310720
Easements	none
Groundwater	- The catchment is in both Redmond Wellhead Protection Zone 1 and 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff. - The catchment has low to high susceptibility to groundwater contamination.
Stream Shade	58% of the stream has less than 50% shading Hot spots of low shade: Near 3126069010 pasture

Table 32. Summary of Identified Strategies for 184th Ave and NE 104th St (BEA100) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

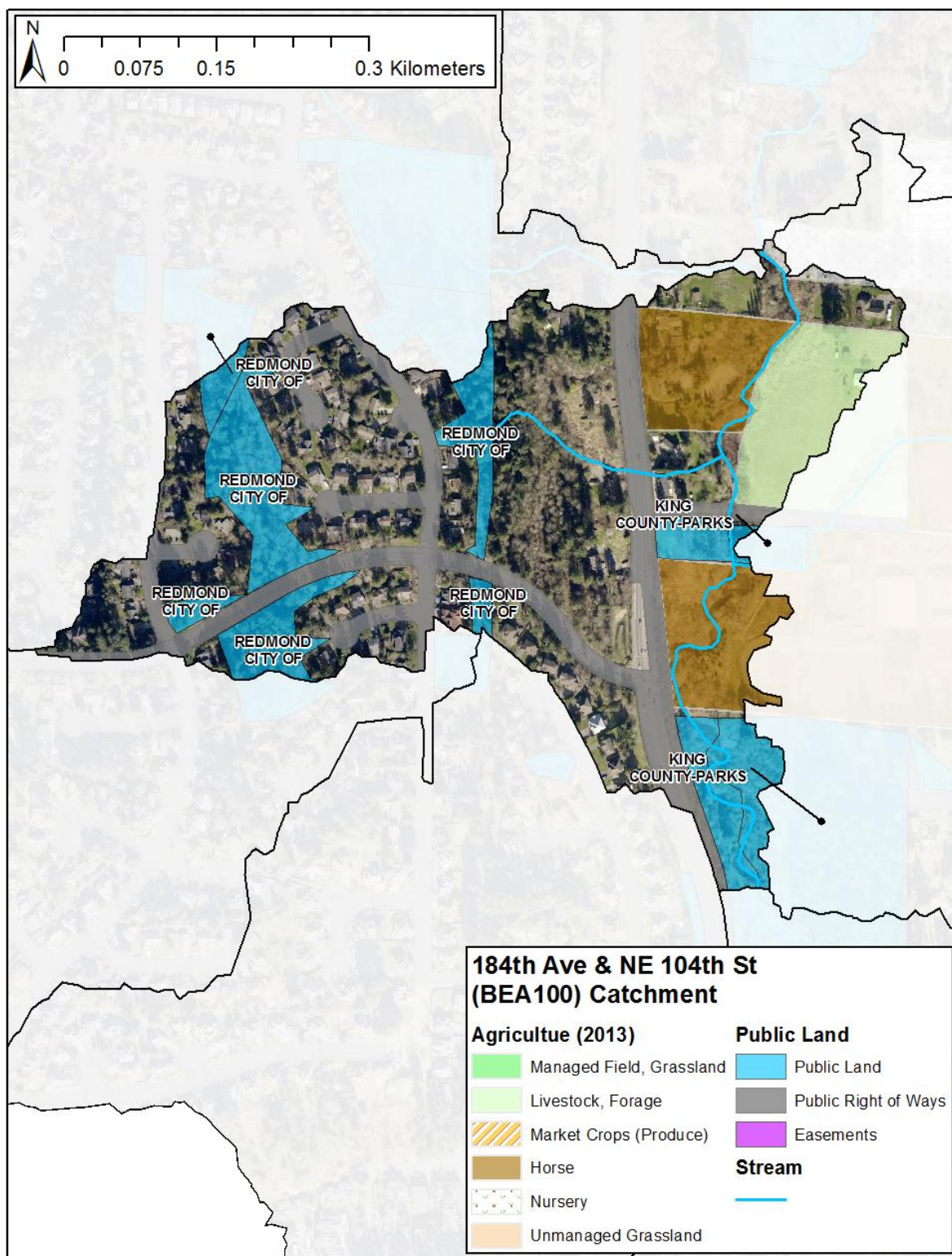


Figure 55. 184th Ave and NE 104th St (BEA100) catchment agricultural and public land.

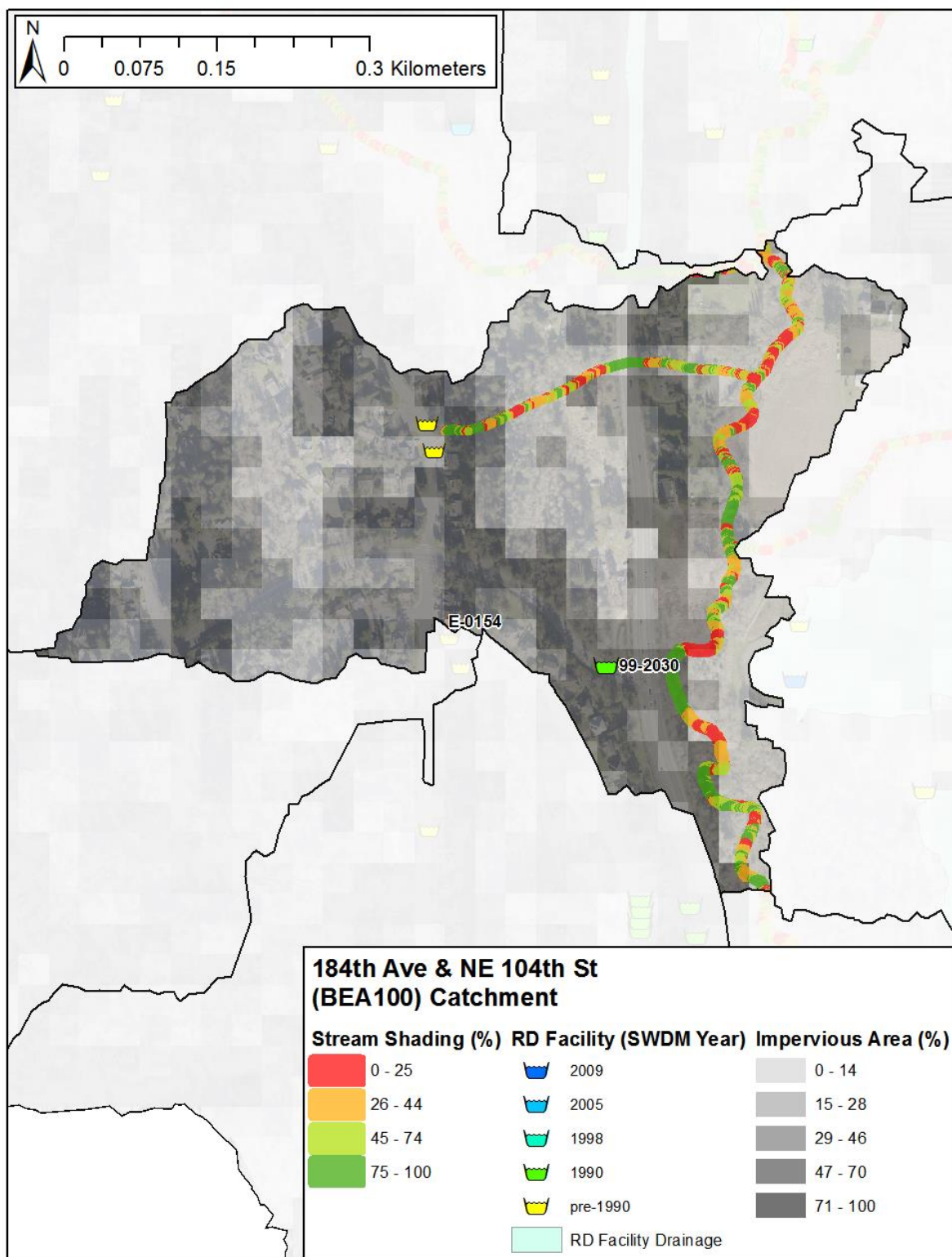


Figure 56. 184th Ave and NE 104th St (BEA100) catchment stream shading, impervious area, and RD facilities and their drainage area.

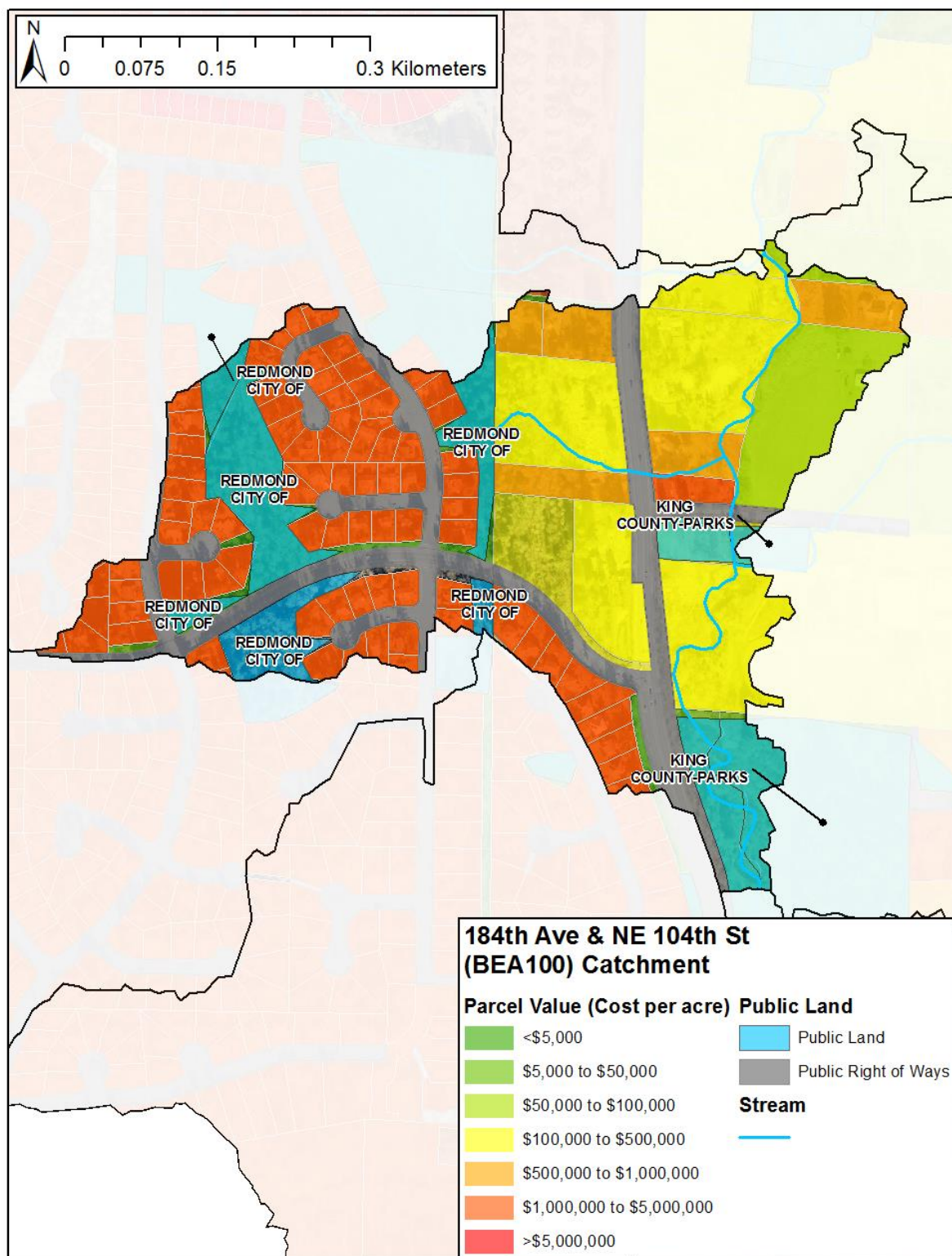


Figure 57. 184th Ave and NE 104th St (BEA100) catchment parcel values and public lands.

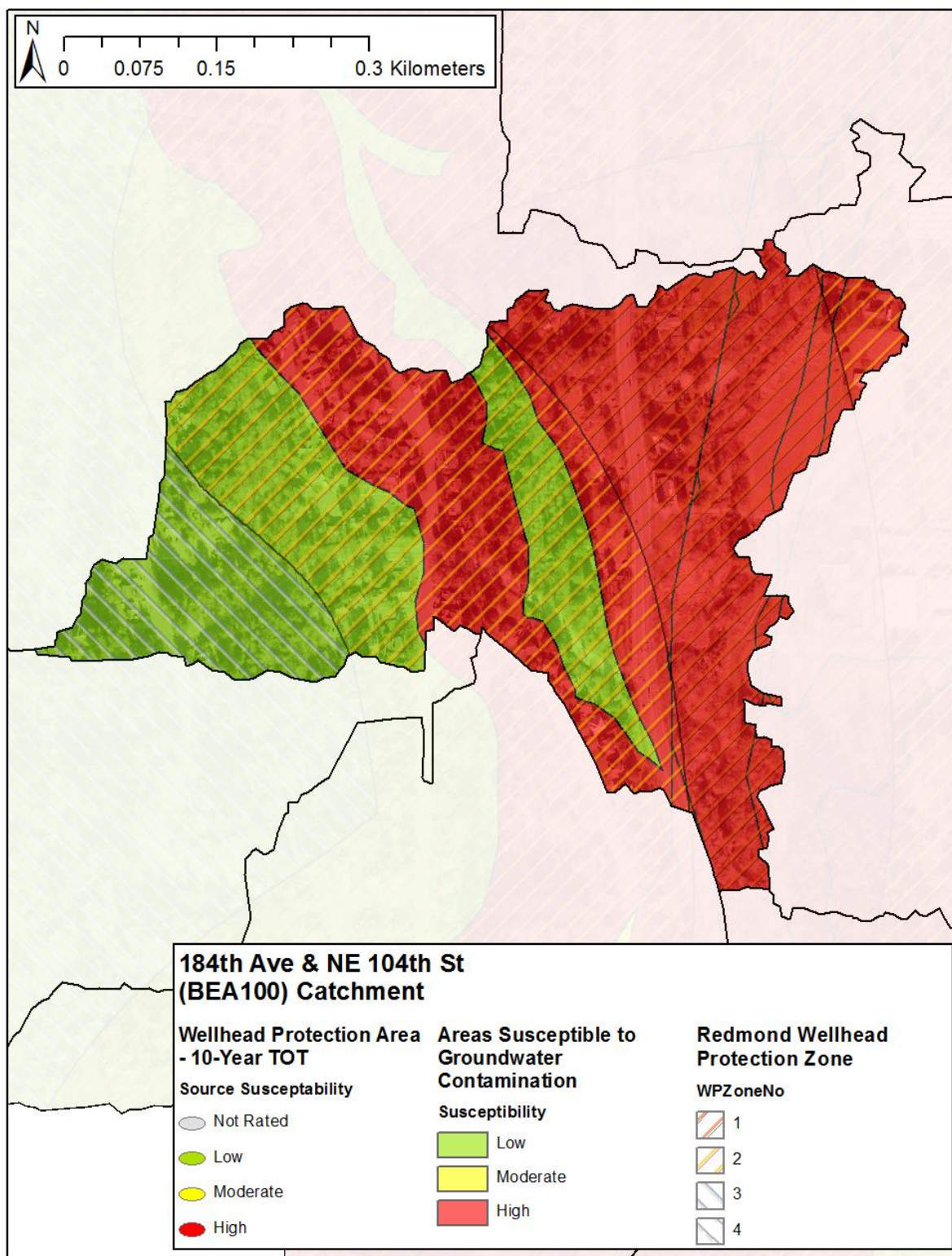


Figure 58. 184th Ave and NE 104th St (BEA100) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff.

5.5 BEA010 – Bear Creek Mouth (Score: 90)

The Bear Creek Mouth (BEA010) catchment is the outlet for the study area. The catchment is 44 acres in area. Most of the catchment drains the Friendly Village mobile home park within the City of Redmond. Installation of a stormwater facility that treats runoff from Friendly Village is identified. Tree planting along the Redmond-owned riparian area is identified, and a program that incentivizes planting within Friendly Village’s riparian area is also identified.

Table 33. Available data for Bear Creek Mouth (BEA010) catchment.

Criteria	Data
Existing water quality problems	• Temperature (91% of summer 7-DADMax temperatures exceed water quality standards) • Dissolved Oxygen (2 of 3 summer samples did not meet water quality standards) • Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria) • Total Suspended Solids (wet-weather samples are five-times that of baseflow samples)
Existing instream habitat problems	• Lower habitat quality (King County et al., 1989) • Bank Erosion/Instability and Lack of Instream Habitat Diversity (Entranco, 1994) • Loss of vegetation and instream large organic debris (King County et al., 1994)
B-IBI (WRIA8 Regression)	Fair (52.7)
Riparian land cover	25% impervious 11% trees 24% shrub 8% pasture 34% other (water, bare area, grass, etc.)
Public Lands	9% public land
City of Redmond	0625069013; 0625069126; 0625069025; 0625069121
WSDOT	0625069159
Horse and Livestock Lands	None
Right-of-Ways	0.50 acres
Property Value	\$810,184 Residential parcels are generally lower cost per acres
Untreated Impervious Area	48% of catchment is untreated impervious land The Friendly Village Mobile Home Park does not have documented stormwater facilities and has a high level of imperviousness.
Existing Stormwater Facilities	• Redmond Pond 92-0200 – built 1992
Easements	None

Criteria	Data
Groundwater	- The catchment is in both Redmond Wellhead Protection Zone 1 and 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff. - The catchment has moderate to high susceptibility to groundwater contamination.
Stream Shade	82% of the stream has less than 50% shading - Hot spots of low shade: - Friendly Village waterfront - Lower reach of Bear Creek

Table 34. Summary of Identified Strategies for Bear Creek Mouth (BEA010) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

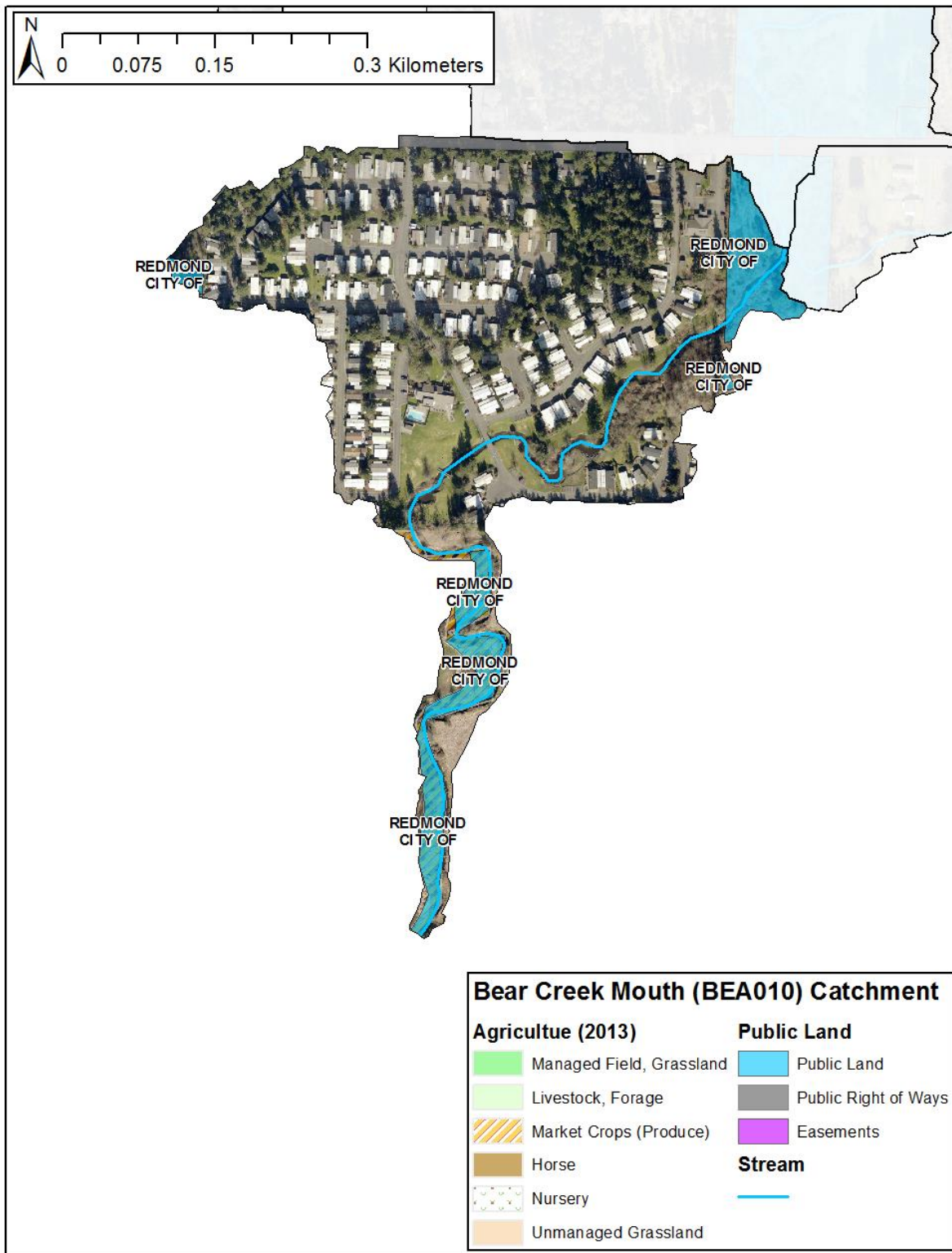


Figure 59. Bear Creek mouth (BEA010) catchment agricultural and public land.

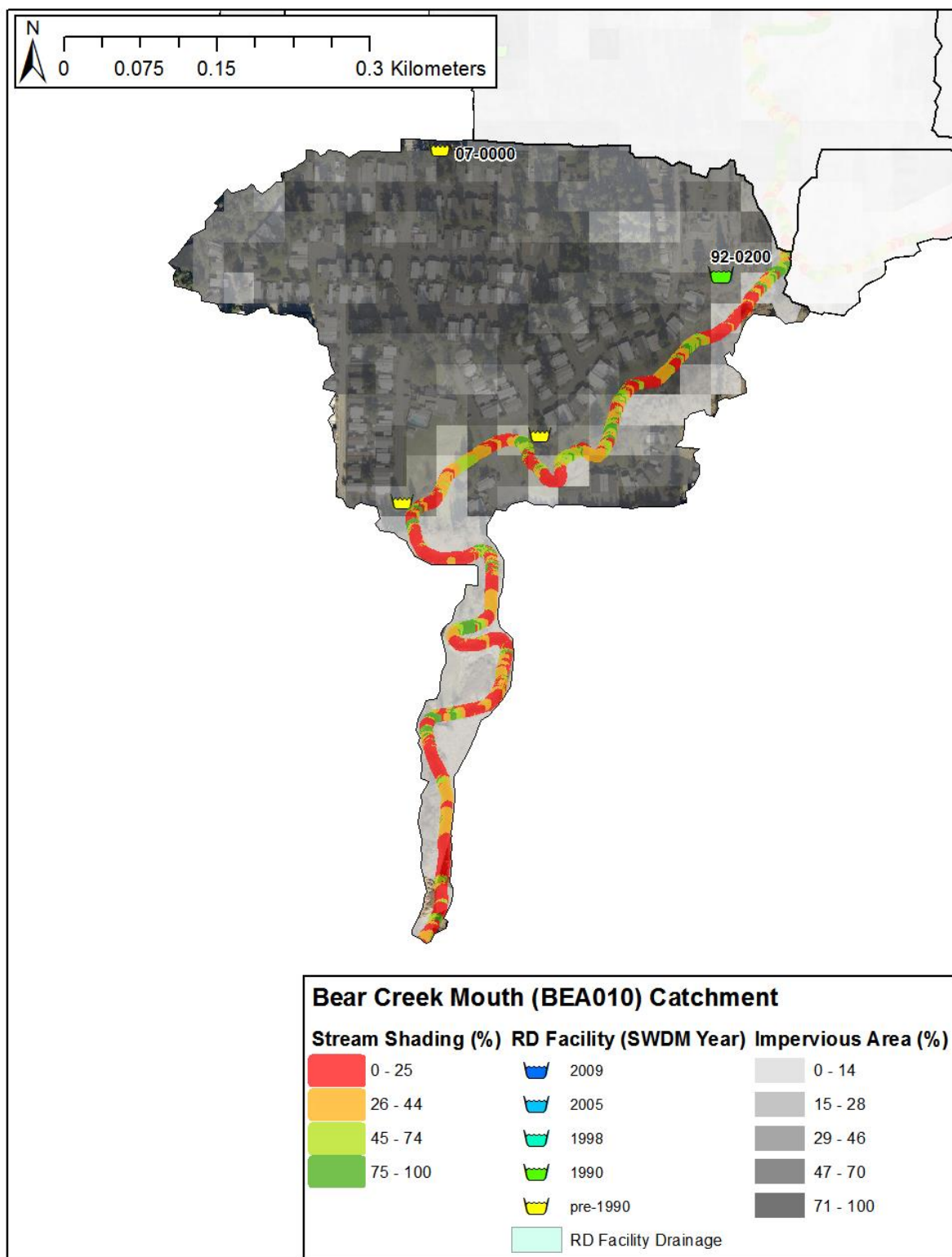


Figure 60. Bear Creek mouth (BEA010) catchment stream shading, impervious area, and RD facilities and their drainage area.

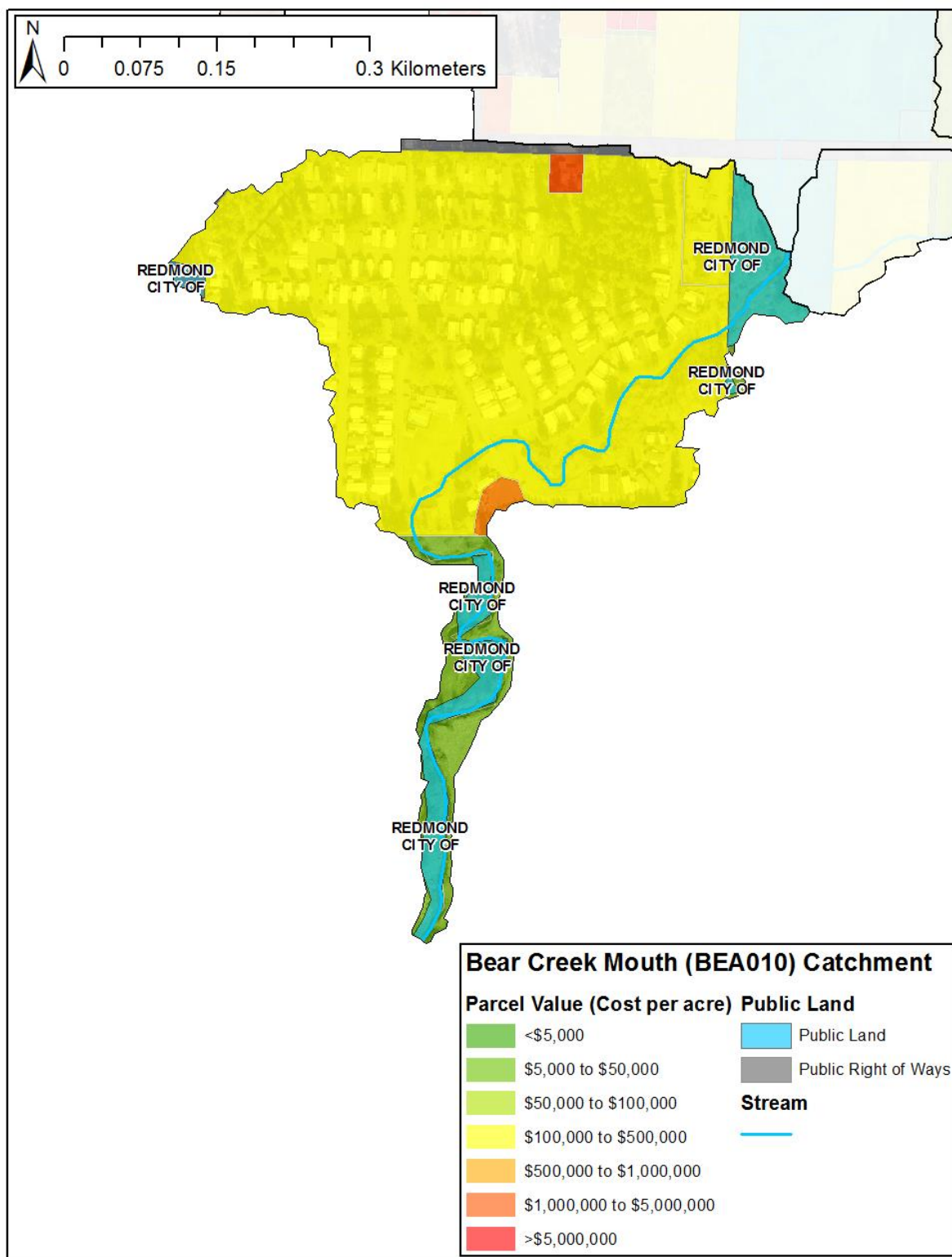


Figure 61. Bear Creek mouth (BEA010) catchment parcel values and public lands.

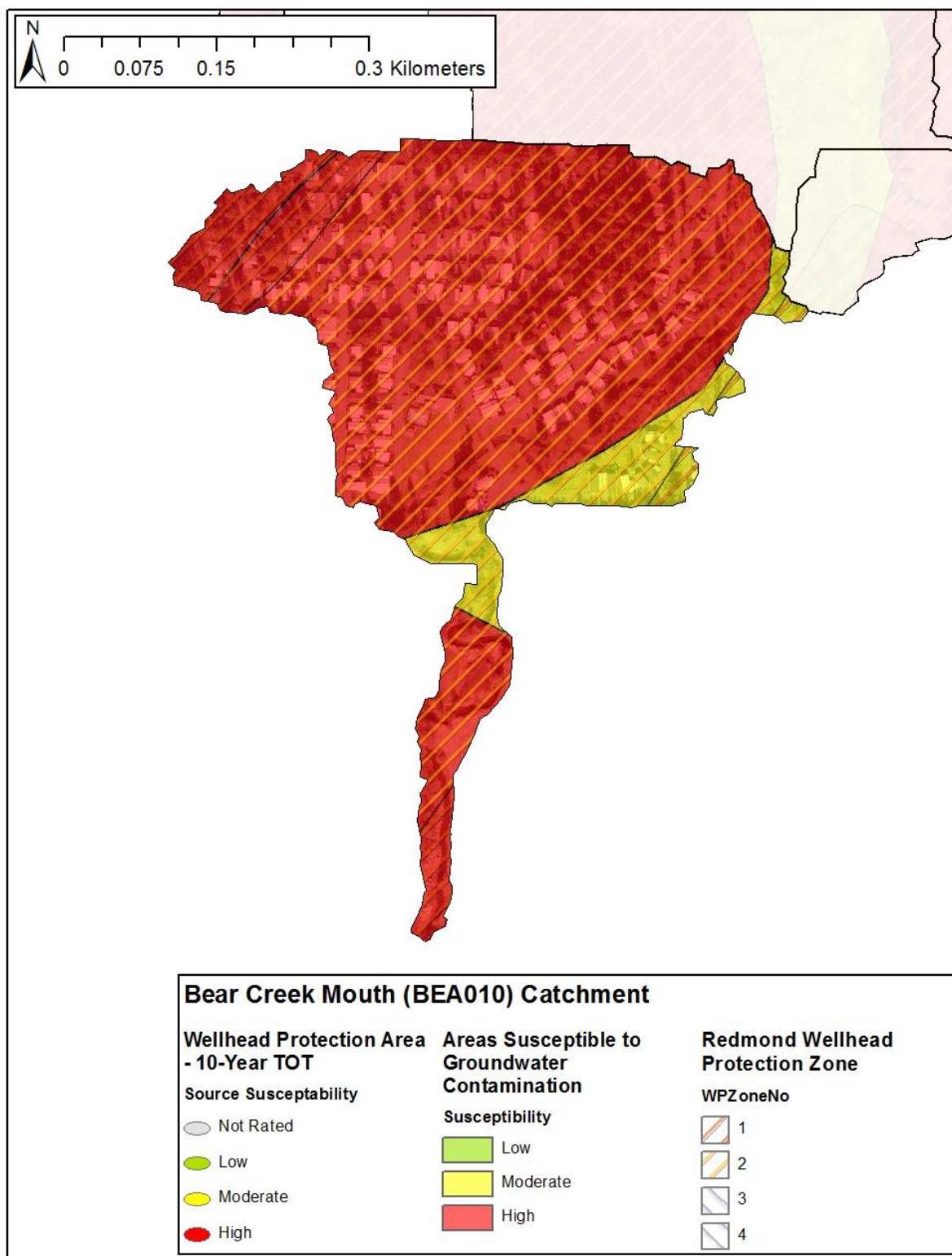


Figure 62. Bear Creek mouth (BEA010) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff.

6.0 PRIORITY CITY OF WOODINVILLE CATCHMENTS

For catchments located primarily within the City of Woodinville, The data input to the prioritization metric and the resulting final score are displayed in Table 35 with the catchments ranked. The following sections detail the ranked catchments and discuss potential projects and actions to improve water quality and hydrology.

Table 35. Ranked catchments located primarily in City of Woodinville and prioritization metric input data.

Catchment	Scoring Metrics									Total Score
	Water Quality	B-IBI	Untreated Impervious	Storm-water Facility	Forage Live-stock	Property Cost	Public Land	Right-of-way	Roof	
BEA840	15	20	20	0	0	10	0	0	10	75
BEA860	15	20	10	0	0	10	0	8	10	73
BEA850	15	10	10	0	0	10	0	8	10	63

6.1 BEA840 – East Woodinville (Score: 75)

The East Woodinville catchment (BEA840) is 255 acres in area. The catchment is predominately low- to mid-density residential development and contains the Wellington Elementary School and Leota Middle School campuses. The catchment drains to Cold Creek downstream of Lake Leota.

No stormwater facilities for the school campuses are mapped (Figure 67). If no stormwater facilities currently receive flow from the campuses, the construction of new facilities are identified.

The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development. Construction of roadside bioswales is also identified where other facilities are lacking.

Table 36. Available data for East Woodinville (BEA840) catchment.

Criteria	Data
Existing water quality problems (Cold Creek)	- Inadequate temperature data were available. The creek went dry during some of the summer sampling period. - Dissolved Oxygen (1 of 1 summer samples did not meet water quality standards) - Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria)

Criteria	Data
Existing instream habitat problems	No data
B-IBI (WRIA8 Regression)	Poor (20.8)
Riparian land cover	27% impervious 44% trees 8% shrub 2% pasture 19% other (water, bare area, grass, etc.)
Public Lands	1% public land
City of Woodinville	8031000080 (Stonegate drainage)
King County Water and Land	9238430710 (Wellington) 0126059277 (stormwater)
Horse and Livestock Lands	None
Right-of-Ways	22 acres (included road surface) Woodinville-Duvall Rd Several residential streets
Property Value	\$739,905 per acre
Untreated Impervious Area	19% of catchment is untreated impervious Drainage areas for stormwater facilities are not mapped.
Existing Stormwater Facilities	- RD Pond (PD0136) year built unknown – Wellington Hills - RD Pond (PD0139) year built unknown – Wellington Hills - RD Pond (PD0129) year built unknown – Cedar Heights - RD Pond (PD0130) year built unknown – Cedar Heights - RD Pond (PD0130) built 2009
Easements	none
Groundwater	The catchment has low to high susceptibility to groundwater contamination
Stream Shade	18% of the stream has less than 50% shading

Table 37. Summary of Identified Strategies for East Woodinville (BEA840) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	

Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

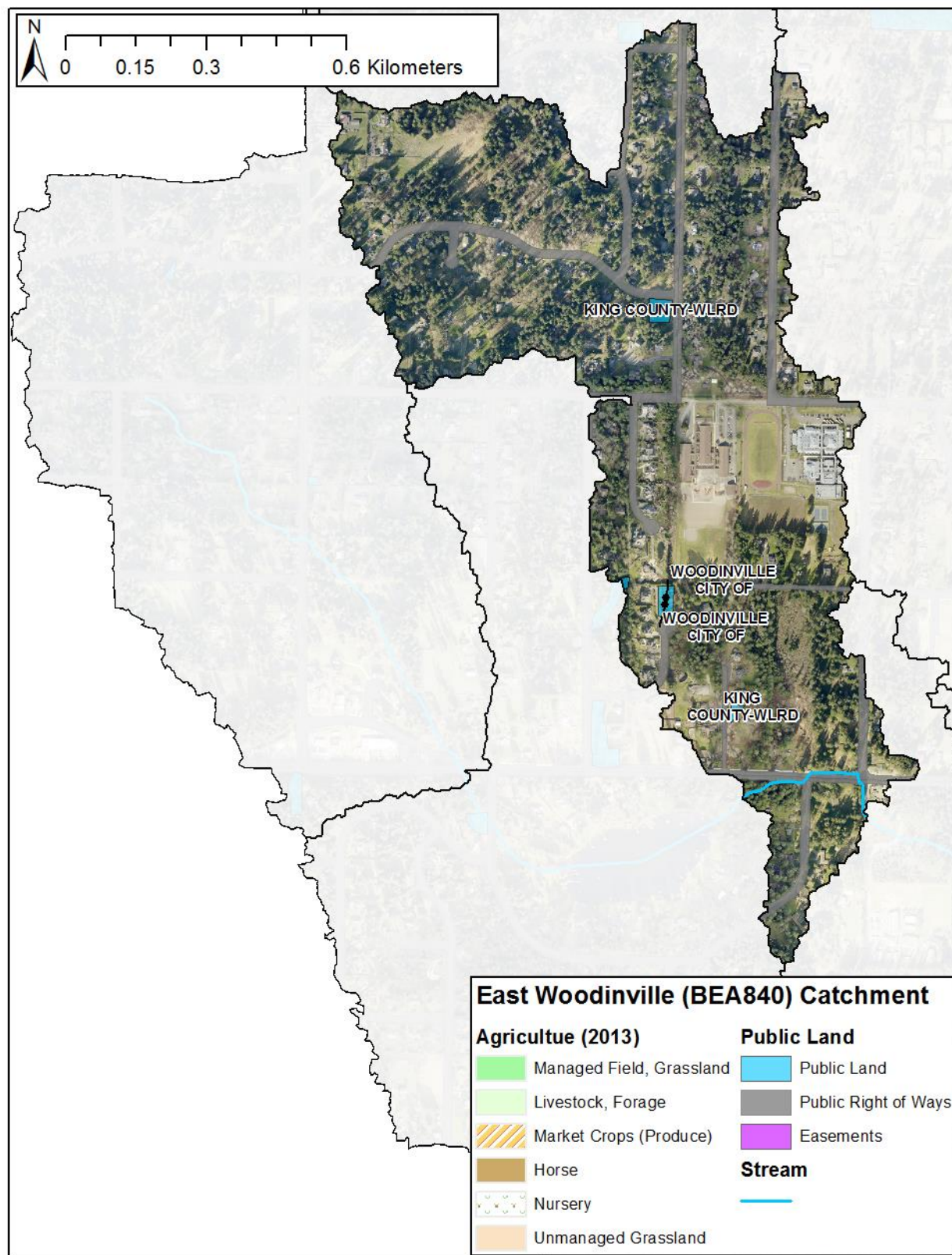


Figure 63. East Woodinville (BEA840) catchment agricultural and public land.

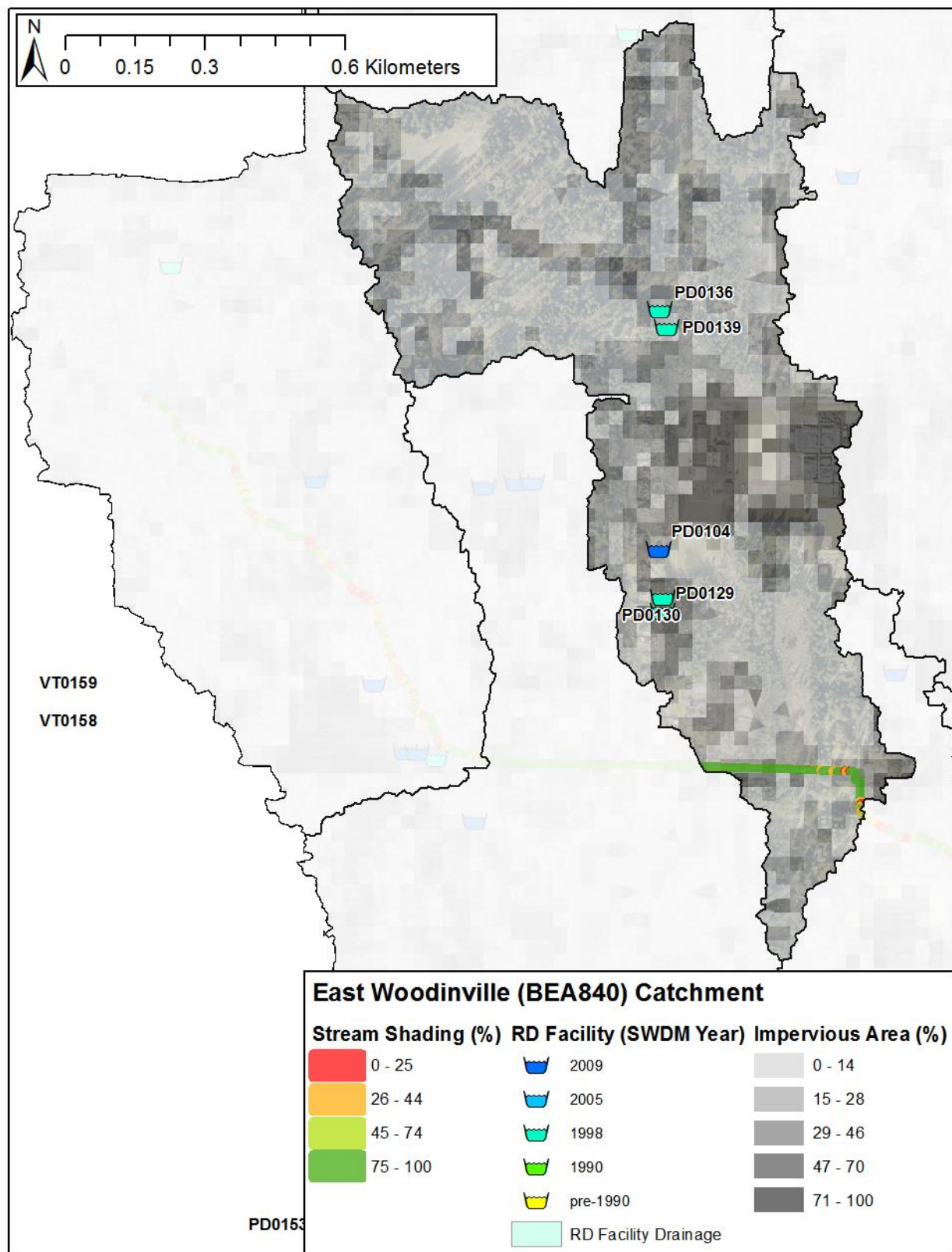


Figure 64. East Woodinville (BEA840) catchment stream shading, impervious area, and RD facilities and their drainage area.

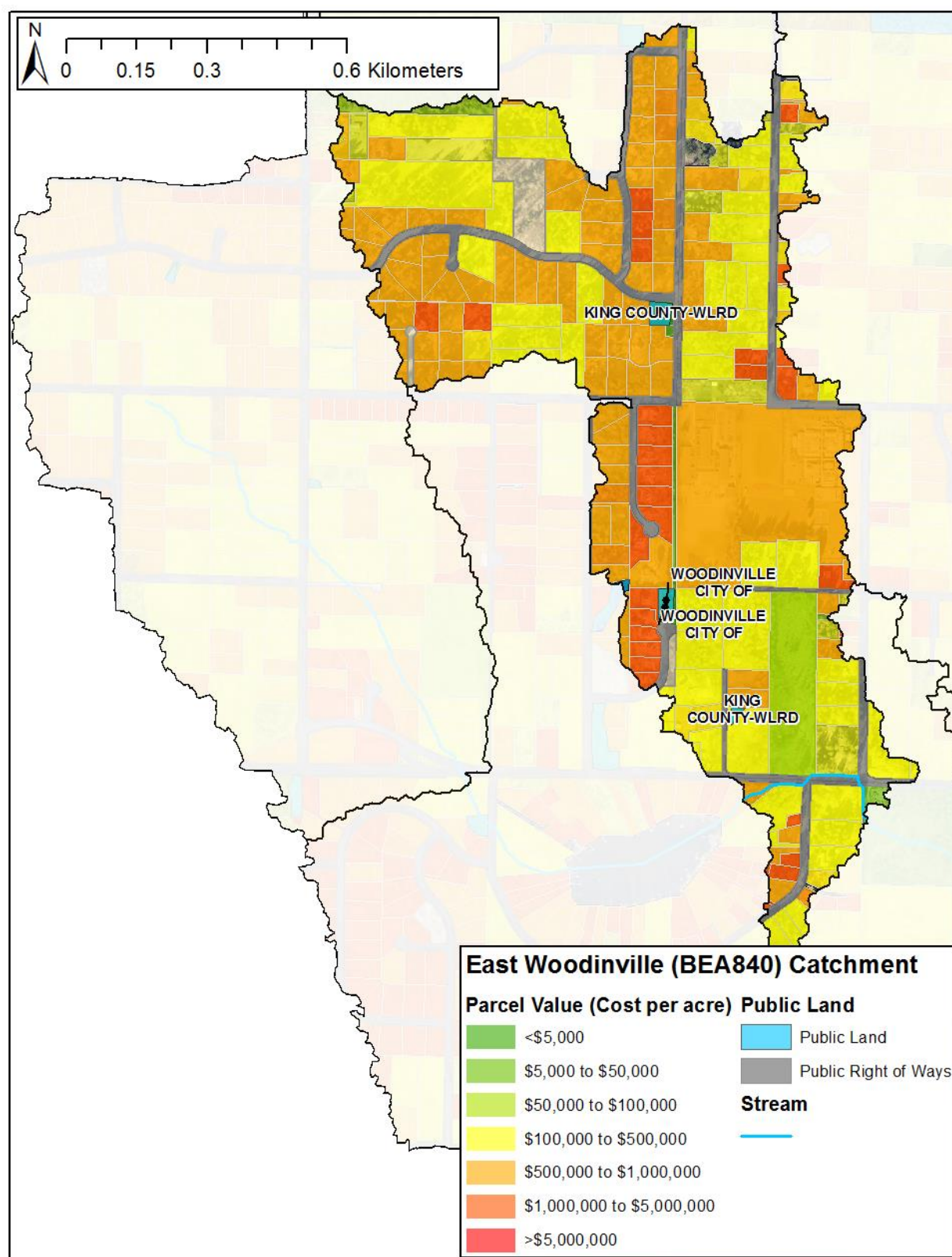


Figure 65. East Woodinville (BEA840) catchment parcel values and public lands.

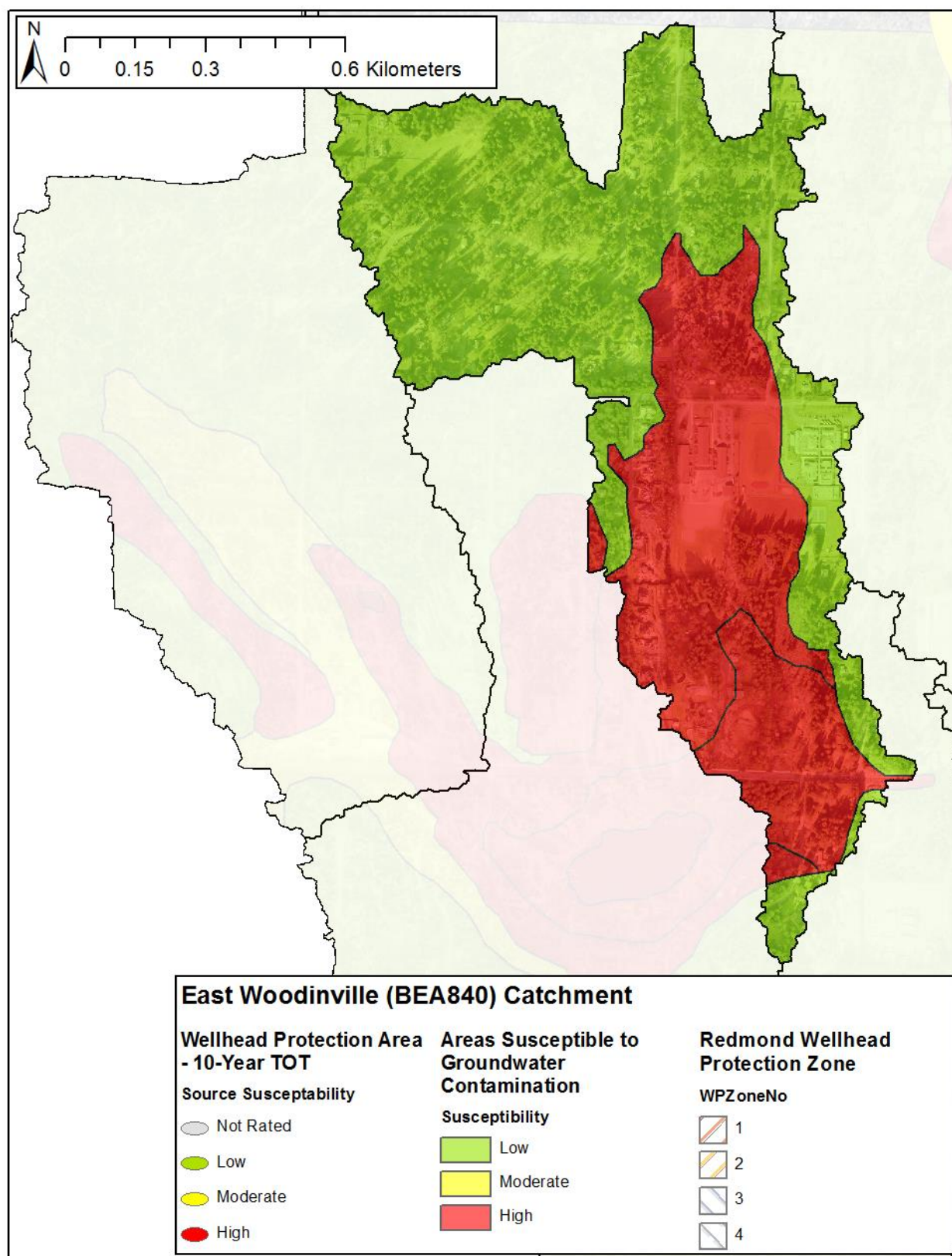


Figure 66. East Woodinville (BEA840) catchment groundwater protection areas.

6.2 BEA860 – Upper Cold Creek (Score: 73)

The Upper Cold Creek catchment (BEA860) is 242 acres in area. The catchment is predominately low- to mid-density residential development with a small amount of commercial along Woodinville-Duvall Rd (Hilltop Commercial Center). The catchment drains into Lake Leota.

There are three stormwater facilities serving the Hilltop Commercial Center (Figure 63). Three other stormwater facilities receive flows from residential land use. It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment.

The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development. Construction of roadside bioswales is also identified along Woodinville-Duvall Rd and 156th Ave NE.

Table 38. Available data for Upper Cold Creek (BEA860) catchment.

Criteria	Data
Existing water quality problems (Cold Creek and Lake Leota)	- Inadequate temperature data were available. The creek went dry during some of the summer sampling period. - Dissolved Oxygen (1 of 1 summer samples did not meet water quality standards) - Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria) - Lake Leota is moderately productive and phosphorus limited (King County, 2010)¹
Existing instream habitat problems	No data
B-IBI (WRIA8 Regression)	Poor (21.0)
Riparian land cover	15% impervious 41% trees 10% shrub 3% pasture 29% other (water, bare area, grass, etc.)
Public Lands	1% public land
King County Roads	1126059153
King County Water and Land	9238510240 0226059172
Horse and Livestock Lands	None
Right-of-Ways	27 acres (included road surface) Woodinville-Duvall Rd 156 th Ave NE Several residential streets
Property Value	\$694,392 per acre
Untreated Impervious Area	16% of catchment is untreated impervious Drainage areas for stormwater facilities are not mapped.
Existing Stormwater Facilities	- RD Pond (PD0138) year built unknown – Wellington Hills - RD Pond (PD0158) built in 2011 – Wellington Hills on 9238510240 - RD Pond (PD0127) year built unknown - RD Pond (PD0112) built 2009 (Hilltop Commercial Center) - Vault (VT0101) built 2009 (Hilltop Commercial Center) - Vault (VT0129) built 2009 (Hilltop Commercial Center)
Easements	None
Groundwater	The catchment has low to high susceptibility to groundwater contamination
Stream Shade	46% of the stream has less than 50% shading

Table 39. Summary of Identified Strategies for Upper Cold Creek (BEA860) catchment.

Strategy	Benefits
----------	----------

¹ http://green2.kingcounty.gov/SmallLakes/Reports/Leota_WY09.pdf

	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

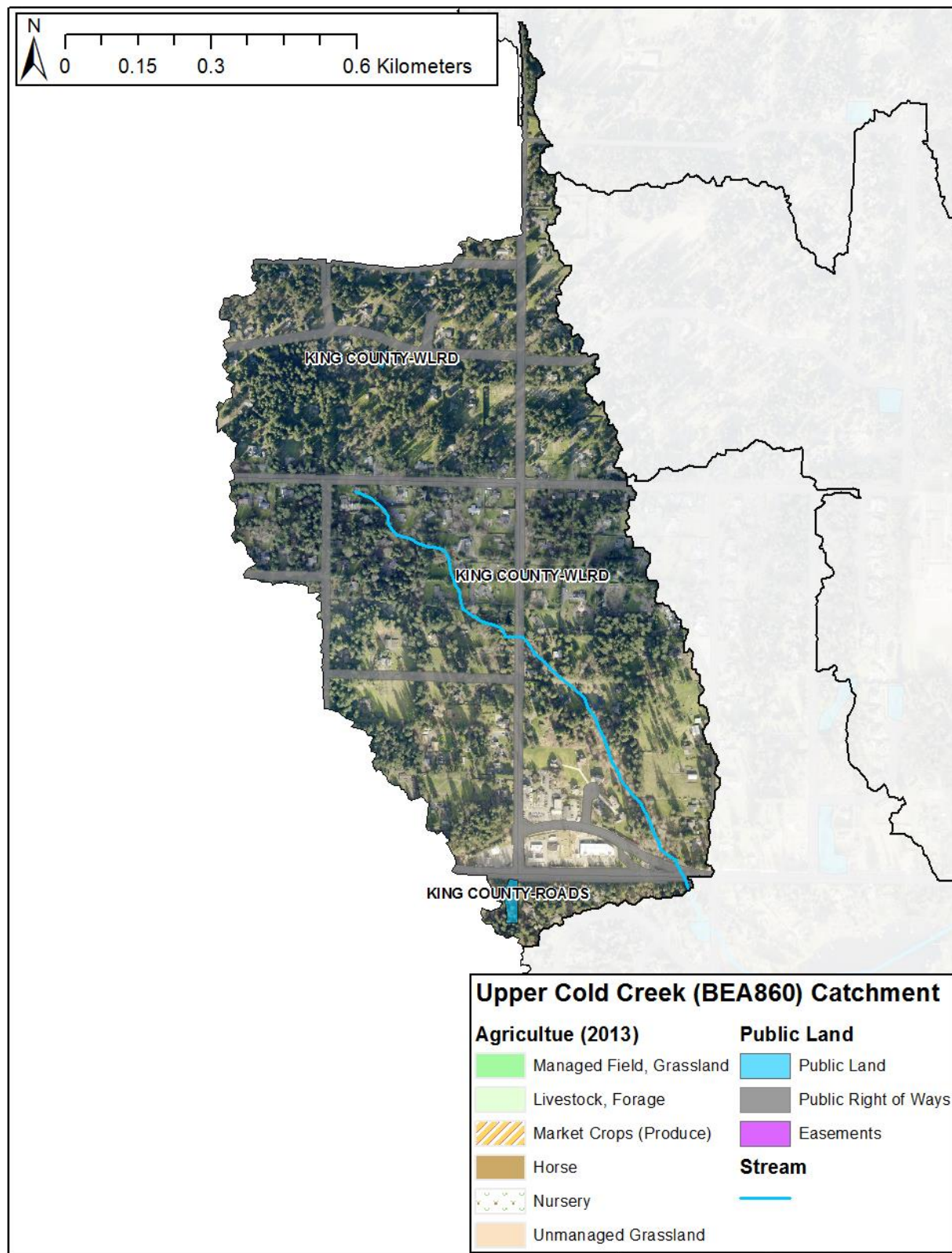


Figure 67. Upper Cold Creek (BEA860) catchment agricultural and public land.

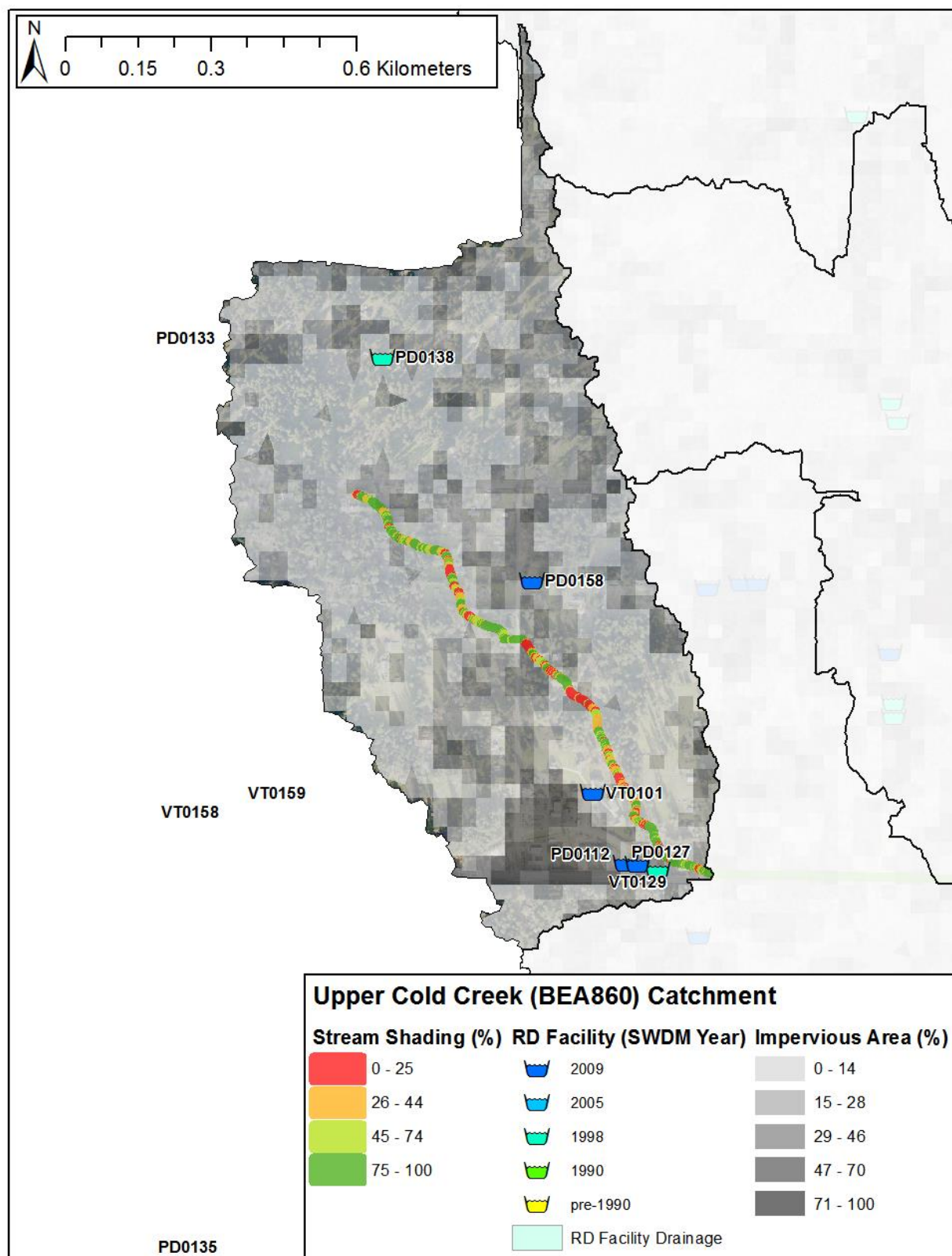


Figure 68. Upper Cold Creek (BEA860) catchment stream shading, impervious area, and RD facilities and their drainage area.

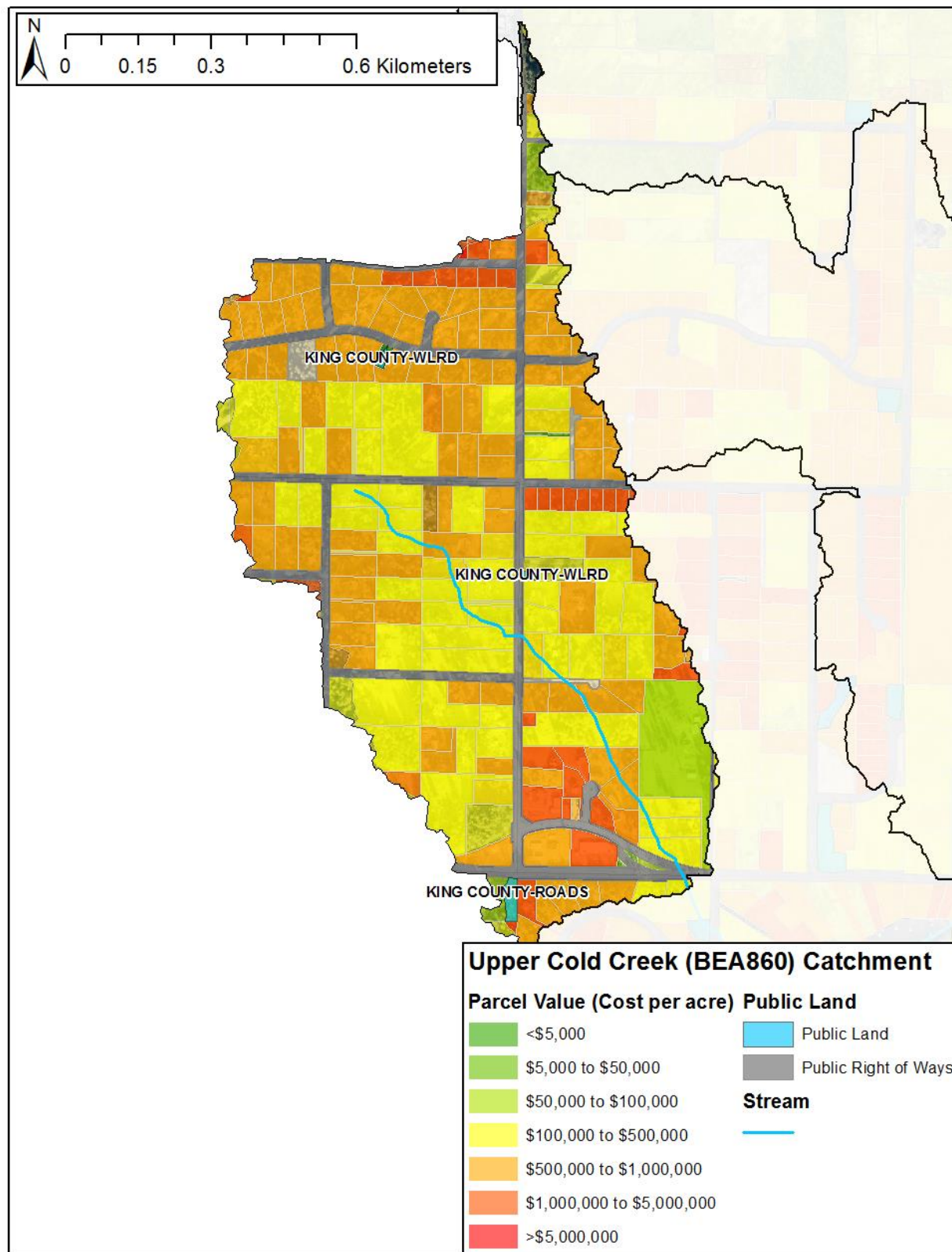


Figure 69. Upper Cold Creek (BEA860) catchment parcel values and public lands.

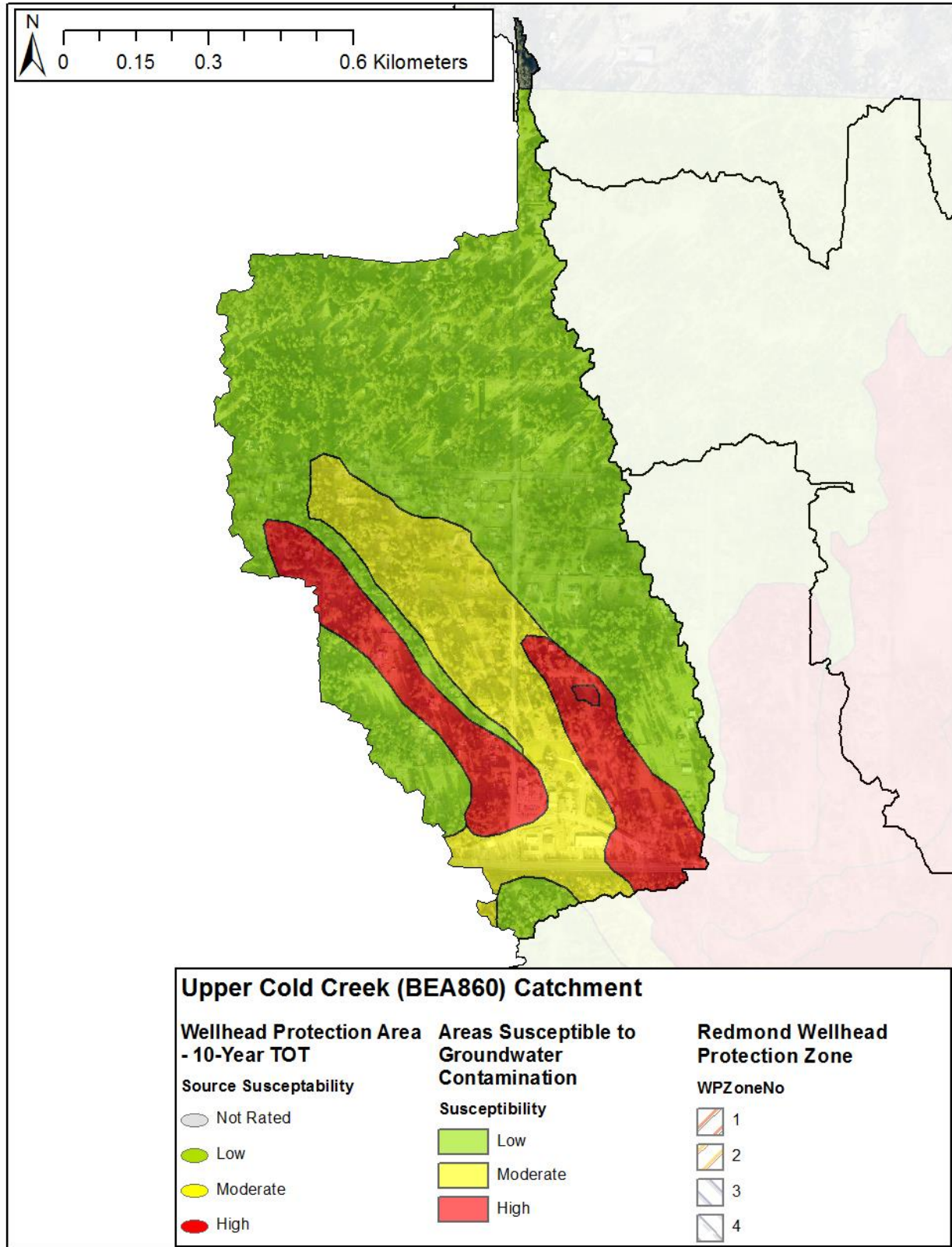


Figure 70. Upper Cold Creek (BEA860) catchment groundwater protection areas.

6.3 BEA850 – Lake Leota (Score: 63)

The Lake Leota (BEA850) catchment is located within Woodinville and drains to Cold Creek, which ultimately flows into Cottage Lake Creek. The catchment is 247 acres in area. The catchment is predominately low- to mid-density residential development, containing Lake Leota, a 10-acre natural lake.

The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development. Construction of roadside bioswales is also identified along 164th Ave NE, 195th Ave NE, NE 180th St, and Woodinville-Duvall Rd.

Encourage shoreline restoration along Lake Leota. Support septic inspection. Support lawn and garden lakeside best management practices (P-free fertilizers, dog waste pickup).

Table 40. Available data for Lake Leota (BEA850) catchment.

Criteria	Data
Existing water quality problems (Cold Creek and Lake Leota)	- Inadequate temperature data were available. The creek went dry during some of the summer sampling period. - Dissolved Oxygen (1 of 1 summer samples did not meet water quality standards) - Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria) - Lake Leota is moderately productive and phosphorus limited (King County, 2010)²
Existing instream habitat problems	No data
B-IBI (WRIA8 Regression)	Fair (45.2)
Riparian land cover	8% impervious 21% trees 2% shrub 69% other (water, bare area, grass, etc.)
Public Lands	<1% public land
City of Woodinville	0226059014; 4277000130
King County Water and Land	4215250590 (retention pond)
Horse and Livestock Lands	None
Right-of-Ways	27 acres
Property Value	\$694,391 per acre
Untreated Impervious Area	16% of catchment is untreated impervious land Drainage areas for stormwater facilities are not mapped.
Existing Stormwater Facilities	- Private pond (PD0128) – year built unknown - King County pond (PD0159) built 2011

² http://green2.kingcounty.gov/SmallLakes/Reports/Leota_WY09.pdf

Criteria	Data
	Beverly Hills Estates vaults (VT0138 and VT0142)
Easements	None
Groundwater	The catchment has low to high susceptibility to groundwater contamination
Stream Shade	46% of the stream has less than 50% shading Much of the catchment's flow path is through the open water of Lake Leota

Table 41. Summary of Identified Strategies for Lake Leota (BEA850) catchment..

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X
Shoreline restoration/stewardship along Lake Leota and outlet		X	X	X	

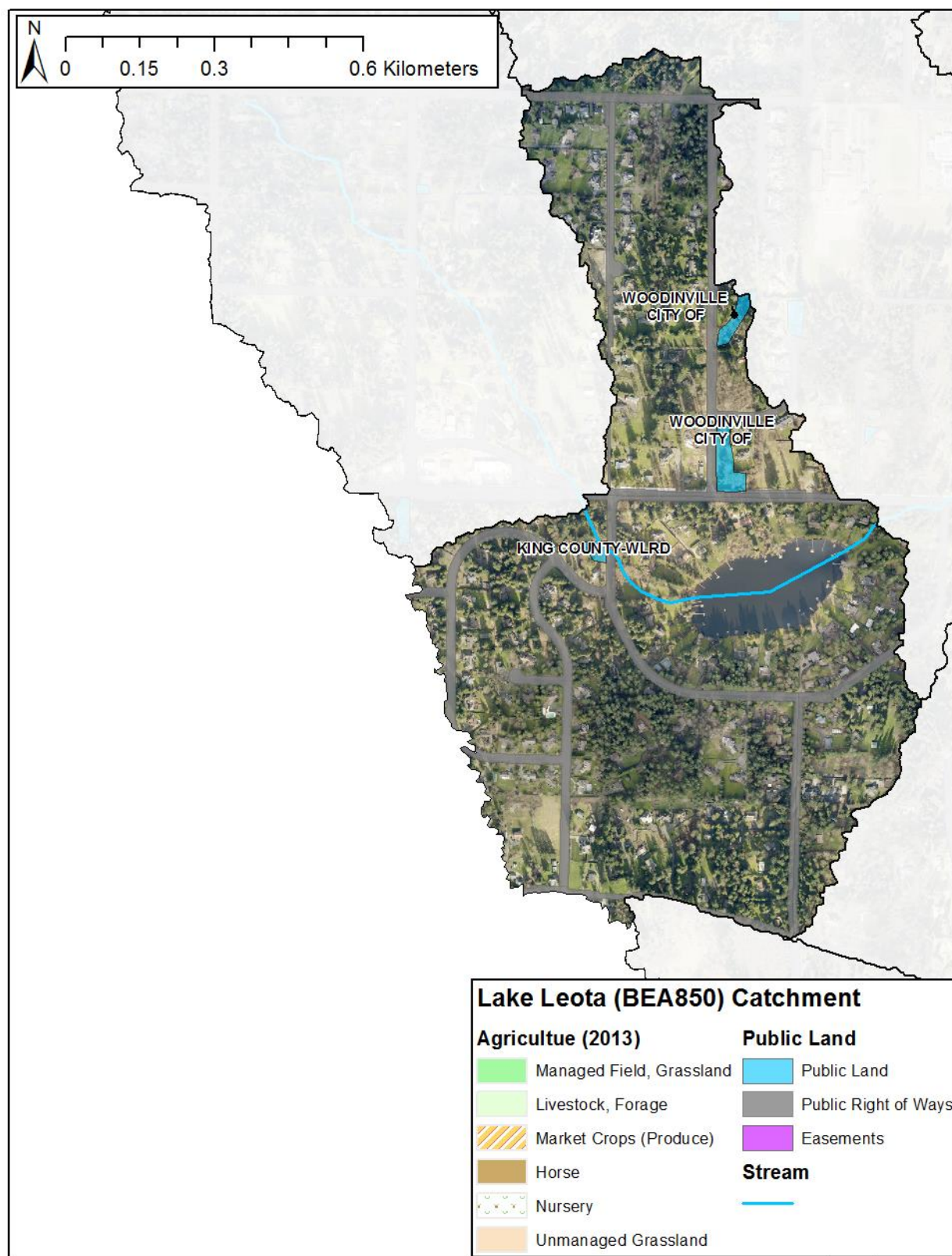


Figure 71. Lake Leota (BEA850) catchment agricultural and public land.

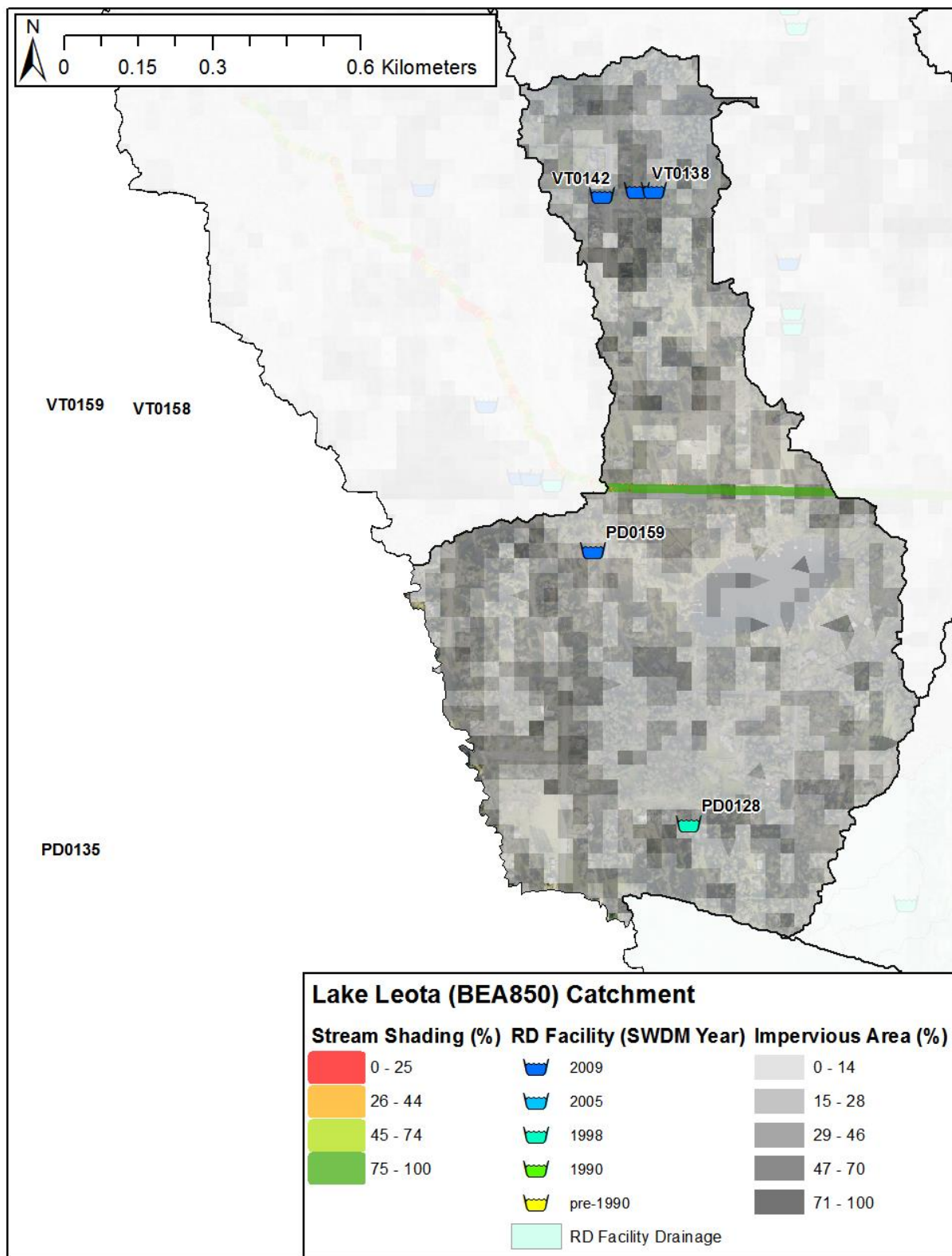


Figure 72. Lake Leota (BEA850) catchment stream shading, impervious area, and RD facilities and their drainage area.

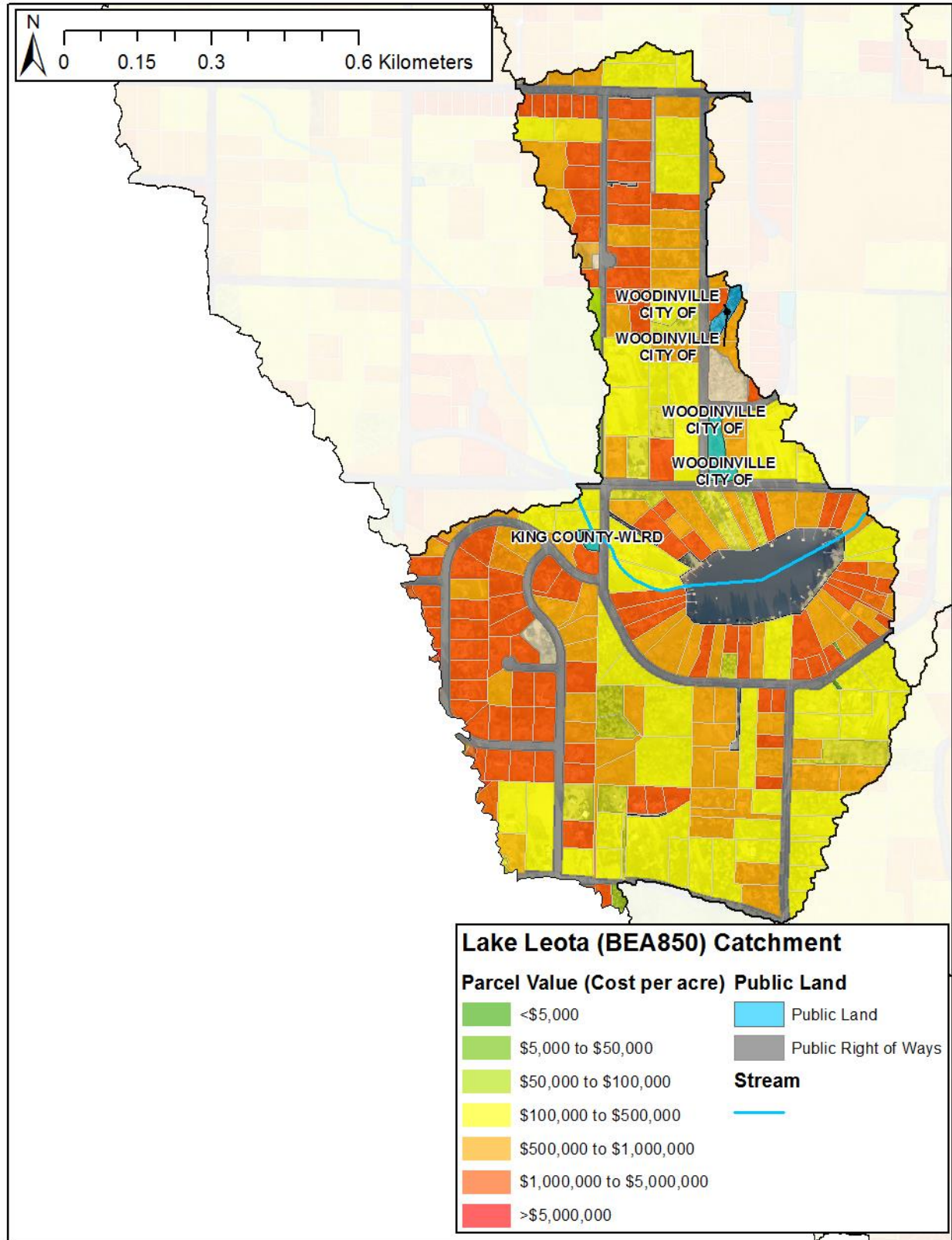


Figure 73. Lake Leota (BEA850) catchment parcel values and public lands.

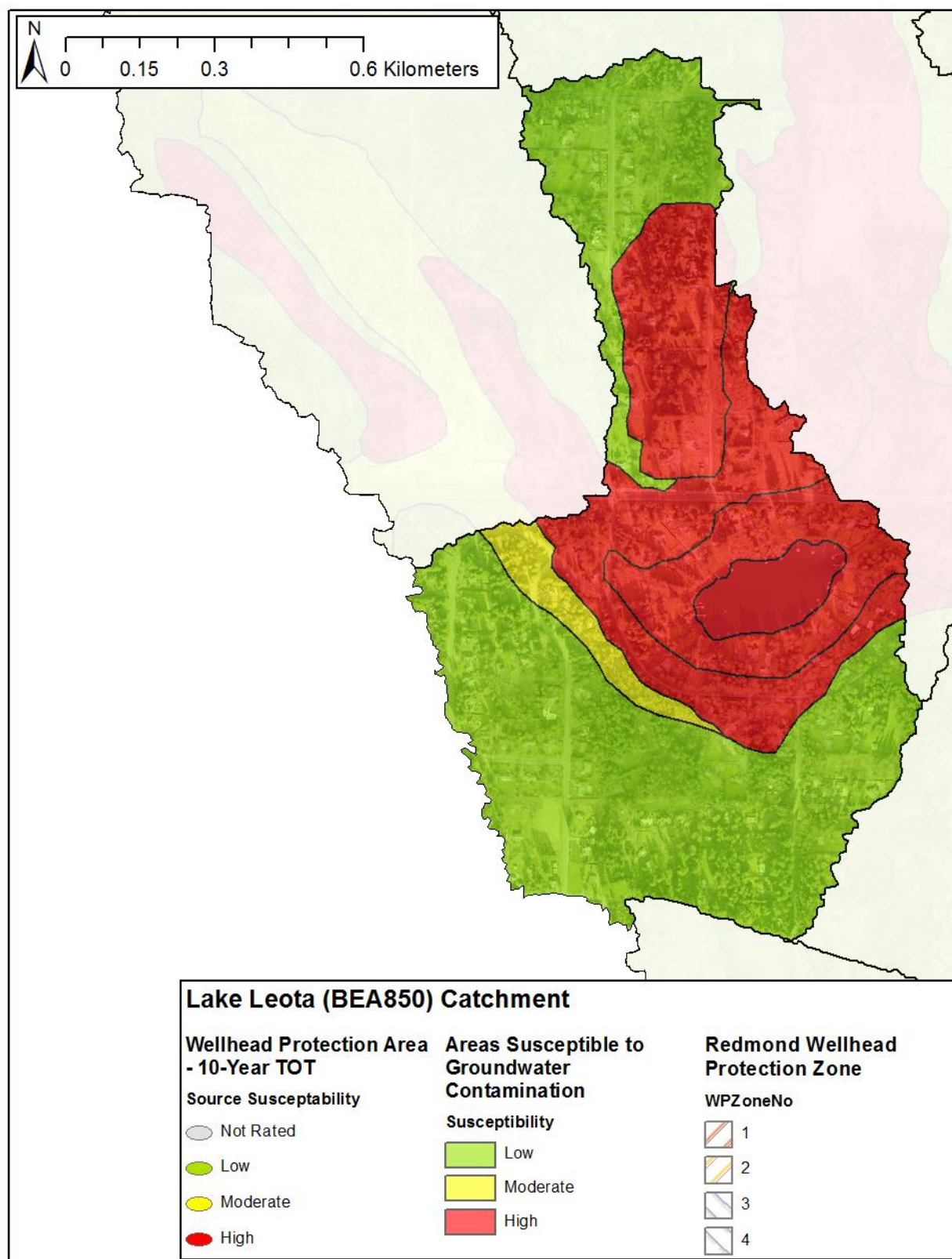


Figure 74. Lake Leota (BEA850) catchment groundwater protection areas.

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APPENDIX B:

Instream Habitat Project Identification and Prioritization

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1.0 INTRODUCTION

Salmonids depend on various habitat types throughout their life-cycle to support individual survival as well as population sustainability (Bjornn and Reiser 1991, Roni et al. 2014). The suite of habitats and associated environmental conditions experienced throughout their life-cycle subsequently influence the abundance, productivity, distribution, and diversity of salmonid populations (McElhany et al. 2000). The quantity, quality, and connectivity of these habitats are thus inherently critical to salmonid survival and productivity (Roni et al. 2014). Since salmonid growth and rearing in freshwater habitats have the potential to influence survival at later stages, it is critical to protect and restore freshwater habitats.

As juvenile salmon grow and transition through early life stages, their habitat use and distribution appears to shift with different habitat types being used at different times of the year (King County 2017a). In order to support the continuum of early life stages, a variety of freshwater rearing habitats are needed throughout the Bear Creek study area. Freshwater habitat quantity, quality, and connectivity are inherently related to well-functioning riverine, floodplain, and riparian processes. Supporting these processes through protection and restoration strategies can promote the habitat conditions needed by juvenile salmonids.

Critical salmonid life stages are sustained by protecting areas where habitat conditions are closer to well-functioning as well as actively restoring areas where habitat conditions are degraded. Protection strategies aimed at conserving well-functioning areas in the Bear Creek watershed may include continued or further implementation of land-use policies that protect habitat areas including regulatory mechanisms such as comprehensive plans, critical areas ordinance, shoreline programs, zoning regulations, storm water management, and reduction of development impacts. Additional strategies aimed at protecting critical habitat areas include conservation easements and transfers/purchase of development rights, water rights and instream flow protection, best management practices and voluntary measures, as well as other strategies. Protection strategies are integral in ensuring that well-functioning area remain intact and help to minimize the net loss and degradation of available habitat areas.

In areas of the Bear Creek watershed where habitats have been degraded, restoration strategies should focus on habitat quantity, quality, variety, and connectivity as well as decreasing the pressures which degrade habitats. Restoration strategies suggested for the Bear Creek watershed include floodplain and wetland restoration/connection, off-channel and side-channel restoration/creation, tributary restoration/connection, large wood supplementation, riparian forest restoration, and road and bridge crossing improvements. These restoration strategies help to support and maintain riverine, floodplain, and riparian processes which in turn provide the habitats that support various salmon life stages. Details of how each strategy supports instream habitats and habitat-forming processes are included in Table 1. Riparian restoration is an integral element in Bear Creek conservation and restoration; however, discussion and prioritization of riparian strategies is not included in this Appendix but rather detailed in *Appendix D – Riparian Corridor Strategies*.

Table 1. Restoration Strategies and Ecological Benefits.

Restoration Strategy	Salmonid Ecological Benefits*
Tributary Confluence Restoration	Provides rearing habitats, high-flow and predator refuge, areas of high food resource availability, potential cold water refugia, increased connectivity to habitat areas, and increased confluence habitat heterogeneity.
Wetland Connection	Provides connection to rearing and overwinter habitats. Improves water quality, hydrology, primary productivity, organic matter retention, and food resources availability.
Floodplain Connection	Reconnects lateral and floodplain habitats important for rearing and refuge, allows channel migration, restores longitudinal connectivity, supports transport of nutrients and sediment. Improves water quality, hydrology, water residence time, overbank fine sediment deposition, primary productivity, and organic matter retention.
Off-channel & Side-Channel Creation	Provides rearing and overwinter habitats, high-flow refuge, areas of food resource availability, spawning habitats, increases habitat heterogeneity and complexity.
Large Woody Debris Addition	Increases pool frequency/depth, woody debris, habitat heterogeneity and complexity, spawning gravel, sediment retention, and organic matter retention. Provides cover from predators, food resources, and promotes hyporheic exchange.
Road/Bridge Crossing Improvements**	Improves channel and floodplain connectivity, fish passage and colonization, water quality, hydrology, and reduces sediment supply.

* Summarized from Roni et al. 2008, Rice et al. 2008, and Roni et al. 2014

** Road/Bridge Crossing Improvements can be accomplished through various efforts and supports fish passage needs

Within the Bear Creek study area, one or more of the aforementioned restoration strategies are included in an **instream habitat project**. Determination of which restoration strategies were included within a given instream habitat project is discussed in *Section 2.1 and 2.2*. Additionally, *Sections 2.3 – 2.6* discuss an approach used to determine the prioritization and ranking of restoration projects across Bear and Cottage Lake creeks.

2.0 INSTREAM HABITAT STRATEGY SELECTION AND PROJECT IDENTIFICATION

2.1 Restoration Project Footprint Areas

In order to determine the locations of habitat projects as well as the relative sizes of project areas, project footprints were determined for the mainstem of Bear and Cottage Lake creeks. A focus was given to mainstem channels since detailed data was not available for many tributaries and since fish-use analyses from 2016 were focused on mainstem channels (King County 2017a). The 100-year floodplain was used as the initial template for the boundaries of project footprint areas. These boundaries were adjusted to site-specific topographic, elevational, and floodplain features along the river corridor using LIDAR, orthophotography, and wetland data sets. These boundary adjustments were focused on aligning project footprint areas around infrastructures and landscape features as well as ensuring footprint areas included floodplain features such as wetlands and tributary confluences. The wetland data set used for these boundary adjustments came from the *Assessment of Bear Creek Watershed Wetlands* (King County 2017b). The upstream and downstream breaks in project footprints were based on road crossing, changes in land-use (e.g., public to private lands), and/or changes in specific restoration strategies. The upstream extents of all project delineation were based on the upstream extents of mapped floodplains as well as the upstream extents of salmonid use within the watershed.

2.2 Restoration Strategies and Habitat projects

Restoration strategies suggested for the Bear Creek watershed include channel restoration, floodplain and wetland restoration/connection, off-channel and side-channel restoration/creation, tributary restoration/connection, large wood supplementation, riparian forest restoration (discussed in *Appendix D*), and road/bridge crossing improvements. These various restoration strategies were grouped into five broad categories including tributary confluence restoration, wetland connection, floodplain connection, off-channel and side-channel creation, and large woody debris addition. Road and bridge crossings were considered as a restoration strategy but were not included in specific project areas. Rather, these projects were identified across the mainstem of Bear and Cottage Lake creeks based on locations where road/bridge crossings intersected the mainstem channel and were subsequently included as a separate point data set.

Within the project areas delineated from *Section 2.1*, determination of specific restoration strategies was based on the relative proximity/adjacency of a project area to floodplain features, wetlands, and landscape modifications. Additionally, land-use and ownership was considered when determining potential restoration strategies within a project area. The selection and rationale of relevant restoration strategies are detailed in Table 2.

Table 2. Determination of Restoration Strategies for Project Areas.

Restoration Strategy	Determination of Inclusion in a Restoration Project	Data Source	Important Limitations/ Caveats
Tributary Confluence Restoration	<i>Proximity/adjacency to tributary confluences:</i> areas around tributary confluences help to support tributary restoration and connection.	King County Streams and Rivers (King County GIS library)	Some tributaries may not be included in the streams and river inventory.
Wetland Connection	<i>Proximity/adjacency to wetlands:</i> areas around wetlands will help support wetland connection, creation, and restoration.	Bear Creek combined wetlands (from 2017 <i>Assessment of Bear Creek Watershed Wetlands</i>)	Limitation of wetland inventory discussed in <i>Assessment of Bear Creek Watershed Wetlands</i> .
Floodplain Connection	<i>Available floodplain extents:</i> areas where the floodplain is less constricted and has a greater extent will provide more area for floodplain connection.	King County 100 Year Floodplains, LIDAR, orthophotography, Bear Creek combined wetlands	Corrections to the 100 year floodplain were made to account for infrastructures, landscape features, and floodplain features.
Off-channel & Side-Channel Creation	<i>Proximity/adjacency to available floodplain extents:</i> floodplain areas may have topographic and geomorphologic characteristics that support channel migration which help to create and connect off-channel and side-channel features.	King County 100 Year Floodplains, LIDAR, orthophotography, Bear Creek combined wetlands	Corrections to the 100 year floodplain were made to account for infrastructures, landscape features, and floodplain features.
Large Woody Debris Addition	<i>Proximity/adjacency to available floodplain extent as well as areas in public ownership and/or areas with minimal infrastructure:</i> areas in public ownership or with minimal infrastructure may be best suited for large wood placement to ensure minimal risk of wood/river movement to infrastructures and public safety.	King County Public Lands Areas, King County 100 Year Floodplains, LIDAR, orthophotography, Bear Creek combined wetlands	Corrections to the 100 year floodplain were made to account for infrastructures, landscape features, and floodplain features.

Within the Bear Creek study area, one or more of the restoration strategies in Table 2 was included in an instream habitat project. Instream habitat projects were determined throughout the mainstem of Bear and Cottage Lake Creeks with a total of 65 instream restoration projects identified for the Bear Creek Study area. A few restoration projects included only one strategy; however, the majority of restoration projects included several strategies. An abbreviated list of projects and specific restoration strategies is included in Table 3 and the comprehensive list is included in Tables 7 – 13.

Table 3. Select Instream Habitat Restoration Projects in the Bear Creek Study Area.

Project	Sub-Basin	Location	Restoration Strategies
LB3	Lower Bear Creek	Downstream of NE 95 th St.	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB4	Lower Bear Creek	Between NE 95 th Street and NE Novelty Hill Rd.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB5	Lower Bear Creek	Upstream of NE Novelty Hill Rd.	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C7	Cottage Lake Creek	Upstream of NE 136 th St.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
C9	Cottage Lake Creek	Adjacent to 194 th Ave NE	Floodplain Connection, Off-channel & Side-Channel Creation, LWD
C20	Cottage Lake Creek	Upstream of NE 165 th St.	Tributary Confluence Restoration, Wetland Connection, LWD Addition
UB4	Upper Bear Creek	Upstream of NE 127 th St.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD
UB11	Upper Bear Creek	Upstream of NE 141 st St.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD
UB17	Upper Bear Creek	Upstream of NE 155 th St.	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation

The cost of restoration projects in similarly sized creeks average about \$3,000,000 per river mile. Restoration projects identified for the mainstem Bear and Cottage Lake creeks range in estimated construction costs from \$90,000 to \$2,100,000 (see *Section 3.4* for specific project costs). These approximated construction costs do not include any related acquisition costs, so a separate approach was used to estimate acquisition costs. The acquisition costs for a given project were estimated based on the average cost-per-acre for private parcels within a project area. The cost was based on the acquisition of only the fraction of the parcels within the proposed project areas and does not include acquisition of outside areas or built improvements. Acquisition costs for projects estimated for the mainstem Bear and Cottage Lake creeks range from \$10,000 to \$1,000,000 (see *Section 3.4* for specific project costs).

3.0 INSTREAM PROJECT PRIORITIZATION

In order to determine the prioritization of individual instream restoration projects, each project was scored and ranked. The process of scoring and ranking instream habitat projects is outlined in the following discussion. A schematic of instream habitat scoring and prioritization is included in Figure 1 and relevant data sets are discussed in *Section 3.4*. Instream habitat projects within the Bear Creek study area were prioritized based on two main scoring criteria including a **restoration value score** as well as an **opportunity/feasibility score**.

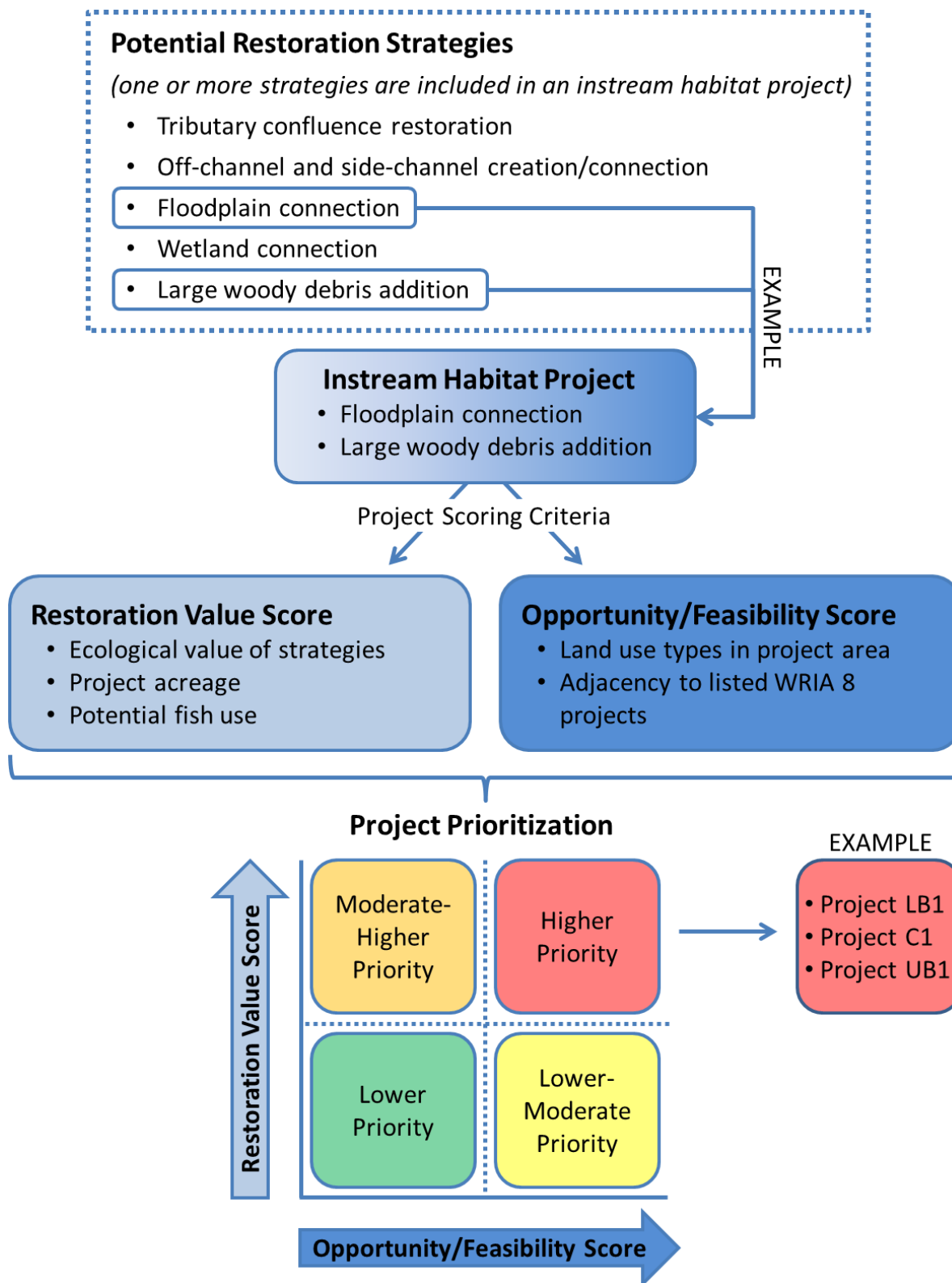


Figure 1. Schematic of instream habitat project scoring and prioritization for the mainstem of Bear and Cottage Lake creeks (detailed in Sections 3.1 – 3.4).

3.1 Restoration Value Score

The **restoration value score** for each instream project was based on three elements including: 1) the ecological value of individual restoration strategies included in the project area, 2) the acreage of a given project area, and 3) the potential likelihood of fish use within a given reach.

$$\text{Restoration Value Score} = \text{Ecological Value Score} * \text{Project Area} * \text{Potential Fish Use}$$

The ecological value of restoration strategies within a project area was based on the influence of a given strategy on habitat quality/quantity, variety, and connectivity. The scoring of individual restoration strategies is outline in Table 4. Scores for individual restoration strategies which were included within each project area were added up and resulted in a combined **ecological value score**. The scoring system was aimed at giving project areas more ecological value if several restoration strategies could be included in the project area (e.g., a project area with all five restoration strategies would have a combined score of 100 while a project area that only one restoration strategy would have a score of 15, 20, or 25).

Table 4. Ecological Value Scores for Restoration Strategies in the Bear Creek Watershed.

Restoration Strategy	Ecological Value Score	Rationale
Off-channel & Side-Channel Creation	25	Off-channel and side-channel areas have the potential to provide year-around habitats for juvenile salmon. The availability and importance of these habitats for juvenile salmon rearing and foraging in Bear and Cottage Lake creeks has been noted by King County (2017a).
Tributary Confluence Restoration	20	Tributaries have the potential to provide year-around habitats for juvenile salmon and the importance of tributary confluences for rearing and refuge has been well documented.
Wetland Connection	20	Wetlands have the potential to provide year-around habitats with connectivity related to season, channel features, and floodplain connectivity. Wetlands are important for juvenile salmon rearing and flood refuge as well as helping to support riverine and floodplain processes.
Large Woody Debris Addition	20	Large woody debris is needed throughout the Bear Creek watershed and influences riverine and floodplain processes. Placement of large wood may be limited due to infrastructures and public safety so opportunistic areas of potential placement are a high priority.
Floodplain Connection	15	Floodplain habitat availability is seasonal and may not be available year-around. Areas of available and connected floodplain habitats can provide juvenile salmon with flow refuge and rearing during winter and spring.

Once an ecological value score was determined for a project area, the ecological value score was then multiplied by an area score for that project. **Project area scores** were determined by binning all of the potential restoration projects areas into three area classes: smaller, medium, or larger. Binning and scoring was based on separating the range of project acreages delineated from *Section 2.1* into thirds with the lowest third designated as smaller projects (score = 1), the middle third designated as medium projects (score = 2), and the top third designated as larger projects (score = 3). The scoring of project areas was based on the potential benefits of a given project acres to salmon habitats (i.e., larger project areas have greater benefits).

The product of the ecological value score and project area score was then multiplied by a potential fish use score. **Potential fish use** of a project was evaluated and scored based on the relative location of projects throughout the mainstem of Bear and Cottage Lake creeks. Projects in Lower Break Creek (downstream extent of the Bear Creek study area upstream to the confluence with Cottage Lake Creek) were given the highest potential fish use score (value = 3) since the vast majority of adult and juvenile salmon moving throughout the Bear Creek system will travel through habitats in Lower Bear Creek. Additionally, since Lower Bear Creek has the greatest amount of instream habitat degradation, the likelihood of restored habitats being utilized by juvenile salmonids may be high in Lower Bear Creek. Upper Bear Creek (confluence with Cottage Lake Creek to upstream extent of salmon use) and Cottage Lake Creek (confluence with Bear Creek to upstream extent of salmon use) are both utilized by adult and juvenile salmon; however, spawning densities of Chinook salmon are generally greater in Cottage Lake Creek. Subsequently, projects in Cottage Lake Creek were given a potential fish use score of 2 and projects in Upper Bear Creek were given a potential fish use score of 1.

Road and bridge crossings were not included in this project scoring system due to the difficulty in deterring potential project area extents as well as limited information on crossing conditions and the related degree of fish passage impairment. Rather than individually scoring and prioritizing road and bridge crossing projects, all projects of this type were highlighted as important and prioritized similarly across the watershed. These projects are important due to the impacts of road and bridge crossing on floodplain constriction, channel connectivity, and riverine-floodplain processes. The prioritization of road and bridge crossings improvements would be a beneficial programmatic strategy moving forward and could be based on the degree of fish passage impairment, location within the watershed, age of facility, and species presence.

3.2 Project Opportunity/Feasibility Score

In addition to a restoration value score, instream projects across the Bear Creek study area were also given an **opportunity/feasibility score**. The opportunity and feasibility of instream projects was determined based on two elements including: 1) the land-uses within a given project area and 2) the adjacency of instream projects to salmon habitat project locations listed in the Water Resource Inventory Area 8 (WRIA 8) Chinook Salmon

Conservation Plan (WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017).

Opportunity/Feasibility Score = Land-Use/Designation Score + Adjacent WRIA 8 Project Locations

The **land-use/designation** element of the opportunity/feasibility scores was calculated based on the percentage of a project area that was in land-use types and designations which may be conducive to restoration strategies (discussed below). Land-use types and designations were grouped into 4 broader bins including public ownership, easements and Public Benefit Rating System (PBRs), farm and agriculture, and non-farm/agriculture private ownership. Land-use types/designations that tend to be more opportunistic for restoration strategies include public ownership, easements and Public Benefit Rating System, as well as farm and agriculture. While areas in non-farm/agriculture private ownership can be opportunistic or feasible to habitat restoration, we were not able to accurately evaluate the degree to which these areas may or may not be supportive of restoration strategies.

Areas in public ownership are considered to be the most opportunistic/feasible for restoration since these lands generally have fewer infrastructures, are highlighted as a priority from public outreach, and have Bear Creek project partner jurisdiction. Parcels with easements or conservation current-use taxation status (e.g., Public Benefit Rating System program) are considered to be the next most opportunistic/feasible land-use for restoration strategies. In the Bear Creek study areas, these parcels tend to still be in private ownership; however, their conservation status for habitat preservation makes these areas ideal locations for potential restoration or for further improvement to riverine conditions. Since infrastructures may still be present in these areas and ownership may not support certain instream restoration strategies, a correction factor was applied to the percentage of project areas in this land-use type/designation (dividing the acreage percentage by 2). Farm and agriculture was considered as the next most opportunistic land-use/designation type for restoration strategies. While areas in this designation are likely in current use for farm/agricultural purposes, these areas may provide restoration opportunities since parcels tend to be larger in area than private non-farm/agricultural parcels and generally have fewer infrastructures near water bodies. However, since these parcels are still in private ownership and may have conflicting land-use priorities (e.g., farmland preservation vs. habitat restoration) a correction factor was applied to the percentage of project areas that were in this land-use type/designation (dividing the acreage percentage by 3). Areas in solely non-farm/agriculture private ownership were considered to be the least opportunistic and feasible for restoration due to smaller parcel sizes, various private land owners, and higher occurrences of infrastructures. As previously mentioned, while these areas have the potential to be opportunistic or feasible for habitat restoration, the degree to which these areas may be supportive of restoration strategies is not easily determined. Across the land-use/designation bins, the opportunity/feasibility scores varied from 0 (project areas being in all non-farm/agriculture private ownership) to 1 (project areas being in all public ownership).

The adjacency of instream habitat project areas to **WRIA 8 project locations** was also included in the opportunity/feasibility score. The WRIA 8 salmon habitat project lists for Bear and Cottage Lake creeks include various projects aimed at addressing the conservation needs outlined in the WRIA 8 Chinook Salmon Conservation Plan (WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017). These projects include various strategies focused on removing pressures which degrade habitats, improving habitat and water quality conditions, protecting aquatic resource, and addressing land-use impacts and management strategies. This information provides a useful reference to various projects which have either been completed or proposed in the Bear Creek watershed. Projects on the WRIA 8 Salmon Conservation list have had some degree of vetting, either through salmon recovery forums, through previous planning efforts, or through communication with local jurisdiction, habitat enhancement groups, or private property owners. Subsequently, adjacency of Bear Creek instream projects to these listed WRIA 8 project locations was considered to increase the opportunity or feasibility of a given instream habitat project. Each WRIA 8 project that fell within or was adjacent to a Bear Creek instream habitat project area increased the opportunity/feasibility score of that given project area by 1 (+1 per project).

3.3 Prioritization Categories for Restoration Projects

Once instream habitat projects were given a restoration value score and an opportunity/feasibility score, the projects were then prioritized by graphically evaluating the relative scores. The ranges of the restoration value scores and opportunity/feasibility scores were divided into 4 quadrant categories, with each quadrant-category indicating the relative project prioritization (Figure 2). Separation of quadrant categories was based on the 50th percentiles of the restoration value scores and the opportunity/feasibility scores for all habitat projects. Quadrant category designations include higher priority, moderate - higher priority, lower - moderate priority, and lower priority.

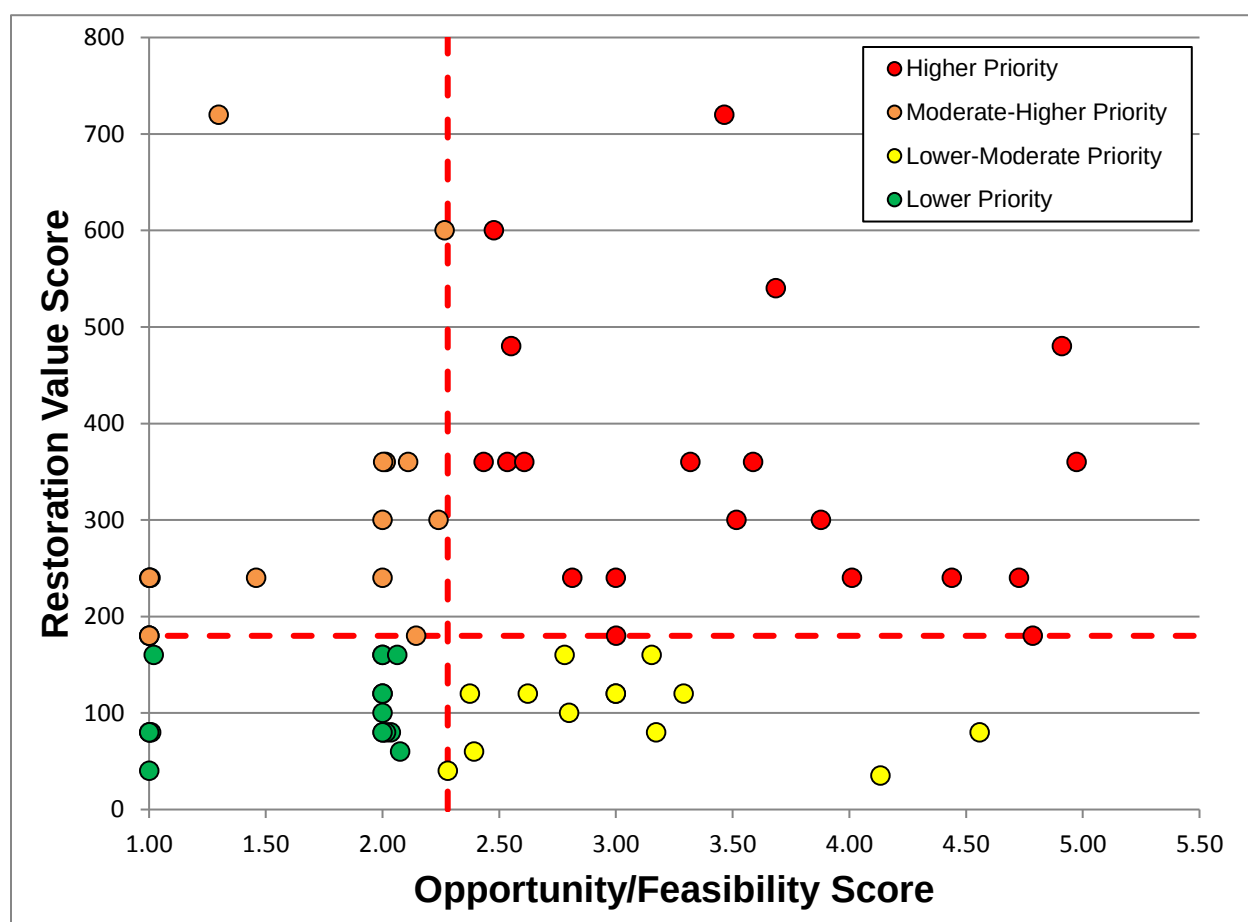


Figure 2. Plot of Restoration Value Scores and Opportunity/Feasibility Scores for Instream Habitat Projects identified in the mainstem of Bear and Cottage Lake creeks.

All of the 65 instream habitat projects identified for the mainstem of Bear and Cottage Lake creeks were prioritized. Twenty one restoration projects were categorized as higher priority with 10 projects being in Lower Bear Creek, 3 in Cottage Lake Creek and 7 in Upper Bear Creek (Figure 3-6). Projects that ranked as higher priority have the highest restoration value scores and the highest opportunity/feasibility scores. These projects should be the highest priority for restoration and protection in the Bear Creek watershed since they have the greatest value and opportunity. Higher priority projects would result in the restoration of ~5.8 river miles at an estimated construction and acquisition cost of ~\$17,370,000 and ~\$4,193,000, respectively.

Fifteen restoration projects were categorized as moderate - higher priority with 7 projects being in Lower Bear Creek, 4 in Cottage Lake Creek and 5 in Upper Bear Creek (Figure 3-6). Moderate - higher priority projects have relatively high restoration value scores but lower opportunity/feasibility scores. These projects may require further private/public outreach as well as conservation/protection strategies (e.g., easements, PBRS, acquisition, etc.) prior to restoration to help increase opportunities and feasibility. Moderate - higher priority

projects would result in the restoration of ~3.8 river miles at an estimated construction and acquisition cost of ~\$11,370,000 and ~\$6,673,000, respectively.

Twelve restoration projects were categorized as lower - moderate priority with 2 being in Cottage Lake Creek and 11 in Upper Bear Creek (Figure 3-6). Projects that ranked as lower - moderate priority have low restoration value scores but relatively higher opportunity/feasibility scores. Since these projects may be opportunistic/feasible but have less value, it may make sense to implement these project in concert with highest priority projects (when funding is available) to increase project connectivity and to increase the relative size of higher priority project areas. Lower - moderate priority projects would result in the restoration of ~2.0 river miles at an estimated construction and acquisition cost of ~\$5,970,000 and ~\$1,784,000, respectively.

Seventeen restoration projects were categorized as lower priority with 1 projects being in Lower Bear Creek, 13 in Cottage Lake Creek and 2 in Upper Bear Creek (Figure 3-6). Lower priority projects have relatively lower restoration value scores and opportunity/feasibility scores. Since these project rank lower, they are a relatively low priority among all projects but may help supplement habitat needs when other prioritized projects have been addressed. Additionally, similar to moderate – higher priority projects, these lower priority projects may require further private/public outreach prior to implementation. Lower priority projects would result in the restoration of ~2.3 river miles at an estimated construction and acquisition cost of ~\$7,020,000 and ~\$4,173,000, respectively.

Across the mainstem of the Bear Creek study area, there were 31 identified road and/or bridge crossings (Figure 3-6). As discussed in *Section 2.3*, road and bridge crossings were not included in the project scoring system, but rather highlighted as important and prioritized similarly across the watershed.

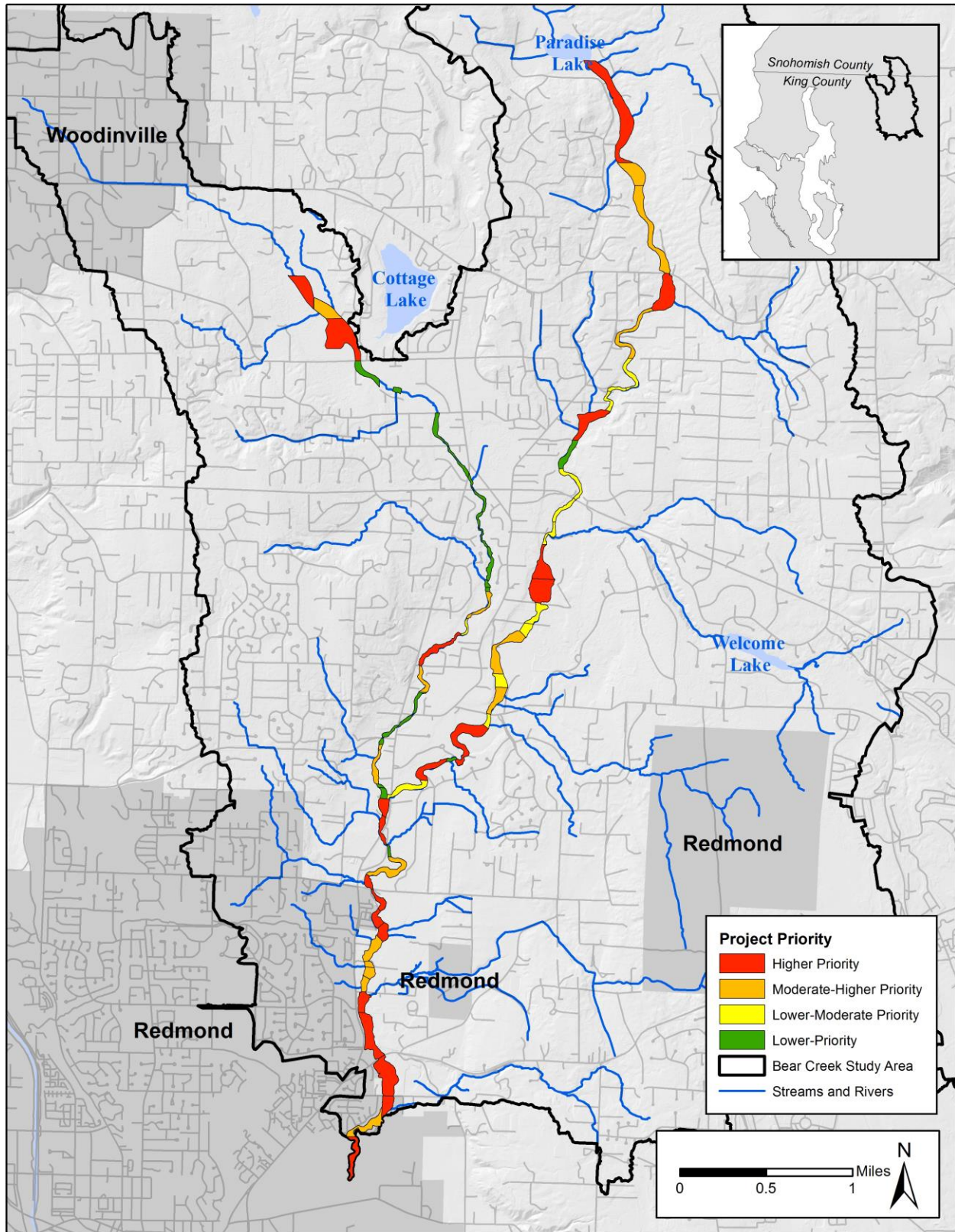


Figure 3. Bear Creek Study Area Restoration Project Prioritization (specific project numbers as well as road/bridge crossing projects are included in Figure 4-6).

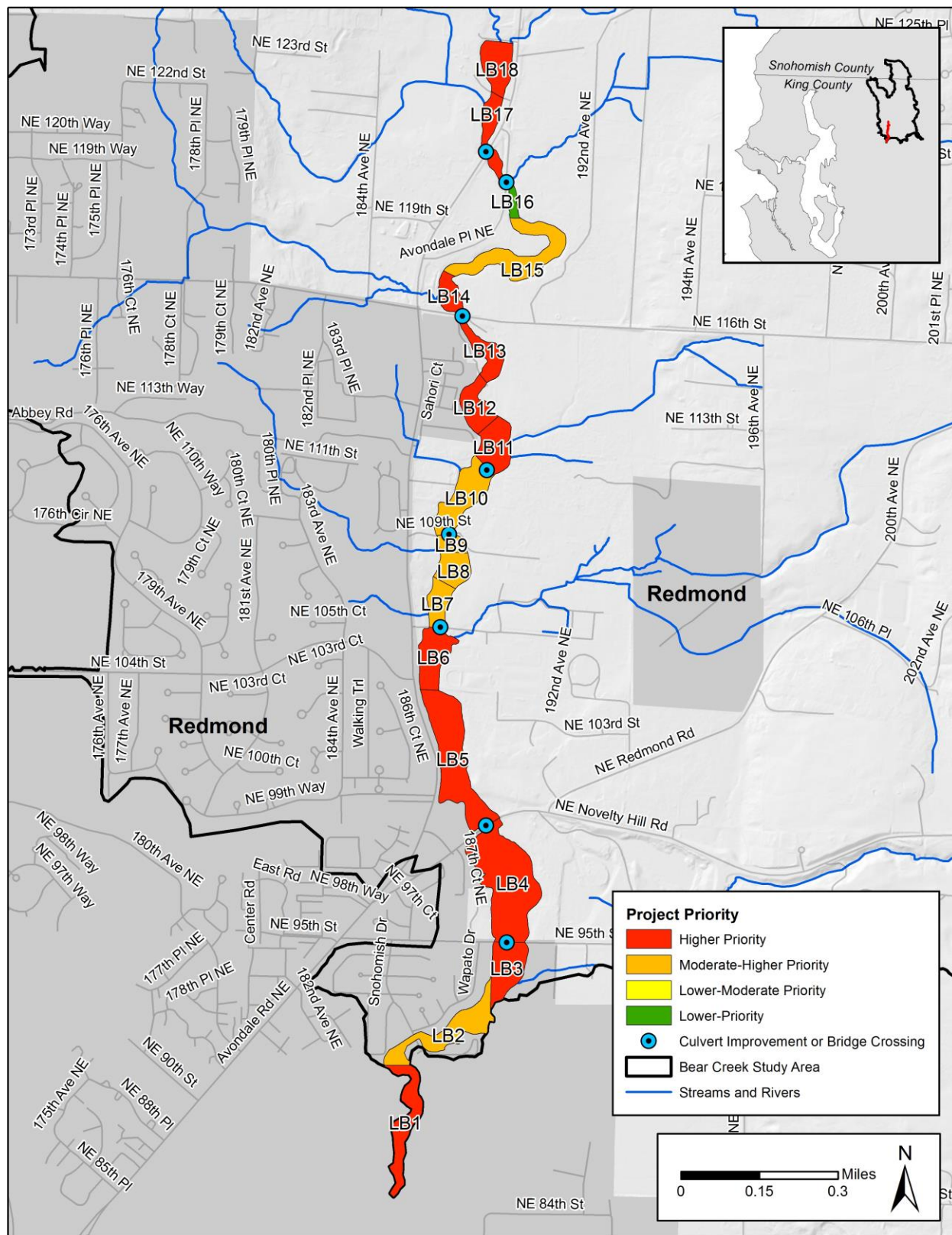


Figure 4. Lower Bear Creek Restoration Project Prioritization (road/bridge crossing projects were not included in the prioritization scoring).

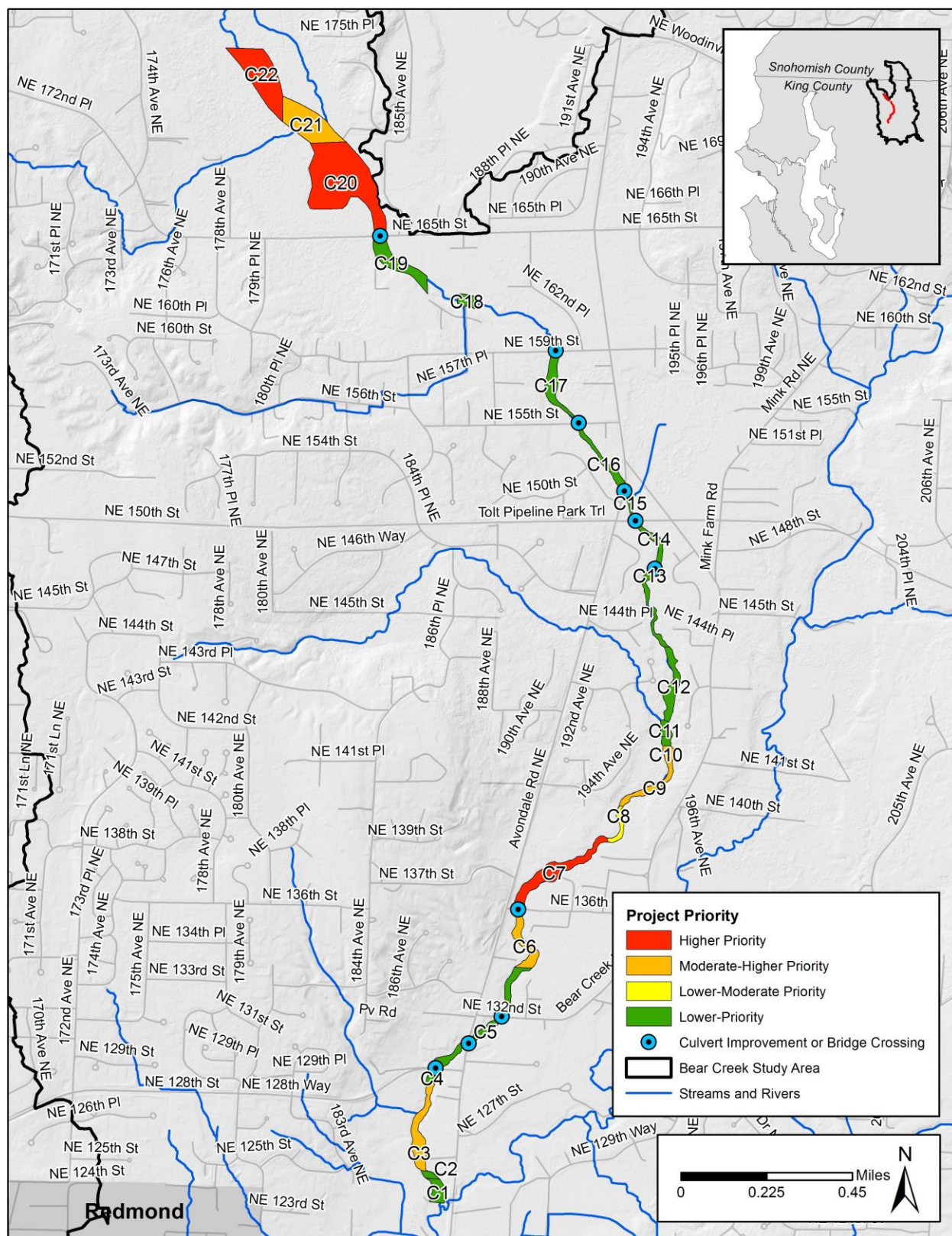


Figure 5. Cottage Lake Creek Restoration Project Prioritization (road/bridge crossing projects were not included in the prioritization scoring).

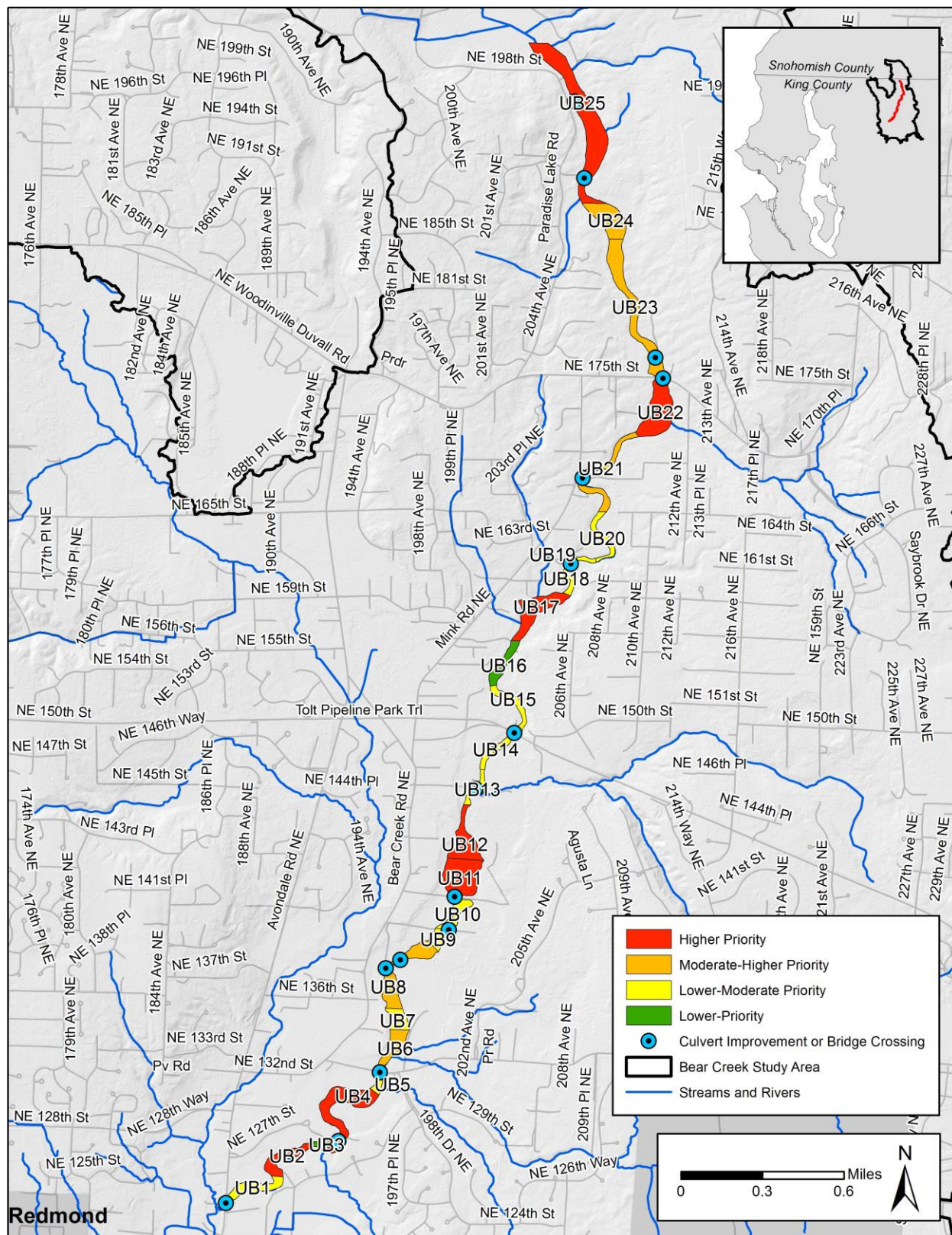


Figure 6. Upper Bear Creek Restoration Project Prioritization (road/bridge crossing projects were not included in the prioritization scoring).

3.4 Restoration Project Ranking within Prioritization Categories and across Sub-Basin Areas

Within prioritization categories, we suggest that individual restoration projects should be ranked using an overall restoration value and opportunity/feasibility score (hereafter referred to as the **ranking score**). This ranking score is the product of the restoration value score and the opportunity/feasibility score (opportunity and feasibility scores were corrected [+1] to adjust for zero values). The ranking scores represent the relative priority of all restoration projects and projects with the highest ranking score should have the highest priority. In addition to this ranking, several supplemental scoring systems and data sets can be used to further inform prioritization and project designs. These additional scoring systems and data sets include Ecosystem Diagnosis Treatment rank, water quality and habitat problems score, and approximate project cost. Each additional information resource is discussed below.

The Ecosystem Diagnosis Treatment (EDT) ranks designate the relative potential of a reach to improve salmon performance (i.e., productivity, abundance, and life history diversity) based on habitat conditions in the reach and the exposure of Chinook life stages to those habitat conditions (WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017). Projects that fall within a designated reach receive that representative EDT rank score. The EDT ranks range from 1 to 14 with highest priority reaches ranking as 1. Since the EDT ranks correspond to reaches generally greater in length than instream habitat project areas, there are several reaches where multiple restoration projects fall within a single prioritization rank (e.g., all Lower Bear Creek projects group within the same EDT prioritization rank). Subsequently, we suggest only using the EDT ranks to further inform the relative prioritizations of Bear Creek ranking scores.

The water quality and habitat problems score shows the frequency of water quality and habitat problems that occur within a project area. Specific water quality and habitat problems are detailed in the supporting technical reports for the Bear Creek Watershed Management Study (King County 2017a, King County 2017b, King County 2017c, King County 2017d, King County 2017e). Project areas with higher values indicate a greater number of water quality and habitat problems. Since the frequency of water quality and habitat problems is highly dependent on the relative availability and extents of various data sets, we suggest only using this information to further inform the relative prioritizations of Bear Creek ranking scores. Understanding the specific water quality and habitat problems within a given project area will help to inform project design aimed at addressing specific issues.

As discussed in *Section 2.2*, the approximated cost of Bear Creek instream habitat projects was estimated based the cost of restoration projects in similarly sized creeks (~\$3,000,000 per river mile). Estimated restoration costs were based on the length of creek that ran through each instream habitat project area. Since these approximated restoration costs do

not include potential acquisition costs, a separate acquisition costs was also estimated for a given instream project area. The acquisition costs were based on the area-normalized assessed land value for private parcels within a project area. The estimated acquisition cost was based on the acquisition of only the fraction of the parcels within the proposed project areas and does not include acquisition of outside areas or built improvements.

Summary tables of estimated costs for instream habitat project are included in Table 5 and Table 6 (habitat projects are organized by prioritization category and sub-basin area). Instream habitat project rankings among prioritization categories and across sub-basins in the Bear Creek study area are included in Table 7 – Table 13. Tables 7 - 10 are organized by prioritization categories and Tables 11 - 13 are organized by sub-basin area. Within each respective Table, restoration projects are organized by the relative ranking score (highest scores listed first). All of the aforementioned supplemental scoring systems and information data sets are also included to further support project ranking/prioritization.

Table 5. Summary of instream habitat projects by priority category.

Prioritization Category	Sub-basin Area	Number of Projects	Estimated Restoration Cost	Estimated Acquisition Cost
Higher	Lower Bear Creek	11	\$7,260,000	\$1,971,000
	Upper Bear Creek	7	\$7,740,000	\$1,981,000
	Cottage Lake Creek	3	\$2,370,000	\$241,000
	Sub Total	21	\$17,370,000	\$4,193,000
Moderate-Higher	Lower Bear Creek	6	\$3,300,000	\$2,354,000
	Upper Bear Creek	5	\$5,610,000	\$2,359,000
	Cottage Lake Creek	4	\$2,460,000	\$1,960,000
	Sub Total	15	\$11,370,000	\$6,673,000
Lower-Moderate	Lower Bear Creek	0	\$0	\$0
	Upper Bear Creek	11	\$5,610,000	\$1,702,000
	Cottage Lake Creek	1	\$360,000	\$82,000
	Sub Total	12	\$5,970,000	\$1,784,000
Lower	Lower Bear Creek	1	\$240,000	\$64,000
	Upper Bear Creek	2	\$750,000	\$372,000
	Cottage Lake Creek	14	\$6,030,000	\$3,737,000
	Sub Total	17	\$7,020,000	\$4,173,000
Grand Total			\$41,730,000	\$16,823,000

Table 6. Summary of instream habitat projects by sub-basin area.

Sub-basin Area	Priority Category	Number of Projects	Estimated Restoration Cost	Estimated Acquisition Cost
Lower Bear Creek	Higher	11	\$7,260,000	\$1,970,000
	Moderate-Higher	6	\$3,300,000	\$2,354,000
	Lower-Moderate	0	\$0	\$0
	Lower	1	\$240,000	\$64,000
	Sub Total	18	\$10,800,000	\$4,388,000
Upper Bear Creek	Higher	7	\$7,740,000	\$1,981,000
	Moderate-Higher	5	\$5,610,000	\$2,359,000
	Lower-Moderate	11	\$5,610,000	\$1,702,000
	Lower	2	\$750,000	\$372,000
	Sub Total	25	\$19,710,000	\$6,414,000
Cottage Lake Creek	Higher	3	\$2,370,000	\$241,000
	Moderate-Higher	4	\$2,460,000	\$1,960,000
	Lower-Moderate	1	\$360,000	\$82,000
	Lower	14	\$6,030,000	\$3,737,000
	Sub Total	22	\$11,220,000	\$6,020,000
Grand Total			\$41,730,000	\$16,820,000

Table 7. Higher Priority Restoration Projects. Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).

Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
LB4	720	3.46	2494.25	BCLC-R6-3-BB, BCLC-R6-7-BB	4	22.5	\$1,320,000	\$515,388	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB5	540	3.68	1989.83	BCLC-R6-4-BB, BCLC-R6-9-BB	4	21.8	\$1,200,000	\$966,719	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB3	480	3.91	1876.81	BCLC-R6-1-BB, BCLC-R6-2-BB, BCLC-R6-7-BB	4	19.0	\$390,000	\$9,912	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C20	360	4.97	1790.41	BCLC-7-BB, BCLC-9-RB, BCLC-10-BB	8	18.4	\$720,000	\$28,723	Tributary Confluence Restoration, Wetland Connection, LWD Addition
LB11	600	2.48	1485.95	BCLC-R6-10-BB	4	10.4	\$360,000	\$0	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB6	600	2.27	1359.71	BCLC-R6-5-LB	4	19.0	\$480,000	\$89,146	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB13	360	3.59	1291.51	BCLC-R6-6-BB, BCLC-R6-10-BB	4	18.2	\$570,000	\$143,921	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB17	480	2.55	1224.63	BCLC-R6-11-BB	4	13.2	\$600,000	\$80,669	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
C7	360	3.32	1194.74	BCLC-3-BB, BCLC-4-BB	12	23.4	\$960,000	\$212,365	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation

*APPENDIX B: Instream Habitat Project Identification and Prioritization
Bear Creek Watershed Management Study*

Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
UB25	300	3.88	1163.52	BCLC-R15-1-BB, BCLC-R15-2-BB		7.1	\$2,130,000	\$104,857	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB12	240	4.73	1134.29	BCLC-R9-1-BB, BCLC-R9-2-INS, BCLC-R10-1-BB	2	20.9	\$660,000	\$126,246	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB11	240	4.44	1065.20	BCLC-R8-2-BB, BCLC-R9-1-BB, BCLC-R9-2-INS	2	18.9	\$780,000	\$301,712	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB22	300	3.52	1054.65	BCLC-R13-1-BB, BCLC-R14-1-LB	9	18.2	\$780,000	\$351,875	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB18	360	2.61	938.79	BCLC-R6-11-BB	4	18.6	\$540,000	\$46,448	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
LB1	360	2.53	912.56	BCLC-R4-1-BB	2	22.6	\$1,080,000	\$0	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB12	360	2.43	875.86	BCLC-R6-10-BB	4	11.8	\$420,000	\$79,431	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
C22	240	3.00	720.00	BCLC-10-BB		11.8	\$690,000	\$0	Wetland Connection, LWD Addition
LB14	180	3.79	681.47	BCLC-R6-8-INS, BCLC-R6-6-BB, BCLC-R6-11-BB	4	18.7	\$300,000	\$39,512	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
UB4	240	2.81	675.19	BCLC-R7-3-BB	7	18.4	\$1,650,000	\$206,329	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB17	300	2.24	672.09	BCLC-R13-1-BB	14	9.2	\$930,000	\$466,681	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
UB2	180	3.00	540.16	BCLC-R7-1-BB, BCLC-R7-2-BB	7	12.7	\$810,000	\$423,302	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition

Table 8. Moderate - Higher Priority Restoration Projects. Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).

Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
LB10	720	1.30	934.77		4	17.1	\$540,000	\$372,760	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB15	360	2.11	759.40	BCLC-R6-11-BB	4	18.8	\$1,230,000	\$538,092	Floodplain Connection, Off-channel & Side-Channel Creation
LB2	360	2.01	724.97	BCLC-R6-1-BB	4	22.5	\$900,000	\$889,138	Floodplain Connection, Off-channel & Side-Channel Creation
C21	360	2.00	720.99	BCLC-10-BB		11.9	\$390,000	\$988,202	Tributary Confluence Restoration, Wetland Connection, LWD Addition
UB6	300	2.00	600.00	BCLC-R8-4-BB	5	13.2	\$570,000	\$270,341	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB8	240	2.01	482.63	BCLC-R8-1-LB, BCLC-R8-3-LB, BCLC-R8-4-BB	5	19.4	\$1,200,000	\$742,063	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C3	240	2.00	480.07	BCLC-2-BB	10	17.5	\$750,000	\$357,686	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
UB21	180	2.14	385.85	BCLC-R13-1-BB	13	18.4	\$1,410,000	\$582,346	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
UB23	240	1.46	349.98		9	18.3	\$1,860,000	\$578,142	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C6	240	1.01	241.40		12	22.5	\$600,000	\$238,167	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation

*APPENDIX B: Instream Habitat Project Identification and Prioritization
Bear Creek Watershed Management Study*

Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
UB24	240	1.00	240.53			11.4	\$570,000	\$186,270	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C9	240	1.00	240.00		11	21.3	\$720,000	\$376,305	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB7	180	1.00	180.00		4	16.0	\$300,000	\$238,683	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
LB8	180	1.00	180.00		4	18.4	\$210,000	\$234,318	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB9	180	1.00	180.00		4	17.8	\$120,000	\$80,791	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition

Table 9. Lower – Moderate Priority Restoration Projects. Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).

Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
C8	160	3.15	504.48	BCLC-3-BB, BCLC-4-BB	11	22.8	\$360,000	\$81,588	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB7	160	2.78	444.71	BCLC-R8-4-BB	5	17.9	\$270,000	\$109,028	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB14	120	3.29	394.82	BCLC-R10-1-BB, BCLC-R11-1-BB	1	19.3	\$570,000	\$274,551	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB10	120	3.00	360.00	BCLC-R8-2-BB, BCLC-R8-4-BB	5	19.5	\$450,000	\$191,100	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
UB20	120	2.62	314.67	BCLC-R13-1-BB	13	19.1	\$870,000	\$139,392	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB1	120	2.37	284.87	BCLC-R7-2-BB	7	17.9	\$900,000	\$283,345	Floodplain Connection, Off-channel & Side-Channel Creation
UB5	100	2.80	279.90	BCLC-R7-3-BB	7	18.2	\$240,000	\$39,796	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB15	80	3.17	253.76	BCLC-R11-1-BB, BCLC-R13-1-BB	14	19.9	\$780,000	\$233,940	Floodplain Connection, Off-channel & Side-Channel Creation
UB9	80	2.56	204.63	BCLC-R8-1-LB, BCLC-R8-3-LB, BCLC-R8-4-BB	5	18.5	\$270,000	\$29,310	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition

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Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
UB13	35	4.13	144.64	BCLC-R9-1-BB, BCLC-R9-2-INS, BCLC-R10-1-BB	1	22.1	\$480,000	\$149,909	Culvert Improvement or Bridge Crossing, Floodplain Connection, Tributary Confluence Restoration
UB18	60	2.39	143.55	BCLC-R13-1-BB	13	18.5	\$450,000	\$119,232	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
UB19	40	2.28	91.17	BCLC-R13-1-BB	13	19.4	\$330,000	\$132,388	Floodplain Connection, Off-channel & Side-Channel Creation

Table 10. Lower Priority Restoration Projects. Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).

Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
C15	160	2.06	329.99	BCLC-6-INS	11	22.7	\$240,000	\$33,105	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
C10	160	2.00	320.00	BCLC-5-INS	11	18.9	\$90,000	\$88,064	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C12	160	2.00	320.00	BCLC-5-INS	11	16.2	\$630,000	\$576,235	Floodplain Connection, Off-channel & Side-Channel Creation
C11	120	2.00	240.00	BCLC-5-INS	11	14.5	\$150,000	\$138,475	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
C2	120	2.00	239.98	BCLC-2-BB	10	18.9	\$90,000	\$0	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
UB3	100	2.00	200.00	BCLC-R7-2-BB	7	8.9	\$180,000	\$51,540	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C5	160	1.02	163.10		12	24.2	\$1,110,000	\$336,529	Floodplain Connection, Off-channel & Side-Channel Creation
C14	80	2.04	162.88	BCLC-6-INS	11	23.8	\$480,000	\$556,436	Floodplain Connection, Off-channel & Side-Channel Creation
C19	80	2.02	161.24	BCLC-7-BB	8	26.2	\$570,000	\$292,844	Wetland Connection

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Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
UB16	80	2.00	160.00	BCLC-R13-1-BB	14	17.3	\$570,000	\$320,793	Floodplain Connection, Off-channel & Side-Channel Creation
LB16	60	2.07	124.50	BCLC-R6-11-BB	4	13.1	\$240,000	\$63,570	Tributary Confluence Restoration
C4	120	1.00	120.00	BCLC-2-BB	10	23.2	\$150,000	\$52,738	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
C13	80	1.01	80.67		11	19.2	\$750,000	\$467,640	Floodplain Connection, Off-channel & Side-Channel Creation
C1	80	1.00	80.07	BCLC-2-BB	10	20.3	\$270,000	\$53,213	Floodplain Connection, Off-channel & Side-Channel Creation
C16	80	1.00	80.00		6	27.5	\$630,000	\$629,522	Floodplain Connection, Off-channel & Side-Channel Creation
C17	80	1.00	80.00		6	28.2	\$720,000	\$354,601	Wetland Connection
C18	40	1.00	40.00		6	21.8	\$150,000	\$157,882	Tributary Confluence Restoration

Table 11. Lower Bear Creek Restoration Project Prioritization (projects displayed in Figure 3). Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).

Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Higher	LB4	720	3.46	2494.25	BCLC-R6-3-BB, BCLC-R6-7-BB	4	22.5	\$1,320,000	\$515,388	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB5	540	3.68	1989.83	BCLC-R6-4-BB, BCLC-R6-9-BB	4	21.8	\$1,200,000	\$966,719	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB3	480	3.91	1876.81	BCLC-R6-1-BB, BCLC-R6-2-BB, BCLC-R6-7-BB	4	19.0	\$390,000	\$9,912	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB11	600	2.48	1485.95	BCLC-R6-10-BB	4	10.4	\$360,000	\$0	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB6	600	2.27	1359.71	BCLC-R6-5-LB	4	19.0	\$480,000	\$89,146	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Higher	LB13	360	3.59	1291.51	BCLC-R6-6-BB, BCLC-R6-10-BB	4	18.2	\$570,000	\$143,921	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB17	480	2.55	1224.63	BCLC-R6-11-BB	4	13.2	\$600,000	\$80,669	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Higher	LB18	360	2.61	938.79	BCLC-R6-11-BB	4	18.6	\$540,000	\$46,448	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
Higher	LB1	360	2.53	912.56	BCLC-R4-1-BB	2	22.6	\$1,080,000	\$0	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB12	360	2.43	875.86	BCLC-R6-10-BB	4	11.8	\$420,000	\$79,431	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Higher	LB14	180	3.79	681.47	BCLC-R6-8-INS, BCLC-R6-6-BB, BCLC-R6-11-BB	4	18.7	\$300,000	\$39,512	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	LB10	720	1.30	934.77		4	17.1	\$540,000	\$372,760	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	LB15	360	2.11	759.40	BCLC-R6-11-BB	4	18.8	\$1,230,000	\$538,092	Floodplain Connection, Off-channel & Side-Channel Creation

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Moderate - Higher	LB2	360	2.01	724.97	BCLC-R6-1-BB	4	22.5	\$900,000	\$889,138	Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	LB7	180	1.00	180.00		4	16.0	\$300,000	\$238,683	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	LB8	180	1.00	180.00		4	18.4	\$210,000	\$234,318	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	LB9	180	1.00	180.00		4	17.8	\$120,000	\$80,791	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower	LB16	60	2.07	124.50	BCLC-R6-11-BB	4	13.1	\$240,000	\$63,570	Tributary Confluence Restoration

Table 12. Cottage Lake Creek Restoration Project Prioritization (projects displayed in Figure 4). Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).

Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Higher	C20	360	4.97	1790.41	BCLC-7-BB, BCLC-9-RB, BCLC-10-BB	8	18.4	\$720,000	\$28,723	Tributary Confluence Restoration, Wetland Connection, LWD Addition
Higher	C7	360	3.32	1194.74	BCLC-3-BB, BCLC-4-BB	12	23.4	\$960,000	\$212,365	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Higher	C22	240	3.00	720.00	BCLC-10-BB		11.8	\$690,000	\$0	Wetland Connection, LWD Addition
Moderate - Higher	C21	360	2.00	720.99	BCLC-10-BB		11.9	\$390,000	\$988,202	Tributary Confluence Restoration, Wetland Connection, LWD Addition
Moderate - Higher	C3	240	2.00	480.07	BCLC-2-BB	10	17.5	\$750,000	\$357,686	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	C6	240	1.01	241.40		12	22.5	\$600,000	\$238,167	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	C9	240	1.00	240.00		11	21.3	\$720,000	\$376,305	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	C8	160	3.15	504.48	BCLC-3-BB, BCLC-4-BB	11	22.8	\$360,000	\$81,588	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Lower	C15	160	2.06	329.99	BCLC-6-INS	11	22.7	\$240,000	\$33,105	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C10	160	2.00	320.00	BCLC-5-INS	11	18.9	\$90,000	\$88,064	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower	C12	160	2.00	320.00	BCLC-5-INS	11	16.2	\$630,000	\$576,235	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C11	120	2.00	240.00	BCLC-5-INS	11	14.5	\$150,000	\$138,475	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C2	120	2.00	239.98	BCLC-2-BB	10	18.9	\$90,000	\$0	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C5	160	1.02	163.10		12	24.2	\$1,110,000	\$336,529	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C14	80	2.04	162.88	BCLC-6-INS	11	23.8	\$480,000	\$556,436	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C19	80	2.02	161.24	BCLC-7-BB	8	26.2	\$570,000	\$292,844	Wetland Connection
Lower	C4	120	1.00	120.00	BCLC-2-BB	10	23.2	\$150,000	\$52,738	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Lower	C13	80	1.01	80.67		11	19.2	\$750,000	\$467,640	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C1	80	1.00	80.07	BCLC-2-BB	10	20.3	\$270,000	\$53,213	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C16	80	1.00	80.00		6	27.5	\$630,000	\$629,522	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C17	80	1.00	80.00		6	28.2	\$720,000	\$354,601	Wetland Connection
Lower	C18	40	1.00	40.00		6	21.8	\$150,000	\$157,882	Tributary Confluence Restoration

Table 13. Upper Bear Creek Restoration Project Prioritization (projects displayed in Figure 5). Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).

Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Higher	UB25	300	3.88	1163.52	BCLC-R15-1-BB, BCLC-R15-2-BB		7.1	\$2,130,000	\$104,857	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	UB12	240	4.73	1134.29	BCLC-R9-1-BB, BCLC-R9-2-INS, BCLC-R10-1-BB	2	20.9	\$660,000	\$126,246	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	UB11	240	4.44	1065.20	BCLC-R8-2-BB, BCLC-R9-1-BB, BCLC-R9-2-INS	2	18.9	\$780,000	\$301,712	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	UB22	300	3.52	1054.65	BCLC-R13-1-BB, BCLC-R14-1-LB	9	18.2	\$780,000	\$351,875	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	UB4	240	2.81	675.19	BCLC-R7-3-BB	7	18.4	\$1,650,000	\$206,329	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	UB17	300	2.24	672.09	BCLC-R13-1-BB	14	9.2	\$930,000	\$466,681	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Higher	UB2	180	3.00	540.16	BCLC-R7-1-BB, BCLC-R7-2-BB	7	12.7	\$810,000	\$423,302	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	UB6	300	2.00	600.00	BCLC-R8-4-BB	5	13.2	\$570,000	\$270,341	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	UB8	240	2.01	482.63	BCLC-R8-1-LB, BCLC-R8-3-LB, BCLC-R8-4-BB	5	19.4	\$1,200,000	\$742,063	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	UB21	180	2.14	385.85	BCLC-R13-1-BB	13	18.4	\$1,410,000	\$582,346	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	UB23	240	1.46	349.98		9	18.3	\$1,860,000	\$578,142	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	UB24	240	1.00	240.53			11.4	\$570,000	\$186,270	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB7	160	2.78	444.71	BCLC-R8-4-BB	5	17.9	\$270,000	\$109,028	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB14	120	3.29	394.82	BCLC-R10-1-BB, BCLC-R11-1-BB	1	19.3	\$570,000	\$274,551	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB10	120	3.00	360.00	BCLC-R8-2-BB, BCLC-R8-4-BB	5	19.5	\$450,000	\$191,100	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Lower - Moderate	UB20	120	2.62	314.67	BCLC-R13-1-BB	13	19.1	\$870,000	\$139,392	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB1	120	2.37	284.87	BCLC-R7-2-BB	7	17.9	\$900,000	\$283,345	Floodplain Connection, Off-channel & Side-Channel Creation
Lower - Moderate	UB5	100	2.80	279.90	BCLC-R7-3-BB	7	18.2	\$240,000	\$39,796	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB15	80	3.17	253.76	BCLC-R11-1-BB, BCLC-R13-1-BB	14	19.9	\$780,000	\$233,940	Floodplain Connection, Off-channel & Side-Channel Creation
Lower - Moderate	UB9	80	2.56	204.63	BCLC-R8-1-LB, BCLC-R8-3-LB, BCLC-R8-4-BB	5	18.5	\$270,000	\$29,310	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB13	35	4.13	144.64	BCLC-R9-1-BB, BCLC-R9-2-INS, BCLC-R10-1-BB	1	22.1	\$480,000	\$149,909	Culvert Improvement or Bridge Crossing, Floodplain Connection, Tributary Confluence Restoration
Lower - Moderate	UB18	60	2.39	143.55	BCLC-R13-1-BB	13	18.5	\$450,000	\$119,232	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Lower - Moderate	UB19	40	2.28	91.17	BCLC-R13-1-BB	13	19.4	\$330,000	\$132,388	Floodplain Connection, Off-channel & Side-Channel Creation

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Lower	UB3	100	2.00	200.00	BCLC-R7-2-BB	7	8.9	\$180,000	\$51,540	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower	UB16	80	2.00	160.00	BCLC-R13-1-BB	14	17.3	\$570,000	\$320,793	Floodplain Connection, Off-channel & Side-Channel Creation

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APPENDIX C:

Prioritization: Wetland Strategies

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1.0 INTRODUCTION

Wetlands provide a variety of ecological, water quality, and landscape services and functions. Washington Department of Ecology (Michaud 2001) elucidates why wetlands are important to the health of natural ecosystems, and these services and functions specifically include:

- protecting water quality by trapping sediments and retaining excess nutrients and other pollutants such as heavy metals.
- providing flood protection by holding the excess runoff after a storm, and then releasing it slowly, thereby maintaining streamflows.
- recharging groundwater systems/aquifers, which, in turn, provide water for drinking, irrigation, and maintenance of streamflow and lake and reservoir levels.
- providing habitat for species of birds, fish, mammals, reptiles, and amphibians that rely on wetlands for breeding, foraging, and cover.

All these functions contribute to the health of a watershed, and they are also all goals of this Bear Creek Watershed-scale Stormwater Management Plan (the Plan). In other words, many of the goals of the Plan, including improved water quality, improved flood protection, and better fish habitat, are also benefits that wetlands may provide. Therefore, protecting, enhancing, and in some cases creating wetlands are all potential best management practices (BMPs). A comprehensive local watershed management strategy includes wetland conservation and restoration because of the many watershed services wetlands provide (Wright et al. 2006).

Managing wetlands at the watershed scale can help minimize indirect impacts caused by urbanization. Impacts may include altered hydrology, increased pollutant loadings, and buffer encroachment. There are two general strategies available to improve, enhance, and conserve wetland conditions and functions in the Bear Creek watershed study area:

- Land conservation—protecting the wetlands and surrounding buffers by acquisition or easement.
- Wetland restoration—enhancing the function of existing or former wetlands by using different restoration techniques.

Each of these strategies is examined in detail in this report.

2.0 METHODS

The “*Assessment of Bear Creek Watershed Wetlands*” (King County 2017b) conducted for the Plan includes an inventory of wetlands currently mapped in the study area from multiple data sources. The combined, merged wetland dataset from seven available data sources shows 327 wetland polygons¹ in the study area totaling 1,793 acres. That wetland data was used to analyze and identify wetland protection via conservation and restoration.

2.1 Land Conservation Strategies to Protect Wetlands

Wetland buffers in the watershed are protected by critical areas regulations. Regulatory buffer sizes were established based on the best available science for the protection of various wetland functions. Buffers range from 25 to 300 ft in the study area depending on the wetland category (or rating), type, and intensity of planned activity adjacent to the wetland. However, for the following reasons, land conservation is a viable alternative to relying solely on regulatory buffers to protect the wetland resources of the Bear Creek watershed:

- It is possible that established buffers are not always adequate to protect wetland functions.
- Some wetlands had been degraded prior to wetland regulations, and public ownership would facilitate restoration activities.
- Regulations are not always adhered to.
- Regulatory buffers may be reduced as a result of alterations exceptions under specific circumstances outlined in agency code.

Land conservation of wetlands is accomplished by one of the following means:

- Land acquisition: acquisition in fee, which provides full control of the land.
- Conservation easement: conveyance of development rights necessary for protection of specific conservation values from a property’s landowner to a municipality, land trust, or other nonprofit organization. The terms of easements vary, but generally speaking, in the areas covered by the easement, no new development may take place.
- Tax incentives: programs such as current use taxation programs in King County that offer an incentive (a property tax reduction) to landowners to voluntarily preserve open space on their property. Once enrolled, a participating property is assessed at

¹ Polygons are a GIS feature class used to represent features and areas, such as wetlands. Because of how the original wetland datasets were combined and merged, a single wetland polygon does not necessarily represent a single wetland – it may be several wetlands in a wetland complex, or it may contain surrounding upland area, depending on the accuracy of the original dataset. Because referring to these areas as “wetlands” implies a greater level of accuracy than is present, they are sometimes referred to as “wetland polygons” in this analysis. See King County 2017b for more detailed discussion of the original wetland datasets.

a “current use” value, which is lower than the “highest and best use” assessment value that would otherwise apply to the property.

Of these three strategies, acquisitions and easements are the two examined in this Plan. Because tax incentive programs cannot be guaranteed in the long term, they were not included in this analysis. However, in many instances the landowner will likely never withdraw from the incentive program, because, for example, the parcel is too small to divide and the portion in the incentive program is wetland or stream riparian area. In these instances the protection is effectively permanent. The Waterways 2000 Program (King County 1996) mapped parcels in the Bear Creek watershed they recommended for tax incentive programs, and many of those parcels were subsequently enrolled. Programs such as the Public Benefit Rating System in King County are worthwhile and should be actively pursued as a valid conservation measure.

Land conservation, especially acquisition in fee, may result in additional lands for King County to manage. The implications of increasing the management requirements by King County is not addressed in this analysis.

2.1.1 Criteria for Selecting Wetlands for Conservation

According to Cappiella et al. (2006), wetlands that are likely candidates for conservation are generally high quality wetlands that have high functional value and are in good condition or wetlands that provide some special social or economic value. There are other useful criteria available in addition to value and condition for prioritizing wetlands for conservation, although data is not always available for some or all of the wetlands in the study area. Table 1 outlines a set of criteria that may be used to prioritize land for conservation as well as provides notes on the availability of relevant data. Each of the criteria in Table 1 are discussed in more detail in Section 2.1.1.1.

Table 1. Criteria for selecting wetlands for conservation strategies (adapted from Cappiella et al. 2006).

Criteria		Priorities for Conservation	Availability of Data
Science-based criteria (descriptions in Section 2.1.1.1)	Type	Sensitive, locally rare, or difficult-to-replace wetland types. Prioritize Sphagnum bog and non-Sphagnum bogs over other wetland types.	Data available.
	Function	High for functions of interest (flood control, water quality, groundwater recharge, and habitat)	Wetland functional analysis not performed. No function data available.
	Condition	Good or excellent, as determined by preliminary estimate of wetland condition.	Data available for percent impervious surface, which is one indicator of condition.
	Connectivity	King County Wildlife Habitat Network intersects wetland or parcel associated with wetland.	Data available.
		Part of a wetland complex.	Limited data available, including distances and land cover between wetlands.
		Adjacent to other protected undeveloped open space (public lands, Tract parcels, Home Owners Associations (HOA) green space).	Data available.
Other criteria (descriptions in Section 2.1.1.2)	Location in watershed	Located in headwaters.	Data available.
	Development pressure	Defined as parcels that are not currently subdivided as small as zoning allows.	Data available.
	Special designation	Identified in riparian analysis (King County 2017a) or King County Land Conservation Initiative (which includes salmon recovery priorities).	Data available.
	Ownership	Willing landowner.	Willingness of landowners required but currently unknown

2.1.1.1 Ecological and other science-based criteria

Science-based criteria are used to identify the most valuable wetlands from an ecological perspective.

Type. Classifying wetlands as sensitive or non-sensitive to development and its effects, including stormwater runoff, provides a useful framework for not just managing stormwater inputs to different types of wetlands but also for prioritizing wetlands for conservation (Cappiella et al. 2006). Some wetlands are sensitive to any disturbance, and will become degraded with even low-level inputs of urban stormwater. This degradation is typically expressed as reduced diversity and abundance of plant or animal species. The most sensitive wetland type in the Bear Creek watershed study area are Sphagnum bogs. As discussed in King County (2017b), *Sphagnum*-dominated peat bogs are included in the King County Comprehensive Plan (Comp Plan) as a habitat of local importance because

they (a) support a unique plant and animal community, (b) have declined as a result of development, and (c) are a fragile ecosystem that can be easily destroyed but cannot be easily restored. Because bogs are the most sensitive wetland type in the watershed, they are therefore a high priority for conservation.

Function. Wetland functions include flood protection, retention of sediments and other particulates such as pollutants, maintaining streamflow, recharging groundwater, and provision of fish and wildlife habitat. Assessments of wetland functions generally measure the wetland's capacity to provide one or more specific functions (Cappiella et al. 2006). Wetland function is arguably the most important criteria to use to prioritize wetland conservation, but wetland functional assessments have not been conducted for the wetlands in the Bear Creek watershed.

Condition. Wetland condition describes how well the wetland is providing its functions (Cappiella et al. 2006). Wetland condition also affects how sensitive a wetland is to stormwater and other impacts. Landscape-scale estimates of wetland condition focus on identifying indicators of disturbance in and around wetlands. The assumption is that wetlands that have a greater number of disturbance indicators will have a more degraded condition (Cappiella et al. 2006). A variety of indicators can be used to estimate wetland condition, including hydrologic alterations, number of vegetation classes, buffer condition, and surrounding land cover. Other factors that may be used to derive disturbance indicators include: fragmentation, percent standing or open water, proximity to other wetlands, proximity to roads, road density, size and shape of wetland, population density, water quality impairments, Breeding Bird survey data, connectivity, wetland type, and more (NEIWPCC and RIDEM 2006). Connectivity and proximity to other wetlands are already being used as a criteria for prioritization in this analysis. Aside from impervious surface, most of the rest of the indicator data is not available, and when it is, it is only available from some of the wetland data sources.

Wetland condition likely degrades with increasing impervious cover and when urban land uses are dominant (Taylor et al. 1995). Amount of impervious surface per contributing drainage area for each mapped wetland was used as the indicator of condition for this analysis. Each wetland in the study area was labeled with the amount of impervious surface within 300 ft of its edge, as mapped in King County (2017b). Cappiella et al. 2006 suggest 300-500 ft. Three hundred feet was chosen because that size more than encompasses the largest possible regulated buffer size for a wetland in the study area (250 ft). Further, because the majority of mapped wetlands in the study area are within 500 ft of another wetland, using 300 ft will include less overlap of potential drainage area.

Connectivity. Wetlands that are connected to other wetlands and naturally vegetated areas such as forest provide valuable wildlife habitat and movement corridors. For this exercise, connectivity was evaluated in three ways:

- Whether a given wetland was part of a wetland complex.
- If a wetland is connected to King County's Wildlife Habitat Network.
- If a wetland is connected to other protected lands.

Wetland Complex. Groups of wetlands, called a wetland complex, may exhibit more wildlife diversity than isolated wetlands of similar sizes. Protection of wetland complexes is important to stem wetland isolation and habitat fragmentation. The King County Critical Areas Ordinance (CAO) uses a complicated set of criteria to identify a wetland complex. Those criteria are intended to be used during the permitting of relatively small areas, such as individual or small groups of parcels, when data may be collected in the field on many wetland parameters, including wetland category. When trying to determine the connectivity of several hundred wetlands using GIS, a simpler method is needed. For this exercise, the following criteria were used to consider a wetland part of a complex:

- wetland is not a farm field or any sort of wet field, and
- wetland is within 300 ft of another non-field wetland, and
- wetland is not severed from all nearby wetlands by any sort of road unless they are connected by a stream and the stream travels under the road, and
- wetlands are connected by either native vegetation or are within 50 ft of each other and are connected by some form of vegetation.

Wildlife Habitat Network. The King County Wildlife Habitat Network (WHN) is a network of contiguous vegetated corridors that are intended to link wildlife habitat with critical area buffers, priority habitats, trails, open space and other areas to provide for wildlife movement and alleviate habitat fragmentation. The WHN is defined and mapped in the King County Comp Plan, and it is regulated via the CAO. The WHN form one contiguous track or setback area that enters and exits properties where the network crosses the property boundary. To the maximum extent practicable, the WHN must be maintained at a width of 300 ft and not be less than 150 ft wide at any point.

Other protected lands. Parcel types that are assumed to provide protection to the wetlands and streams within them include:

- Publicly owned lands and conservation easements.
- Undeveloped, vegetated parcels that are associated with Home Owners Associations (HOA).
- “Tract” parcels, which are parcels held in undivided interest. It is possible some of these areas will not provide permanent protection; however, they appear to be vegetated areas mostly around streams and wetlands and associated with developments (similar to HOA green spaces).

These parcel types are also important because if most parcels around a wetland are either publicly owned or otherwise already in permanent protection, it may take relatively little effort to conserve the remaining parcels.

Location in watershed. Wetlands were identified as headwaters if a stream originates in the wetland. The most important geographic location for wetlands is in the headwaters. Headwaters streams and wetlands are important because they exert critical influences on the character and quality of downstream waters (Meyer et al. 2007; Alexander et al. 2007).

Headwater streams contribute to maintaining hydrologic connectivity and ecosystem integrity at regional scales (Freeman et al. 2007). The natural processes that occur in such headwater systems benefit humans by mitigating flooding, maintaining water quality and quantity, recycling nutrients, and providing habitat for plants and animals (Meyer et al. 2007).

A wetland may be divided in two by a road and still have both portions count as headwater wetlands. A wetland may be mapped “upstream” of the mapped stream (that is, the stream is not mapped as flowing out of the wetland), but if the topography and aerial imagery indicate the wetland likely drains the stream, it is included as a headwater wetland.

2.1.1.2 Other criteria

Additional non-scientific criteria may be used to help prioritize wetlands for land conservation strategies. These criteria are intended to be applied to parcel data (see Section 2.1.2 on prioritizing parcels).

Development pressure. If wetlands are located in parcels that are vulnerable to subplanning, they are a higher priority than those that are not, because they may represent multiple houses, etc., in the future.

Special designation. Parcels and areas prioritized in other programs and analyses will be prioritized over parcels that are not. Some of these other programs and analyses include the riparian analysis (King County 2017a) and those parcels that are identified via the King County Conservation Lands Initiative, which includes parcels identified specifically for salmon recovery and other goals.

Ownership. Willingness of landowner to sell their property or participate in a conservation easement is necessary. No surveys have been conducted yet to determine which landowners are or would be in the future willing to participate in these types of land conservation actions, so to include that criteria might falsely imply acquisitions would be pursued regardless of willingness. Owner willingness would be addressed once priorities have been identified and funding secured.

2.1.2 Prioritizing for Wetland Conservation

The criteria described above are all useful and valid for identifying the relative value of wetlands. In order to know where to start conservation efforts, the wetlands must be evaluated, and the parcels they are found on need to be prioritized. This section addresses prioritizing wetlands and the parcels associated with them.

2.1.2.1 Scoring wetlands

The geospatial data file containing all mapped wetlands in the study area was attributed (labeled) with the following information, all of which are ecological criteria associated with the wetlands:

- If the wetland is a bog.

- The percentage of impervious land cover within 300 ft of the wetland.
- Whether the wetland was part of a wetland complex, as defined above.
- Whether the wetland was connected to the King County WHN.
- Whether the wetland is partially or fully on public lands, Tract parcels, or HOA green space parcels.
- Whether the wetland was located in the headwaters.

After the wetlands were attributed, the point system shown in Table 2 was applied to each of the wetlands. The scoring is based on the criteria in Table 1, and the questions derived from the criteria are the “Evaluation questions” in column one of Table 2.

Table 2. Scoring system for prioritizing wetlands for conservation strategies. These points apply to wetlands.

Evaluation questions	Land conservation score	Rationale for point assignment
Is the wetland a bog?	Yes = 100 No = 0	Because of the sensitive and relatively rare nature of bogs, the point value assigned for them is high enough to elevate them to a top priority.
Percent impervious land cover within 300 ft of the wetland?	0 = 30 <5% = 20 5-10% = 10 >10% = 0	No impervious surface within the buffer of a wetland should indicate a wetland in relatively better condition than those with buffers that do have impervious surface. Above 10% impervious surface in a wetland buffer area is assumed to degrade wetland condition.
Is the wetland part of a wetland complex?	Yes = 10 No = 0	Wetland connectivity is very important for wildlife survival and biodiversity. But because of the limitations of identifying wetland complexes geospatially, the scoring for wetlands defined herein as being in a complex is relatively low. Additionally, many of the single wetland polygons are actually wetland complexes.
Does the King County Wildlife Habitat Network (WHN) intersect the wetland or parcel associated with wetland?	Yes = 20 No = 0	Regulated connectivity increases the wildlife habitat value of the wetland.
Is the wetland already fully or partially protected (e.g., public lands, Tract parcels, HOA green space)?	Partially protected = 40 Fully protected = -100 Not protected = 0	If the wetland is partially protected, completing the level of conservation is considered highly desirable. If the wetlands is fully protected, it does not need further conservation, so the negative score serves to filter it out.
Is the wetland located in headwaters?	Yes = 20 No = 0	Headwaters of streams impact water quality, including water temperature. Lowering a headwater wetland's water temperature should also lower the stream water temperature.

2.1.2.2 Prioritizing parcels

Because wetlands are contained within parcels and sometimes spread across many parcels, it is the parcels or the development rights to the parcels associated with the wetlands that would need to be purchased. Therefore, all relevant wetland scoring data discussed above and shown in Table 2 must be attached to the corresponding parcels.

Using orthoimagery in GIS, each wetland in the study area was visually examined in relation to parcel data. The following parcels were imported into a new “wetland conservation parcel” file:

- Undeveloped parcels in the study area that contained all or a part of a mapped wetland.
- Undeveloped forested parcels that were adjacent to parcels with wetlands.
- Parcels with development that also contained wetland and wetland buffer, if a conservation easement looked possible.

There were two main reasons that a parcel containing part or all of a mapped wetland might not be identified as a candidate for land conservation:

- A mapped wetland was clearly no longer present in the mapped location and had little chance of one being re-established (buildings, roads, or farm fields covered the entire polygon).
- The mapped wetland was a lake with residential development around the entire lakeshore.

Small parcels that were mostly developed but contained a sliver of wetland or wetland buffer were still generally included despite that (a) it may be cost prohibitive to try to purchase many of these properties for such the relatively small area of wetland protection, and (b) an easement would presumably make no difference with buffer regulations already in place. It is assumed that the scoring system used to prioritize parcels for conservation will put these parcels at the bottom of the list.

In a few instances, parcels adjacent to CAO wetlands were included, because although the mapped portion of the wetland did not extend into those parcels, it was clear it would have if the delineation had occurred on the adjacent properties.

In order to attach the wetland scores to the relevant parcels, the wetland data listed in Table 2 was intersected with the potential wetland conservation parcel file. For each criterion attributed to the wetlands, the highest value was assigned for any given parcel. For example, if two wetlands intersected one parcel, and one wetland was associated with the WHN but the other was not, the parcel would be attributed as being associated with the WHN, and it would get those 20 points.

Parcels in the potential wetland conservation parcel file were attributed with information associated with the criteria in Table 3. A parcel was attributed as to whether it is:

- Currently not subdivided as small as zoning allows.

- Identified as part of the riparian analysis (King County 2017a), King County Land Conservation Initiative, or similar program.
- Adjacent to public lands, Tract parcels, or HOA green space parcels.

After the parcels were attributed, the point system shown in Table 3 was applied to each parcel. The scoring is based on the criteria in Table 1, and the questions derived from the criteria are the “Evaluation questions” in column one of Table 3. Final prioritization for wetland conservation was based on the summation of all land conservation scores – the wetland-specific scores from Table 2 and the parcel-specific scores from Table 3.

Table 3. Scoring system for parcels associated with wetlands. These points apply to parcels.

Evaluation questions	Land conservation score	Justification for point assignment
Is the parcel currently not subdivided as small as it can be? That is, can the parcel be subdivided?	Yes = 10 No = 0	If the parcel associated with the wetland can be further subdivided, the development pressure is assumed to be higher than undividable parcels.
Are associated parcels identified as part of the riparian analysis (King County 2017a), King County Land Conservation Initiative, or similar program?	Identified by another program = 10 per occurrence	Assumes that if there are multiple values associated with preservation versus only one conservation target, parcel is more valuable from a conservation standpoint.
Are associated parcels adjacent to other protected undeveloped open space (e.g., public lands, Tract parcels, HOA green space)?	Yes = 10 No = 0	This attribute is already partially covered by tagging the wetland polygons for whether they are already protected. In some instances the parcels will be connected to protected lands when their associated wetlands are not. Parcels therefore also play an important role in overall connectivity.

2.2 Wetlands Restoration Strategies

Different agencies use different definitions for the same term or use different terms to define the same action. The Wetlands Subcommittee of the Federal Geographic Data Committee (see US EPA 2017) developed definitions for wetland restoration and related activities designed to aid agencies in accurately reporting wetland increases resulting from their program activities. This report adopts those definitions, which include:

Restoration: the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to former or degraded wetland. For the purpose of tracking net gains in wetland acres, restoration is divided into:

- **Rehabilitation:** the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions of degraded wetland.

Rehabilitation results in a gain in wetland function, but does not result in a gain in wetland acres.

- **Re-establishment:** the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland. Re-establishment results in rebuilding a former wetland and results in a gain in wetland acres.

In general, wetland rehabilitation improves the functions of existing wetlands, whereas wetland re-establishment builds a wetland where one does not currently exist but did exist within the past 100-200 years. Wetlands may also be created to perform water quality functions; however, site selection for created wetlands was not in the scope of this report. Information regarding created wetlands is provided in Section 2.2.3.

2.2.1 Rehabilitation

Goals associated with wetland rehabilitation are generally associated with the primary four functions of wetlands in the Bear Creek watershed: water quality improvement, flood water retention, groundwater recharge, or wildlife habitat. Rehabilitation results in a gain in wetland function but does not result in a gain in wetland acres. The terms rehabilitation and enhancement are often used interchangeably. Gwin et al. (1999) define enhancement as "the modification of specific structural features of an existing wetland to increase one or more functions based on management objectives, typically done by modifying site elevations or the proportion of open water. Although this term implies gain or improvement, a positive change in one wetland function may negatively affect other wetland functions."

Wetland rehabilitation is defined in this plan as planting native vegetation (trees and shrubs) in areas of the wetland and its buffer that are currently covered in grass, impervious surface, or some other non-native vegetation.

2.2.1.1 Identifying

All 327 wetland polygons were visually examined in GIS, and notes were made as to indicators of degradation. Degraded wetlands generally fell into the following categories:

- The wetland contains reed canarygrass.
- The open-water wetland is mowed to the edge along all or some portion of the wetland.
- The area with a mapped wetland is in some form of agricultural use (pasture, livestock yard, etc.). Sometimes wet areas are visible, and other times they are not. No forest or other native vegetation is present.
- A mapped wetland partially contains lawn, driveway, buildings, or other form of non-native land cover.
- The wetland is fully or partially on a powerline corridor.
- A mapped wetland is a farm pond with livestock access.
- A mapped wetland is a stormwater pond.

- A mapped wetland is a pond on a golf course.
- No wetland is visible: the polygon contains a house, road, or other development, so wetland area has either been lost or it was never wetland to begin with.

2.2.1.2 Prioritizing

Tree planting is assumed to improve water quality and wildlife habitat. Prioritizing wetlands for tree planting should therefore be done with improvements to water quality and wildlife habitat functions in mind. Prioritizing wetlands for rehabilitation is a multi-step approach:

- Polygons with wetlands clearly not present were removed from consideration.
- Any wetland polygons that appeared in 2015 aerial imagery to have no need for rehabilitation were removed from consideration. These wetland polygons did not fall into any of the categories listed in Section 2.2.1.1, and any vegetation present appeared to be native vegetation.
- For the final set of wetland polygons, a set of criteria indicating the functions and values of the wetlands were applied to score them for rehabilitation (Table 4). Points were also assigned for type of degradation present (reed canarygrass, mowed edges) as well as whether degradation was occurring on public lands.²

Final prioritization for tree planting around wetlands was based on the summation of the restoration scores shown in Table 4. The scoring is intended to indicate greatest potential to rehabilitate one or more wetland functions, prioritized by those wetlands that otherwise have the greatest value in terms of connectivity, the least amount of impervious surface, highest potential for improving water temperatures, and are most easily accessible (publicly owned, therefore most feasible). This information is intended to be used to get the most out of rehabilitation dollars.

² Publicly owned lands get one score, and publicly owned lands with reed canarygrass and/or mowed water edges gets another score, guaranteeing a high score for those areas most ripe for rehabilitation projects. Because these lands are already publicly owned, it is assumed that permission to do rehabilitation activities would be easiest to obtain.

Table 4. Criteria for prioritizing wetlands for rehabilitation strategies (adapted from Cappiella et al. 2006). [Points in each category and sub-category are additive.]

Criteria	Evaluation questions	Restoration score	Notes / Assumptions
Type	Is the wetland a bog?	Yes = 40 No = 0	If a bog is damaged, it should be a priority for repair.
Condition	Percent impervious land cover within 300 ft of the wetland.	<5 = 20 5-10 = 10 >10 = 0	Wetlands with little to no impervious surface in their immediate draining area are assumed to be in better condition or have the potential for better condition once repaired.
Connectivity	Is the wetland along the King County Wildlife Habitat Network (WHN)?	Yes = 20 No = 0	Regulated connectivity increases the wildlife habitat value of the wetland.
	Is the wetland part of a wetland complex?	Yes = 10 No = 0	The wildlife habitat value is higher if wetlands are connected (part of a wetland complex), because amphibians and other wildlife are able to move between them.
Location in watershed	Is the wetland located in the headwaters?	Yes = 20 No = 0	Headwaters of streams impact water quality, including water temperature. Lowering a headwater wetland's water temperature should also lower the stream water temperature.
	Does the stream water temperature exceed the standards?	Yes = 20 No = 0	If the wetland is located along a stream reach with elevated water temperatures, it is assumed that tree planting may help alleviate the high water temperatures.

Table continued on next page.

Criteria	Question derived from criteria	Restoration score	Notes / Assumptions
Gain in function	Does the wetland have reed canarygrass present? Is the wetland mowed on some portion of its shoreline? (These questions are intended to be surrogates for the following questions: Can water quality functions be improved? Can wildlife habitat functions be improved?)	Mowed = 20 Reed Canarygrass = 10	The two primary wetland-related problems that may be addressed with rehabilitation (tree planting) are lack of shade and invasive species. Planting trees along a shoreline is assumed to provide both water quality and wildlife benefits, hence the higher score for “mowed.” Even in the absence of an open-water component, replacing reed canarygrass with native vegetation will improve wildlife habitat.
	Is there water present?	Yes = 30 No = 0	This question addresses both feasibility and the impact a planting project will have. If the wetland is agriculture field full of reed canarygrass, planting trees will not results in cooling water temperatures. This element raises the priority for wetlands that have water present to some degree.
Feasibility	Is the wetland in need of rehabilitation on protected lands such as public land, HOA green space, Tract parcels, or conservation easements?	Yes = 30 Partial = 15	It is assumed that it will be much more feasible to conduct wetland restoration projects on public lands over private lands.
	This questions gets at whether the current land use is compatible with restoration. The second part of this question, which further subdivides exactly what form of degradation is present, helps filter out which lands will benefit most from rehabilitation.	Mowed & fully located on public land = 30 RCG & fully located on public land = 20 Mowed & partially located on public land = 20 RCG & partially located on public land = 10	Because these rehabilitation projects are assumed to be associated with either invasive species (reed canarygrass) or lack of shade around wetland edges, these scores separate out wetlands with these types of degradation from all the other wetlands.

2.2.2 Re-establishment

A change analysis was conducted in the “Assessment of Bear Creek Watershed Wetlands” (King County 2017b), which showed wetland loss that has occurred over the past 35 years. Additionally, 70 percent of the smaller wetlands delineated as part of the CAO permit process did not intersect with National Wetlands Inventory (NWI) or King County Wetland Inventory wetlands, and if that type of smaller wetland had been filled in the past, there would be no record of their potential historic presence whatsoever. It is almost certain that wetlands have been filled in the past; the number and acreage of filled wetlands are unknown. Finally, as part of the rehabilitation analysis above, 9 of the 327 wetland polygons were found to be not wetlands currently, and several (approximately 30) are currently agricultural fields with no open water component and some or all of the area with no native vegetation present. Although those fields may be technically wetlands (based on hydrology and soil conditions plus the obligate wetland species present, reed canarygrass), they have no wildlife habitat function, no flood storage capacity, and no groundwater recharge function greater than surrounding terrestrial landcover. All of these functions are provided by healthy wetlands and could be provided by re-established wetlands.

Wetland re-establishment is the rebuilding of a former wetland. Knowing the locations of former wetlands helps identify sites that may be suitable for wetland re-establishment (Cappiella et al. 2006), however, little to no data exists for the Bear Creek watershed that shows definitively where wetlands were located historically but are no longer present. Potential re-establishment sites can be identified using other data, such as former wetlands with effectively drained hydric soil map units, filled areas with no development (based on NWI data), impounded areas, excavated areas, and farmed wetlands Tiner (2005).

For this analysis, wetland polygons were intersected with soil data to identify all polygons that intersect mapped hydric soils. All wetland polygons showing open water were removed from consideration, because a wetland typically already exists in those locations or they are addressed above under “Rehabilitation.” Wetland polygons showing native vegetation were removed from consideration under the assumption they may be forested or scrub-shrub wetlands.

Because of the small number of potential sites and affected landowners (see Section 3.0 Results and discussion), it may not be necessary to prioritize them. It might be worthwhile to contact all the landowners to inquire about interest in creating a wetland feature on their property. If prioritization were needed, wetland polygons could be prioritized based on:

- Number of affected landowners (prioritize single landowners over multiple landowners)
- Proximity to stream or other wetlands.

2.2.3 Wetland Creation

Natural wetlands should not be specifically used to treat stormwater runoff, as it increases the depth of temporary or permanent ponding in a wetland (Wright et al. 2006). Over time,

the altered hydrology transforms a natural wetland into a stormwater wetland with loss of biological diversity and functional value. Wetlands may be created for this purpose, and although wetland creation was not examined as a part of this analysis, this section presents a small amount of information on wetland creation to complement the other restoration BMPs examined in this report. Additional information on wetland creation may be found in Section 6.4.3 of the King County Surface Water Design Manual.

When wetlands are lost or degraded as a result of land development, the services they provide must often be replaced by water treatment and flood control infrastructure (Wright et al. 2006). Stormwater ponds and other facilities are a common tool to help deal with stormwater. Created wetlands can be built to serve the same water quality and quantity functions for stormwater controls and impacts. Because wetlands provide functions beyond what stormwater ponds typically provide, in some instances wetland creation may be a preferred alternative to stormwater facilities.

Wetland creation is defined as establishing a wetland where one had not existed in the past. The Wetlands Subcommittee of the Federal Geographic Data Committee uses the term Establishment to mean wetland creation. They define establishment as “the manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist on an upland or deepwater site. Establishment results in a gain in wetland acres” (US EPA 2017).

Constructed wetlands are treatment systems that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages typically to improve water quality (US EPA 2017). Wetlands created to mimic the sediment and nutrient removal processes occurring in natural wetlands are designed based on holding or slowing the passage of effluent through the wetland, where a range of physical, chemical, and biological processes can operate to store, transform, or remove various pollutants (Cappiella et al. 2005).

Wetland creation occurs when a wetland is placed on the landscape on a non-wetland site (Lewis 1989). Typically, a wetland is created by excavation of upland soils to elevations that will support the growth of wetland species through the establishment of an appropriate hydrology (US EPA 2017).

3.0 RESULTS AND DISCUSSION

This section includes results for the wetland polygons and associated parcels when applicable. Because this analysis is GIS-based, the results are limited by the accuracy and availability of disturbance indicators as well as the accuracy of the mapped wetland polygons. Outreach and field visits may be used to verify wetland hydrologic and habitat value.

3.1 Wetlands Identified for Conservation Strategies

The wetland dataset used for this analysis included 327 mapped wetland polygons. Visual inspection of aerial photos revealed that 9 of the polygons were clearly not wetlands (buildings, roads, or relatively dry-appearing farm fields covered the entire polygon). Another 50 wetlands were already in public ownership or under some other form of permanent protection (Tract or HOA greenspaces). The distribution of the remaining 268 wetland polygons is as follows:

- King County: 168
- Redmond: 18
- Redmond and King County shared: 1
- Snohomish County: 54
- Snohomish County and King County shared: 1
- Woodinville: 25

The 268 wetland polygons had scores ranging from 0 to 200. Figure 1 indicates a ranking of high, medium, low, and very low, where:

- High = 100-200 points
- Medium = 50-80 points
- Low = 20-40 points
- Very Low = 0-10 points

Table 5 presents a sample of the final prioritization of the wetland polygons by jurisdiction. Lists of all parcel data will be provided to all partnering jurisdictions.

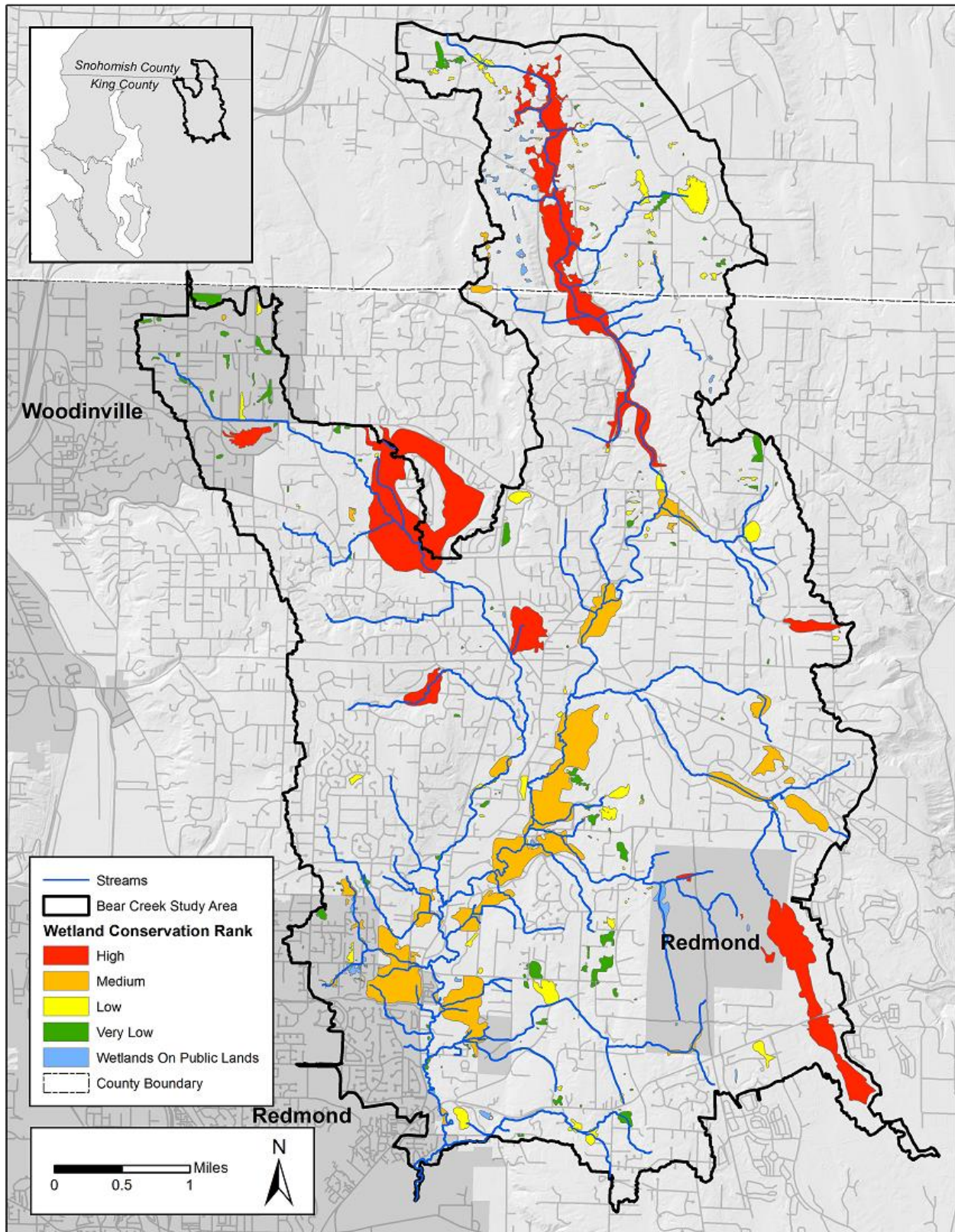


Figure 1. Prioritization of wetland polygons for conservation strategies (acquisition or easement). Note that some wetland polygons span across study area boundaries.

Table 5. Sample of prioritized wetlands for conservation strategies by jurisdiction. [Points shown here do not include parcel-related points. Wetlands scoring the same points are ordered by size. The top five wetlands per jurisdiction are shown; the full lists will be given to the partner jurisdictions to aid in conservation implementation.]

Jurisdiction	Wetland ID	Ranking	Acres	Head-waters	WHN	Bog	Already protected	Complex	Impervious category	Aerial photo interpretation notes
King County	39	High	55.33	Yes	Yes	Yes	Partial	Yes	11-20%	includes powerline corridor
	215	High	308.38			Yes	Partial	Yes	>20%	Lake; RCG; vegetated
	161	High	17.48			Yes	Partial	Yes	11-20%	Scrub-shrub; road cuts through
	153	High	25.73			Yes	Partial		>20%	Vegetated; including powerline
	165	High	45.36	Yes		Yes			>20%	forested; continues to next parcel
Redmond	94	High	90.89	Yes	Yes	Yes	Partial	Yes	5-10%	forested; in good shape
	87	High	0.31	Yes	Yes		Partial	Yes	0	Beaver pond, bigger than mapped
	72	High	3.24	Yes			Partial	Yes	0	forested
	107	High	2.79		Yes		Partial	Yes	0	Beaver pond, way larger than mapped
	53	Medium	1.81	Yes			Partial		11-20%	forested
Snohomish County	327	High	9.98	Yes			Partial	Yes	0	Beaver ponds with RCG
	269	Medium	2.31				Partial	Yes	0	Vegetated - scrubby; possibly way bigger
	261	Medium	0.58				Partial	Yes	<5%	Vegetated - forest and scrub
	294	Medium	0.48				Partial	Yes	<5%	Vegetated; road down center
	303	Medium	0.40				Partial	Yes	<5%	Scrub-shrub; larger than mapped
Snohomish Co. - King County*	323	High	284.84		Yes	Yes	Partial	Yes	5-10%	Is actually many wetlands; roads, RCG
Woodinville	213	High	17.70			Yes	Partial	Yes	>20%	Lake Leota - residential w/docks
	245	Medium	0.68				Partial		5-10%	Forested; landscaping. Wetland to east?
	221	Low	3.20				Partial		>20%	Several small scrub-shrub wetlands; development
	247	Low	1.75				Partial		11-20%	Vegetated; house, yard, driveway
	218	Low	0.17				Partial		>20%	forest & sidewalk - mismapped? no wetland?

Notes:

*This is a large wetland complex that spans across county boundaries.

WHN = Wildlife Habitat Network

A total of 588 parcels were identified that were associated with the 268 wetland polygons:

- 107 undeveloped privately owned parcels containing all or part of a mapped wetland polygon.
- 462 developed residential parcels that might be candidates for conservation easements or partial acquisition because they contain part or all of a wetland.
- 19 undeveloped forested parcels directly adjacent to parcels with wetlands.
- 17 parcels with easements already in place.

The parcels were ranked for conservation by combining the wetland scores with points from parcel-specific criteria (see Section 2.1.2.2). The 588 parcels had scores ranging from 0 to 220. Parcels were ranked as high, medium, low, and very low, where:

- High = 160-220 points
- Medium = 80-150 points
- Low = 20-70 points
- Very Low = 0-10 points

Parcels that scored only 0 or 10 points are assumed to not be a priority for conservation. The analysis reveals the following data for parcels that scored at least 20 points for conservation:

- King County – 335 parcels out of 409 scored; points ranging from 20 to 220
- Redmond – 21 parcels out of 23 scored; points ranging from 20 to 80
- Snohomish County – 71 parcels out of 94 scored; points ranging from 20 to 210
- Woodinville – 22 parcels out of 62 scored; points ranging from 20 to 180

Undeveloped parcels are candidates for acquisition or easement; cost analyses assume acquisition, which is more costly. Parcels with development are assumed to be candidates for easements and not acquisitions, though there may be some circumstances when a developed parcel is purchased and any structures demolished.

Costs of acquisition were calculated by first obtaining the combined assessed land value and assessed improved value (value of improvements, such as houses) from King County parcel data and the combined market land value and market improved value from the Snohomish County parcel data. Next, a multiplier of 115 percent³ was applied to those values to account for the difference between the assessed value and appraised value. Costs of easements were calculated by taking the assessed land value from King County parcel data and the market land value from the Snohomish County data and using a multiplier of

³ 15 percent is added to the assessed value because appraisals were running higher than assessed value by about 15 percent in 2015 and 2016.

40 percent⁴. Easement calculations assumed less than half the parcel would be put in easement.

For the cost analysis, in all instances where parcels in the riparian analysis in Section 7.3 overlapped parcels in this wetland analysis, they were removed from this wetland analysis.

A total of 126 parcels were identified for potential wetland acquisition (had no development). Sixty-four (64) of those parcels were also identified in the riparian analysis for acquisition. This wetland cost analysis for acquisition only includes the remaining 62 parcels.

Costs for acquisition for each partner jurisdiction are present in Table 6. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total costs for acquisition in priority basins and remaining High and Medium ranked parcels would be approximately \$5,520,000.

⁴ 40 percent assumes the following: (a) the amount of the parcel that would be placed under easement would be less than 50 percent and more than 1 percent, and 25 percent is the average between 1 and 50, and (b) 15 percent is added to the 25 percent to account for the difference between assessed value and appraised value.

Table 6. Cost estimates for all 62 parcels identified for potential acquisition. Priority catchments described in Section 4.2 are identified separately.

Prioritization Ranking	Catchment	Cost	number of parcels
King County			
High	All others	\$1,431,000	4
Medium	BEA120	\$99,000	1
Medium	All others	\$2,650,000	9
Low	BEA120	\$86,000	1
Low	All others	\$5,271,000	10
Very Low	All others	\$3,705,000	9
Unknown	All others	\$1,750,000	3
Redmond			
Low	All others	\$7,626,000	5
Very Low	All others	\$1,000	2
Snohomish County			
High	BEA660	\$600	1
High	All others	\$1,000	1
Low	BEA660	\$488,000	2
Low	All others	\$156,000	2
Very Low	BEA660	\$264,000	1
Very Low	All others	\$264,000	1
Unknown	BEA660	\$289,000	3
Unknown	All others	\$601,000	3
Woodinville			
Low	All others	\$2,279,000	3
Very Low	BEA850	\$210,000	1

A total of 462 parcels had some development on them and thus were identified for potential wetland easements. One hundred and eighty-seven (187) of those parcels were also identified in the riparian analysis for easements. This wetland cost analysis for easements only includes the remaining 275 parcels. The total estimated value of the 275 parcels is approximately \$69,688,000.

Costs for easements for each partner jurisdiction are presented below in Table 7. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total easement costs are estimated to be approximately \$41,053,000 if easements were purchased on all 275 parcels identified for potential easements, including those prioritized as Low and Very Low. Total costs for easements in priority basins and remaining High and Medium ranked parcels would be approximately \$12,104,000.

Table 7. Cost estimates to for all 275 parcels identified for potential easements. Priority catchments described in Section 4.2 are identified separately.

Prioritization Ranking	Catchment	Cost	number of parcels
King County			
High	All others	\$1,632,000	12
Medium	All others	\$6,835,000	48
Low	BEA120	\$205,000	2
Low	All others	\$8,362,000	55
Very Low	All others	\$7,396,000	58
Redmond			
Medium	All others	\$975,000	10
Low	All others	\$6,217,000	2
Snohomish County			
High	BEA660	\$410,000	5
High	All others	\$183,000	2
Medium	All others	\$112,000	1
Low	BEA660	\$581,000	6
Low	All others	\$1,437,000	17
Very Low	BEA660	\$252,000	3
Very Low	All others	\$618,000	8
Unknown	All others	\$58,000	1
Woodinville			
Low	BEA850	\$162,000	1
Low	All others	\$1,178,000	7
Very Low	BEA850	\$756,000	6
Very Low	All others	\$3,683,000	31

3.2 Wetlands Identified for Restoration Strategies

The primary focus of wetland restoration in this study is rehabilitation, which is defined as tree planting in this plan and discussed in Section 3.2.1. Re-creating wetlands where they were once likely located is discussed in the Section 3.2.2 on Re-establishment.

3.2.1 Rehabilitation

Of the 327 mapped wetland polygons, as discussed above, 9 were clearly no longer wetlands. Of the remaining 318 wetland polygons, 121 did not appear to need rehabilitation judging from aerial imagery (they appeared to only have native vegetation present in and around them). Of the remaining 198, 67 were identified as having reed canarygrass present, and 55 were mowed along at least some portion of the edge plus 3 appeared to be degraded from livestock access (for a total of 58 generally referred to as “mowed”). These 112 wetlands are potential targets for rehabilitation, which is defined

herein as planting native trees and shrubs. The distribution of the wetland polygons with reed canarygrass and/or mowed edges is as follows:

- King County: 89
- Redmond: 5
- Snohomish County: 14
- Snohomish County and King County shared: 1
- Woodinville: 3

Of the 58 wetlands identified as being mowed to the edge:

- 6 are fully on public property and 3 are partially on public property.
- 13 also have reed canarygrass.
- 5 are also in the riparian corridor (total of 8.4 acres in need of trees around the wetlands).
- 2 have concrete paving around some of the edges, and one has a gravel driveway.
- 5 are ponds on golf courses.

Of the 67 wetland polygons identified as having reed canarygrass present:

- 11 are fully on public lands, and 16 are partially on public property.
- 3 are beaver ponds, which pose extra challenges for tree plantings because they are so wet.
- 25 do not have an open-water component associated with them, and approximately 8 of these are farm fields with no other indication of a wetland present beyond the reed canarygrass.

Not including golf course ponds and lawns along residential lakes, approximately 34.5 acres could be planted in trees and shrubs around these “mowed” wetlands if all landowners cooperated 100 percent (Table 8).

Wetlands identified as benefiting from tree-planting were evaluated for restoration cost. The cost of tree-planting is assumed to be about \$30,000 per acre in 2018. The cost of restoring wetlands on public lands is estimated to be \$306,000 (Table 8). The total cost to restore wetlands on private lands (excluding any costs to acquire the land or easement to the land) is estimated to be \$2.95 million.

Table 8. Acres of land, by jurisdiction and ownership, that would benefit from tree-planting restoration. Includes areas around wetlands mowed to the edge of the open-water component and areas covered in reed canarygrass. For areas that are mowed and have reed canarygrass present, acreage is included with mowed wetlands. Area in this table does not overlap with restoration areas identified in *Appendix D – Prioritization: Riparian Corridor Strategies*.

Jurisdiction	Mowed to edge				Reed canarygrass			
	Total	Public	Private	Est. Cost	Total	Public	Private	Est. Cost
King	30.5	2.7	27.8	\$915,000	70.5	5.6	64.9	\$2,115,000
Snohomish	1.8	0.0	1.8	\$54,000	2.0	0	2.0	\$60,000

Redmond	1.6	1.6	0	\$48,000	1.5	0	1.5	\$45,000
Woodinville	0.6	0.3	0.3	\$18,000	0	0	0	\$0

Many of the wetlands that have reed canarygrass present but are not identified as being mowed to the edge are in stream riparian corridors, and there is no open water component to the wetland other than the stream. These riparian areas would benefit from tree planting. Many of these areas are captured in the riparian analysis (*Appendix D – Prioritization: Riparian Corridor Strategies*). Other areas with reed canarygrass but no “mowed edges” are farm fields. Planting trees in these farm fields would have terrestrial habitat benefits but likely very low benefits for wetland function. Reed canarygrass areas not associated with the riparian analysis, not included in the mowed estimates, and not including farm fields total approximately 74 acres and are shown in Table 8.

The remaining 85 wetland polygons showing some form of degradation other than being mowed to the edge or having reed canarygrass planted were also scored. Often these polygons are active farm fields, scrub-shrub wetlands severed by roads, and polygons with some portion native vegetation and some portion lawn. Although they were scored as part of the prioritization, in most cases there is very little to be done in terms of tree planting in these areas.

Figure 3 indicates a ranking of high, medium, low, and very low for wetland rehabilitation, where:

- High = 110-165 points
- Medium = 70-105 points
- Low = 20-65 points
- Very Low = 0-10 points

Table 9 provides a sample of the wetlands ranked highest for planting trees in each jurisdiction. All information generated from this analysis for tree planting will be provided to all of the partnering jurisdictions. They will make their choices how to proceed with tree planting and other wetland restoration.

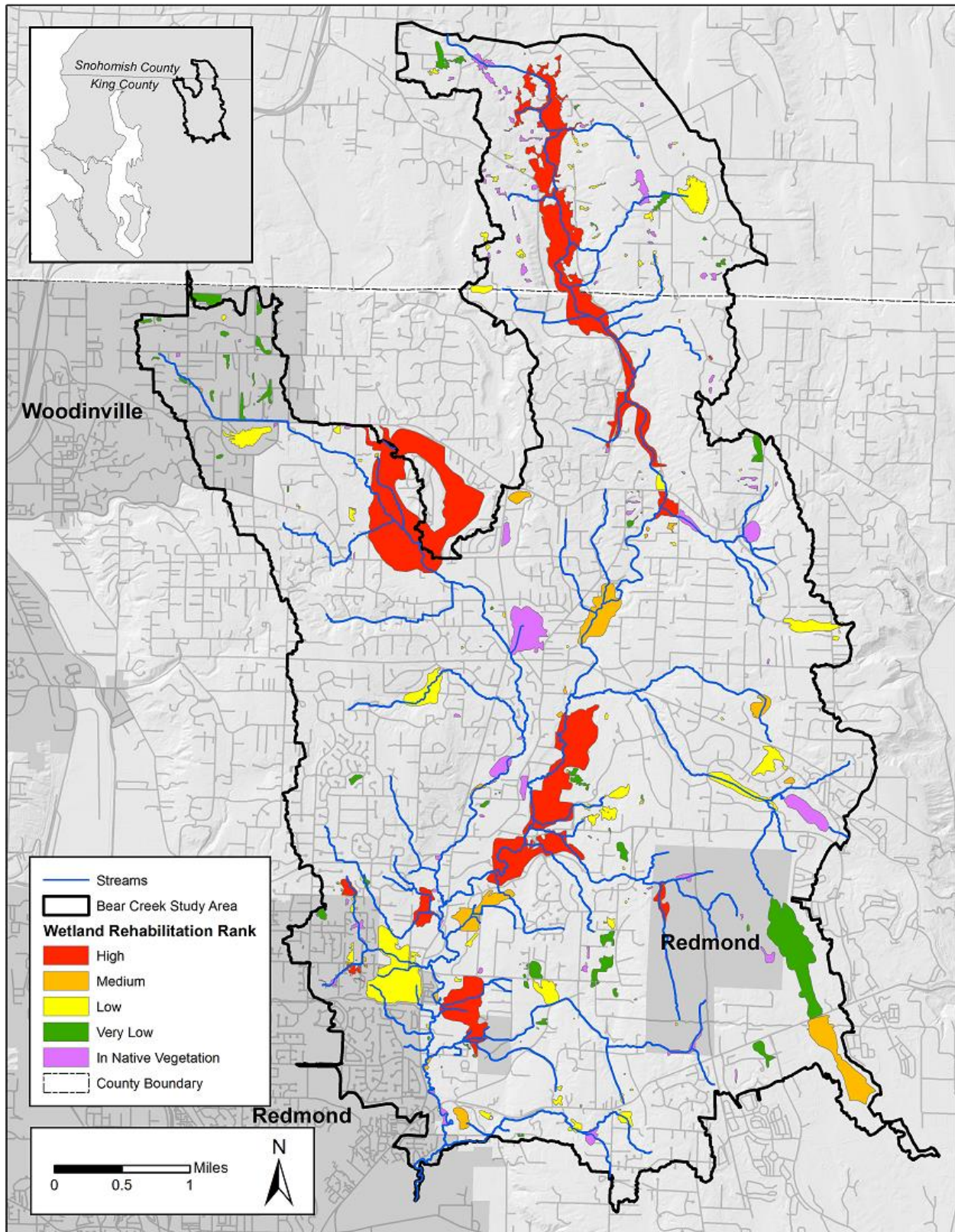


Figure 2. Prioritization of wetland polygons for rehabilitation strategies (tree planting). Note that some wetland polygons span across study area boundaries.

Table 9. Sample of prioritized wetlands for rehabilitation strategies by jurisdiction. [Wetlands scoring the same points are ordered by size. The top five wetlands per jurisdiction are shown; the full lists will be given to the partner jurisdictions to aid in implementation of tree planting projects.]

Jurisdiction	Wetland ID	Points	Acres	Reed canarygrass	RCG & on Public Land	Mowed	Mowed & on Public Land	Aerial photo interpretation notes
King County	233	150	0.23	Yes	Yes	Yes	Yes	RCG in stormwater pond
	215	145	308.38	Yes	Yes			Lake; RCG; vegetated
	118	125	79.79	Yes	Yes			vegetated; some mismapping
	105	125	6.64	Yes	Yes			half is degraded RCG pasture
	113	120	0.13			Yes	Yes	Pond – stormwater
Redmond	103	140	9.94	Yes	Yes			Beaver ponds, many. RCG
	62	120	3.15	Yes	Yes			Pond; forest; scrub/shrub/tons RCG
	68	90	0.44	Yes	Yes			vegetated, including RCG
	61	90	0.23	Yes	Yes			degraded scrub-shrub with some RCG
	95	80	1.78					forested: half okay, half parklike
Snohomish County	327	125	9.98	Yes	Yes			Beaver ponds with RCG
	284	90	0.09	Yes	Yes			RCG; scrubby area - bigger than mapped
	288	80	25.05			Yes		degraded - Echo Lake - home along shore
	260	80	0.22			Yes		Pond - could use bigger buffer
	249	70	0.07	Yes		Yes		Pond - RCG buffer
Snohomish Co. – King County*	323	165	284.84	Yes	Mix			many wetlands; roads, RCG
Woodinville	240	110	0.06			Yes	Yes	Pond - fully mowed & mismapped
	223	70	0.43			Yes		Pond - two back yards; mowed
	213	95	17.70					Lake Leota - residential with docks
	219	40	0.08					vegetated; likely degraded on private land
	245	25	0.68					Forested; landscaping. Wetland to east?

*This is a large wetland complex that spans across county boundaries.

3.2.2 Re-establishment

There are 9 wetland polygons that fit the criteria for re-establishment. Six of the 9 polygons are on farm fields or pasture, and 2 of the polygons are actually in a single farm field. Two of the areas have reed canarygrass. These 9 wetland polygons intersect a total of 15 parcels, and none are publicly owned. All of the potential re-establishment sites are all in King County's jurisdiction.

These potential re-establishment sites could be evaluated further in the field to confirm assumptions based on mapping data and further evaluate restoration feasibility. As mentioned above, these locations may in some instances technically be wetlands, but they are providing little if any wetland function. Excavation combined with native vegetation planting would transform these sites from fields to wetlands with habitat value, flood storage, and groundwater recharge functions. It is very possible that the landowners with farm fields in active use will be reluctant to give up their fields for wetlands. The properties with potential re-establishment sites composed of reed canarygrass and shrubs may be more willing to allow wetland re-establishment on their properties. In all cases, the potential impacts of beavers should be evaluated if and when they were to move into the newly established ponds, and that information should be shared with cooperative landowners.

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APPENDIX D:

Prioritization: Riparian Corridor Strategies

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1.0 INTRODUCTION

A riparian zone or riparian area is the interface between land and a river or stream. Natural riparian corridors provide an extremely wide range of highly valuable functions. Healthy riparian areas, defined as being vegetated in native trees and shrubs, provide several functions that help maintain good water quality by filtering nutrients, sediments, and pathogens before they reach waterways. In addition to being important habitats for a wide range of wildlife (Knutson and Naef 1997), they are also considered essential for sustaining wild fish populations (Naiman et al. 1993).

Specifically, healthy riparian areas are important because they:

- improve water quality by filtering pollutants
- reduce stream bank erosion
- increase instream shade, which decreases water temperatures, which in turn support the higher dissolved oxygen levels important to salmonids
- provide a source for the natural recruitment of large wood into streams to create channel complexity needed for salmonid refugia and protection from predators
- provide over-hanging vegetation, a source of food (invertebrates) for juvenile salmonids

These riparian functions contribute to the health of the watershed and its biodiversity, including fish populations. The decline of native salmonid populations in the Pacific Northwest has been largely attributed to habitat loss and degradation (Yeakley et al. 2014). Riparian corridors contribute to instream functions and are a key component to improve salmonid habitat. Ultimately, restoring riparian areas will contribute to the restoration of the watershed, including fish, wildlife, and vegetation communities.

The “*Assessment of Bear Creek Watershed Riparian Areas*” (King County 2017a) identified the current land cover in the riparian corridor study area¹ of the Bear Creek watershed. Two of the primary problems that interrupt the proper functioning of the riparian corridor were clearly in evidence: (1) lack of native vegetation, especially trees, and (2) a significant presence of invasive vegetation. There are two general strategies available to directly improve, enhance, and conserve riparian conditions in the Bear Creek watershed study area:

1. Restoration (planting native vegetation)
2. Land conservation (acquisition, easement, or incentive)

Using data from the King County (2017a) report and data generated for this report, each of these strategies is examined in detail in this report, which outlines methods for improving riparian conditions and prioritizes the locations for restoration and conservation. These strategies are not mutually exclusive, but the following analysis treats them separately.

¹ All known stream extents within the Bear Creek watershed study area where Chinook, sockeye, coho, kokanee, and steelhead salmon, and cutthroat trout were recorded in the study area were included in this analysis, as described in King County 2017a.

2.0 RESTORATION STRATEGIES

The riparian area can be improved and enhanced by planting native trees and shrubs in areas lacking shade and sometimes infested with invasive species. Benefits of planting trees in the riparian zone include:

- increased shade
- provide a source of large wood for the stream
- improved water quality
- reduced erosion potential
- reduced invasive species coverage

2.1 Identifying Lands in Need of Restoration

Before it is possible to identify areas in the watershed that could benefit from restoration planting, areas that could be planted (those areas not currently in native forest) were identified. Land cover that is not currently in native forest include:

- Shrub
- Non-forested wetland
- Pasture
- Other (much of this category is lawn and other grass surfaces as well as mud or other cleared area)
- Impervious surfaces (sometimes it's possible to remove roads or even buildings)

Those land cover types were all mapped in King County (2017a). Of those areas that could potentially be planted with trees (because they are not currently forested), the next step in identifying areas for potential tree planting was to determine what locations would provide the greatest benefit to the watershed if planted in native vegetation. The “vegetation criteria” used to help identify lands for potential planting projects include:

1. Whether the riparian zone has been cleared of native vegetation all the way to the stream edge or whether the stream is lacking shade in a given area.
2. Presence of invasive species.

All land cover polygons² in the riparian corridor study area were identified in King County (2017a) as to whether an area along a stream lacked shade and if the polygon had invasive species (reed canarygrass or Himalayan blackberry).

All polygons attributed as having no shade were intersected with the stream file to generate a line file that shows those reaches of streams and water bodies lacking of shade/native vegetation. Out of the 46.9 stream miles in the riparian study area, 17.3 miles (36.9 percent) were identified as lacking tree shade on one or both sides of the stream channel (though native shrubs are present in some locations) (King County 2017a).

² Polygons are a GIS feature class used to represent features and areas, such as wetlands. Land cover was mapped in GIS in King County 2017a.

Land cover identified as having invasive species present is shown in Table 1 by type for the 200-ft riparian study corridor (200 ft on both sides of the stream center line). A buffer size of 200 ft on each side of the stream centerline was chosen as the width of the riparian corridor to be analyzed because a buffer this size will capture the area regulated as critical areas (165 ft in King County and 150 ft in Snohomish County) and generally capture the area regulated under Shoreline Management (200 ft)³. Figure 1 shows areas within the 165-ft riparian buffer identified as lacking trees or with invasive species or both.

Table 1. Land cover identified as having reed canarygrass or Himalayan blackberry present within 200 ft of the stream center line on both sides of the stream (King County 2017a).

Land cover class	Area with invasive species (acres)	Total riparian study area in land cover class (acres)	Land cover class covered by invasive species (percent)
Non-forested Wetland	105.9	115.8	91.5
Other	15.1	265.3	5.7
Pasture	43.9	137.3	32.0
Shrub	158.5	394.5	40.2
Total	323.3	912.9	35.4

All parcels intersecting the riparian corridor were saved into a new file. Initially, all polygons with invasive species and areas lacking shade were intersected with the parcel file in order to identify which parcels contain areas in need of restoration. However, a lack of precision in this method resulted in some treeless areas being missed and other areas marked as treeless that had trees. For example, because polygons containing invasive species are often not entirely composed of invasive species, simply intersecting parcels with polygons containing invasive species results in a gross overestimate of which parcels have large areas of reed canarygrass.

All parcels in the riparian corridor were subsequently examined visually in GIS to identify those parcels lacking trees along streams or in stream buffers, regardless of the presence of invasive species. Parcels were attributed accordingly. A total of 371 parcels were identified as needing trees planted either along the stream or in the regulated riparian buffer.

³ Because the riparian corridor file was created based on stream centerlines and not Ordinary High WaterMark (OHWM), the entire Shoreline Management regulated area is typically not fully within the 400 foot corridor. Therefore, if there were ever a specific request to study land cover within the Shoreline Management jurisdiction regulated area in the watershed, some portions of the study corridor would need to be expanded.

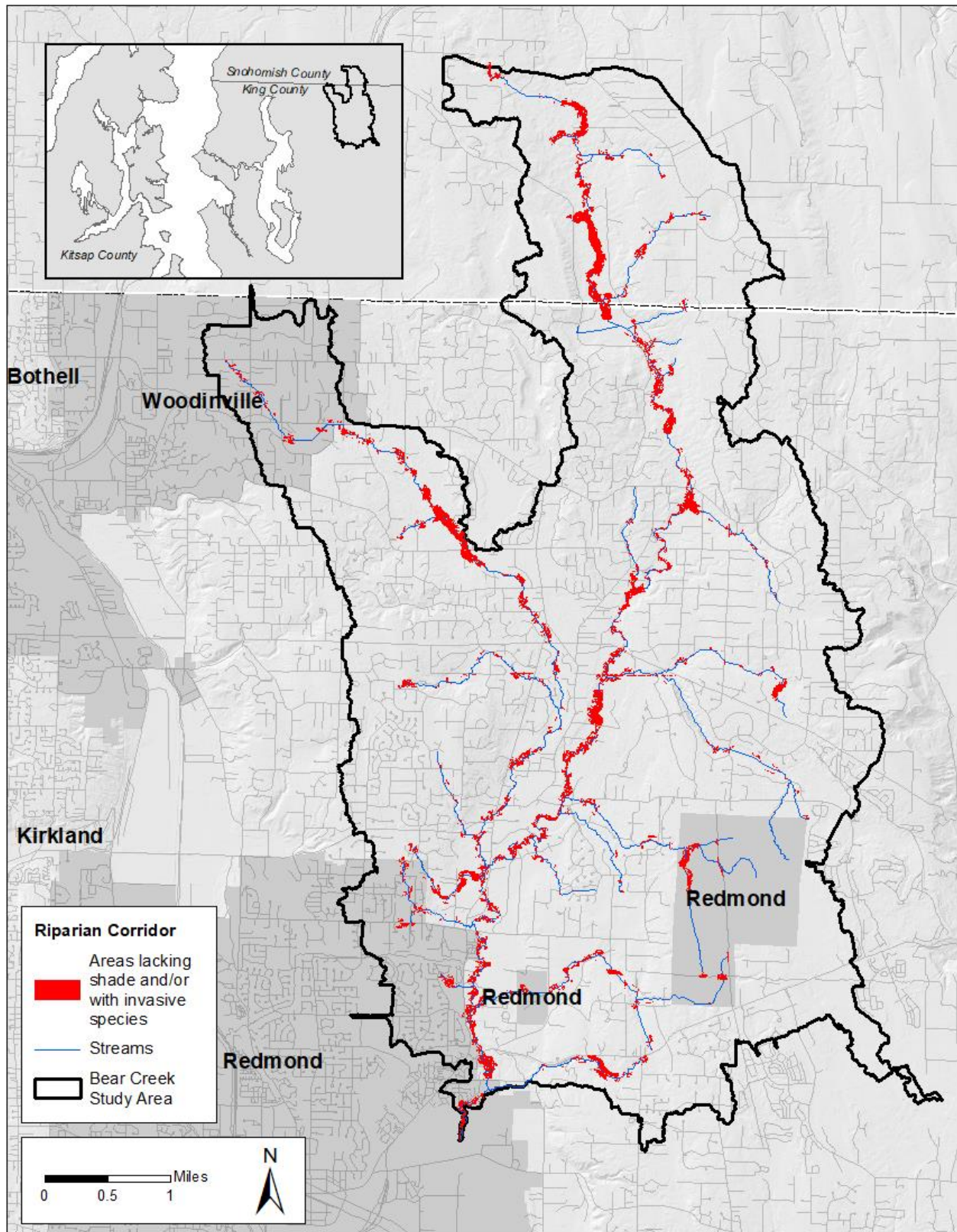


Figure 1. Areas identified as either lacking trees or with invasive species or both (within the 165-ft riparian buffer).

2.2 Prioritizing Lands for Native Vegetation Planting

Once the locations in the riparian corridor lacking trees or covered in invasive species are identified, they need to be prioritized for restoration. Other reports and studies have suggested ways to prioritize revegetation projects. The Green-Duwamish revegetation strategy (WRIA 9 Riparian Revegetation Work Group 2016) suggested the following types of sites should be considered highest priority for revegetation:

- Large parcels or multiple adjacent parcels with at least 1,000 km (3,200 ft) of stream or river;
- Areas that do not already have trees over more than 50 percent of the site within 150 ft of the stream or channel;
- Areas where plantings are most likely to be maintained in the future (e.g., publicly owned, conservation easements).

In order to potentially save costs on public involvement and project mobilization, Entranco (1994) recommended identifying strategic clusters of high priority stream parcels by considering:

- Parcels that are back to back and across the stream from each other, and
- Contiguous parcels with the same owner.

One large factor in restoration planning is landowner willingness. Because landowner willingness has not yet been surveyed, there is no way to map private landowner willingness using available GIS data or to use such information in the current analysis. If the site is on public land, it may be reasonably assumed that obtaining landowner approval/cooperation would be relatively likely for restoration activities like tree planting.

Taking the above information into consideration along with the goals of the Plan, criteria shown in Table 2 were determined to be the best and most useful criteria to use for prioritizing restoration tree planting. These criteria include areas that may benefit most from shade and riparian vegetation. The criteria also take into account the type of degradation present (reed canarygrass, mowed edges) and whether the degradation occurs on public lands. A point system was designed for the restoration criteria (Table 2) and applied to all parcels to prioritize areas for vegetation planting. Final prioritization for tree planting in the riparian corridor was based on the summation of the restoration scores.

Table 2. Criteria and point system for prioritizing planting projects along streams in study area.

Criteria	Points	Rationale
On public land	40	This criteria gets a high point value because of presumed agency cooperation.
Along Chinook-bearing waters	10	Trees planted here will eventually contribute to large wood in the streams.
Along headwater streams, defined as first-order streams (Strahler 1957)	10	Trees planted along the stream here help contribute to lower water temperatures at the stream's source.
Where water temperatures are known to exceed state standards for salmon streams (see King County 2017c)	10	Trees planted here help to lower or at least maintain water temperatures.
Along the Wildlife Habitat Network (WHN) (a regulated corridor that is ideally 300 ft wide and covered in native vegetation)	10	Trees planted here contribute to vegetated wildlife corridors.
No shade / mowed to edge of water	40	This criteria implicitly includes immediate proximity to stream and so gets a high point value.
Presence of invasive species	10	Reed canarygrass is an invasive monoculture that reduces biodiversity and native habitat. Parcels includes areas that lack shade <u>and</u> contain reed canarygrass or Himalayan blackberry, as identified in aerial imagery.

The rankings of high, medium, low, and very low for riparian restoration are defined as:

- High = 90-120 points
- Medium = 70-80 points
- Low = 20-60 points
- Very Low = 0-10 points

Parcels that scored only 0 or 10 points are assumed to not be a priority for restoration. This analysis reveals the following data for parcels that scored at least 20 points for riparian restoration (tree planting):

- King County – 262 parcels; points ranging from 20 to 120
- Redmond – 20 parcels; points ranging from 20 to 100
- Snohomish County – 13 parcels; points ranging from 20 to 60
- Woodinville – 16 parcels; points ranging from 20 to 80
- WSDOT – 1 parcel; 100 points

Lists of all parcel data will be provided to all partner jurisdictions.

Some parcels were examined but not ranked. Parcels that were fully vegetated are classified as “Vegetated.” Parcels whose riparian buffers were constructed because of houses or other development but whose remaining riparian buffer was vegetated are classified as “Vegetated small buffers.”

If needed (for King County because of the large number of parcels), a second tier of criteria may be applied for additional prioritization, which draws from the WRIA 9 Riparian Revegetation Work Group (2016) and Entranco (1994):

- A. Prioritize planting projects that cover the largest reaches. Give high priority to revegetating stretches of riparian area at least 100 ft long. Planting these relatively longer stream lengths would have a larger impact, all else being equal. The challenge with this method is if multiple land owners are involved. Table 3 illustrates the break-down of reach sizes where there is no shade on one or both sides of the stream. Some of the longest reaches run through wetlands and might not be good candidates for tree planting.

Table 3. Stream reaches with no shade on one or both sides of the stream.

Stream length (ft)	Number of reaches	Total feet	Total stream miles
>1000	10	17,544	3.3
500-1000	21	14,126	2.7
100-500	194	41,224	7.8
<100	621	20,467	3.9

- B. Prioritize planting projects that require permission of the fewest landowners. Parcel data may be used in combination with criteria to find those patches in need of revegetation that affect the fewest number of property owners. The benefit of this approach is that it would require the least number of willing landowners for planting.

2.3 Outreach

Education and outreach about the benefits of planting trees will be a critical component in encouraging landowners to plant trees. Because tree planting can be done voluntarily by landowners, the data generated in this study can be used for targeted outreach. Further, if incentive programs such as King County’s Public Benefit Rating System are available, landowners may be educated about such tax incentives, which provide a tax break when non-forested riparian buffers are planted in native vegetation.

Additionally, King County is tracking the number of trees being planted anywhere in the county as part of its Million Trees initiative⁴, and they have developed a mobile app where

⁴ <http://www.kingcounty.gov/services/environment/stewardship/one-million-trees.aspx>

individuals doing plantings can report their numbers. Information about this initiative and the app can be shared with landowners, and the app can be used to help inform King County when landowners are doing their own riparian plantings.

2.4 Beaver Management

Many new young trees and shrubs will be planted near streams when planting projects proceed as a part of this plan. Whenever tree planting restoration activities take place near water, there is a risk that beavers will move into the area. In these instances, beavers may cut some of the trees, build one or more dams, form one or more ponds, and establish an entirely new ecosystem. Beaver activity provides many environmental benefits, including flood control, groundwater recharge, pollution filtration, and habitat for a wide variety of fish and wildlife, including salmonids. Beaver may also present challenges for landowners, primarily related to flooding and tree cutting.

Solutions are frequently available to reduce or avoid flooding and help protect trees while allowing the beavers to remain on site. Beaver management in the Bear Creek Watershed will likely become increasingly important as Plan implementation progresses.

3.0 LAND CONSERVATION STRATEGIES

A second method for retaining riparian function or making improvements to the riparian corridor entails the permanent conservation of lands. Riparian buffers in the watershed are protected by critical areas regulations established in all partner jurisdictions. Regulatory buffer sizes were established based on the best available science for the protection of riparian functions. Buffers in the riparian study area range from 150 to 165 ft on each side of the stream depending on the jurisdiction. However, for the following reasons, land conservation is a viable alternative to relying solely on regulatory buffers to protect the riparian areas of the Bear Creek watershed:

- Some riparian areas had been degraded prior to the establishment of regulations, and public ownership would facilitate restoration activities.
- Regulations are not always adhered to.
- Regulatory buffers may be reduced as a result of alterations exceptions under specific circumstances outlined in agency code.

Land conservation of riparian areas is accomplished by one of the following means:

- Land acquisition: acquisition in fee, which provides full control of the land.
- Conservation easement: conveyance of development rights necessary for protection of specific conservation values from a property's landowner to a municipality, land trust, or other nonprofit organization. The terms of easements vary, but generally speaking, in the areas covered by the easement, no new development may take place.
- Tax incentives: programs such as current use taxation programs in King County that offer an incentive (a property tax reduction) to landowners to voluntarily preserve open space on their property. Once enrolled, a participating property is assessed at a "current use" value, which is lower than the "highest and best use" assessment value that would otherwise apply to the property.

Of these three strategies, acquisitions and easements are the two examined in this Plan. Because tax incentive programs cannot be guaranteed in the long term, they were not included in this analysis. However, in many instances the landowner will likely never withdraw from the incentive program, because, for example, the parcel is too small to divide and the portion in the incentive program is wetland or stream riparian area. In these instances the protection is effectively permanent. The Waterways 2000 Program (King County 1996) mapped parcels in the Bear Creek watershed they recommended for tax incentive programs, and many of those parcels were subsequently enrolled. Programs such as the Public Benefit Rating System in King County are worthwhile and should be actively pursued as a valid conservation measure.

Land conservation, especially acquisition in fee, may result in additional lands for King County to manage. The implications of increasing the management requirements by King County is not addressed in this analysis.

Public ownership of undeveloped lands protects them from future development and more easily facilitates the retention (or improvement) of water quality and wildlife functions. Permanently undeveloped tracts of land can result in large vegetated areas that function as wildlife corridors in addition to performing water quality functions. Permanent protection can ensure areas that are larger than regulated buffers are retained in forest.

Conservation easements are used to ensure development does not occur in a particular location. Conservation easements may be placed on undeveloped parcels or on portions of developed parcels, regardless of the size of the property, although if the amount of undeveloped riparian area is smaller than the regulatory buffer, it may be assumed the regulations will keep the remaining portion undeveloped.

Land conservation can be used to protect the highest value lands from a stormwater perspective or an ecological perspective, or it can be used to acquire lands most in need of restoration. Both strategies are valid. Because this is a stormwater plan, the preferred strategy prioritizes those parcels with the highest stormwater and ecological value: undeveloped, forested riparian buffers.

3.1 Identifying Lands for Conservation

The riparian corridor parcel dataset described in Section 2.1 was examined for potential conservation. Publicly owned parcels (136), Tract parcels (55), and Home Owners Associations (HOA) parcels (5) were removed from consideration for land conservation because they are already publicly owned or otherwise conserved. Parcels were also removed from consideration if an easement is already in place (13 parcels).

The remaining privately owned parcels were attributed as to whether they:

- lack trees along the stream
- lack trees in the regulated buffer
- are adjacent to public, Tract, and HOA parcels
- are along Chinook-bearing waters
- are along headwater streams, defined as first-order streams
- are along the WHN

Potential conservation parcels were put into one of the following categories:

- *Undeveloped*: may be forest, wetland, or grass. Parcels that appeared to be undeveloped in aerial imagery were verified as such by checking the parcel data for the assessed (King County) or market value (Snohomish County) of any improvements on the lot.
- *Potential Easement*: development is present on some portion of the parcel as well as the riparian corridor. Oftentimes an area larger than the regulated buffer is present

and undeveloped within the parcel. These parcels may warrant further examination during Plan implementation, as this designation (a) assumes acquisition and demolition of existing structures is undesirable when in fact that may be the best option in a specific location, and (b) assumes there is a compelling reason to purchase an easement when stream buffers are protected regulatorily.

- *Limited Options:*
 - Parcels with riparian corridors reduced in size and constrained by roads, driveways, or buildings (including houses).
 - Parcels covered with homes and relatively small yards (although it is possible to purchase lands with homes on them and demolish the buildings, this analysis assumes that is typically undesirable).
 - Parcels with only a very small portion of the parcel in the riparian buffer (can target for tree planting efforts, but assumes regulations protect buffer from development).

3.2 Prioritizing Lands for Conservation

Once the parcels were fully attributed, points were applied to parcels based on the scoring system shown in Table 4. Criteria shown in Table 4 were determined to be the best and most useful criteria to use for prioritizing conservation of riparian parcels. Emphasis is placed on those areas already fully forested and undeveloped as well as those areas adjacent to lands already protected. This approach to land conservation focuses on acquiring and protecting the highest value lands from a stormwater and an ecological perspective. By protecting lands adjacent to lands already in protection, connectivity of conserved lands is increased. Final prioritization for conservation in the riparian corridor was based on the summation of the conservation scores.

Table 4. Criteria and point system for prioritizing planting land conservation strategies in the study area.

Criteria	Points	Notes
Adjacent to public, Tract, and HOA parcels	20	Parcels adjacent to parcels that are already protected increase the contiguously protected area and may fill in gaps in protected areas.
Along Chinook-bearing waters	10	Trees planted here will eventually contribute to large wood in the streams.
Along headwater streams, defined as first-order streams	10	Trees planted along the stream here help contribute to lower water temperatures at the stream's source.
Along the Wildlife Habitat Network	10	Trees planted here contribute to vegetated wildlife corridors.
Full regulated buffer is forested	30	No apparent restoration activities are needed; most cost-effective; zero wait time for tree-growth.
Parcel is undeveloped	30	No impervious surface present. Will not incur demolition costs.
Development pressure	20	Parcels that are not currently subdivided as small as they may be.
Special designation	10 per occurrence	Identified in wetland analysis (King County 2017b) or King County Land Conservation Initiative (which includes salmon recovery priorities).
Limited Options designation	-30	This designation is assigned to parcels that have little or no options for conservation under their current land cover. However, they may be desirable for large-scale efforts involving surrounding parcels. Therefore they are included but a negative score is assigned to them to de-prioritize them.

The rankings of low, medium, and high are defined as:

- High = 100-140 points
- Medium = 70-90 points
- Low = 20-60 points
- Very Low = 0-10 points

Of the 115 parcels identified as having “limited options,” 75 scored a negative number (from -10 to -30). Those 75 parcels are identified as “Limited Options,” and no action is identified for those parcels. The remaining 40 limited options parcels are included in the low and very low categories because they scored between 0 and 30 points.

Parcels that scored only 0 or 10 points are assumed to not be a priority for conservation. Of the 741 parcels that were scored, 524 scored at least 20 points for conservation. The analysis reveals the following data for parcels that scored at least 20 points for conservation:

- King County – 444 parcels; points ranging from 20 to 140
- Redmond – 16 parcels; points ranging from 20 to 110
- Snohomish County – 48 parcels; points ranging from 30 to 120
- Woodinville – 16 parcels; points ranging from 20 to 100

For those parcels that are developed and cannot be subdivided, conservation easements are a potential option. For those parcels that are developed and can be subdivided, both conservation easements and acquisition are options; however, piecemeal public ownership is often not desirable, so adding easements over time as landowners were willing may be more feasible.

Costs of acquisition were calculated by first obtaining the combined assessed land value and assessed improved value (value of improvements, such as houses) from King County parcel data and the combined market land value and market improved value from the Snohomish County parcel data. Next, a multiplier of 115 percent⁵ was applied to those values to account for the difference between the assessed value and appraised value. Costs of easements were calculated by taking the assessed land value from King County parcel data and the market land value from the Snohomish County data and using a multiplier of 40 percent⁶. Easement calculations assumed less than half the parcel would be put in easement.

Costs for acquisition for each partner jurisdiction are presented in Table 5. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total acquisition costs are estimated to be \$37,859,000 if all 128 parcels identified for potential acquisition were purchased, including those prioritized as Low and Very Low. Total costs for acquisition in priority basins and remaining High and Medium ranked parcels would be \$31,753,000.

Table 5. Cost estimates for all 128 parcels identified for potential acquisition. Priority catchments described in Section 4.2 are identified separately.

Prioritization Ranking	Catchment	Cost	number of parcels
King County			
High	BEA300	\$43,000	1
High	All others	\$10,087,000	28
Medium	All others	\$13,060,000	50

⁵ 15 percent is added to the assessed value because appraisals were running higher than assessed value by about 15 percent in 2015 and 2016.

⁶ 40 percent assumes the following: (a) the amount of the parcel that would be placed under easement would be less than 50 percent and more than 1 percent, and 25 percent is the average between 1 and 50, and (b) 15 percent is added to the 25 percent to account for the difference between assessed value and appraised value.

Low	BEA120	\$1,044,000	3
Low	BEA300	\$32,000	1
Low	All others	\$5,645,000	18
Redmond			
High	All others	\$1,611,000	1
Medium	All others	\$145,000	2
Snohomish County			
High	BEA640	\$363,000	1
High	BEA660	\$1,179,000	4
Medium	BEA660	\$572,000	3
Medium	All others	\$1,535,000	6
Low	BEA660	\$281,000	2
Low	All others	\$460,000	4
Woodinville			
High	BEA850	\$292,000	1
Medium	BEA850	\$1,114,000	2
Medium	All others	\$394,000	1

Costs for easements for each partner jurisdiction are present in Table 6. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total easement costs are estimated to be \$210,682,000 if easements were purchased on all 538 parcels identified for potential easements, including those prioritized as Low and Very Low. Total costs for easements in priority basins and remaining High and Medium ranked parcels would be \$28,972,000.

Table 6. Cost estimates for all 538 parcels identified for potential easements. Priority catchments described in Section 4.2 are identified separately.

Prioritization Ranking	Catchment	Cost	number of parcels
King County			
High	All others	\$590,000	1
Medium	All others	\$16,389,000	41
Low	BEA120	\$3,125,000	6
Low	BEA300	\$1,571,000	5
Low	All others	\$109,785,000	290
Very Low	BEA120	\$1,710,000	8
Very Low	All others	\$34,435,000	111
Redmond			
Medium	All others	\$251,000	1
Low	All others	\$29,330,000	12
Snohomish County			
Medium	BEA660	\$444,000	2
Low	BEA640	\$201,000	1
Low	BEA660	\$3,058,000	17
Low	All others	\$1,728,000	8
Very Low	BEA660	\$624,000	4
Very Low	All others	\$793,000	6
Woodinville			
Low	BEA850	\$1,521,000	5
Low	All others	\$1,668,000	7
Very Low	All others	\$3,468,000	13

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APPENDIX E: Public Engagement Summary

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Comments on the Draft Bear Creek Watershed Management Study (Study) were received during the public comment period (February 21, 2018 through March 21, 2018) via an online questionnaire, email and handwritten submittals, and at the public meeting on March 7, 2018. The themes of these comments are listed in Table 1.

Table 1. Themes of written and verbal comments at the Public Meeting 3 and from online and email submittals.

Themes	How Addressed in the Study
Community members were excited about what they can do to help improve the watershed and reduce runoff through tree planting, reducing use of chemicals and rain barrels and volunteering to plant trees, etc.	Public engagement is a recommended strategy to train and supports local community members to effectively participate and impact the Study goals. The program will include methods to connect the community to funding and non-governmental organizations (NGOs) that support small projects and volunteers for stream monitoring. Chapters 4 to 7 of the Study present some non-structural strategies that the community members can participate in to help improve water quality and habitat in the watershed.
Provide general education and community awareness of the importance of the Bear Creek watershed, the value of a more natural looking streams and "backyard" areas, and how to get more involved.	As above, the Study recommends to educate the residents and visitors on the importance of the watershed through an outreach program. Efforts to conserve and restore lands to a more natural setting are a key recommendation of providing healthy habitat and clean water. These efforts may be through wetland, riparian and instream restoration efforts and conservation of healthy land located along the streams. Chapters 5 through 7 address these types of recommendations. In addition, community members will be able to be a part of this effort by planting trees on their own land or volunteering on local tree planting projects.
There were a few strong comments about the importance of future coordination when beginning to implement the Study with various stakeholders already involved with local conservation and restoration outreach and projects, communities and groups already actively partaking in local stormwater and water quality concerns, and residents wanting to partake in the outreach process of the Study once it is implemented. Some groups mentioned were Water Tenders, tribes, Forterra, Willowmoor community group, etc.	Various stakeholders and the public have been involved with partaking in workshops and providing comments (Appendix E of the Study documents this process). The Study recommends to continue with the Partners and to have an open approach with the various stakeholders and community interest groups. In addition, many complementary efforts where these relationships are already ongoing will help to further along the process for the stormwater management study.

Themes	How Addressed in the Study
Many people gave favorable opinions about stormwater ponds. They preferred natural looking ponds. Some expressed a desire to have community use of the area, clean and maintained areas, and concerns about safety for children.	Involvement of the local community in stormwater facility siting and design is a recommendation of the Study. Project managers are recommended to include local residents and incorporate their input.
Interest was expressed in getting technical assistance, design plans, and financial assistance to install raingardens. Some interest expressed in technical and financial assistance for a cistern, tree planting, and invasive plant removal.	A program with incentives, technical assistance, and rebates is recommended for green stormwater infrastructure on private land for private property owners to disconnect impervious surfaces from direct drainage systems and infiltrate or disperse runoff via small scale BMP (Chapter 4 of the Study).
One commenter asked when the strategies and catchments identified for after the near-term would be completed.	Following the completion of the identified near-term actions, it is recommended that the implementation plan be updated based on the successes and challenges found during the first 10 years.
One commenter questioned how the jurisdictions will use their authorities to improve stormwater management from new development? They also questioned why an in-lieu fee was proposed.	Existing stormwater code requirements (<i>Stormwater Management Manual for Western Washington</i> or equivalent) are believed to adequately mitigate stormwater runoff as those sites. However, at locations where the adequate stormwater management controls are not feasible, the Study recommends that developers pay an in-lieu fee. The collection these fees would be used for regional stormwater facilities or habitat restoration.
A few members of audience at the public meeting expressed concern about the development growth and how this issue feeds back into the work done on the Study.	This was addressed in the public meeting ¹ . The City of Redmond and other jurisdictions have stormwater management programs that include stormwater fees as well as complementary efforts. All municipalities in Washington State are required to account for population growth and this is done as part of development of their Comprehensive Land Use plans. Stormwater mitigation for new development is 100 percent paid for by the developer.

¹ https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public3/BCP_public3_Notes.pdf

Themes	How Addressed in the Study
One commenter asked how the strategies aligned with the load allocations defined by the Bear Creek TMDL.	The load allocations from the TMDL and prioritized strategies were constructed under a different set of goals and with different models.
A few individuals expressed concerns about possible flooding from wetlands on neighboring properties.	Restoring vegetation around wetlands will not cause additional flooding.
A few individuals expressed concerns about the unintended impacts and damage caused by beavers to flooding of homes and roads.	There are a few different solutions that may allow property owners, vegetation, and the local beavers to all co-exist. There are various engineered solutions available for property owners to review on the King County (KC) beaver management website . ²
There were a few members of the audience at the Public Meeting concerned about whether we would be assessing the conditions of land before we implemented these projects. There was a concern mentioned around unintentionally saturating the ground and causing landslides, diseased trees and in other cases trees that remove high volumes of water from the ground. Climate change was mentioned a few times with respect to increased stormwater.	In general, any future work will require feasibility assessments as there are many things to consider at each location. If a method is found to not be feasible, we must come up with another strategy. With respect to climate change, we noted that we are working with UW and the Climate Impacts Group, and have modelled the impacts for KC. This work is part of a later phase in another study.
One concern was expressed that a 165 ft buffer along the stream was too much.	This is a regulated critical area. (KCC 21A.24)

² <https://www.kingcounty.gov/beavers>

Themes	How Addressed in the Study
A property owner expressed concern about the unintended impacts by the public accessing streams when salmon are spawning.	As above, the Study recommends to educate the residents and visitors on the importance of the watershed through an outreach program.
One person questioned if there would be a special purpose district to fund the implementation of the Study.	This was addressed at the public meeting ³ . There is no intent for new taxing districts.
Forterra suggested using their prioritization method of parcels for planting projects, conservation and strategic communication efforts.	The partners look forward to partnering with Forterra as part of the riparian and wetland conservation effort in Bear Creek. The project team values the prioritization method employed by Forterra and recommends their methods be evaluated and combined with the Study's method in future prioritization efforts.
One commenter questioned why Evans Creek and lower Bear Creek were excluded.	Evans Creeks and Bear Creek downstream of the confluence with Evans Creek were excluded from the Bear Creek Watershed Management Study. Their exclusion was to increase the feasibility of this novel effort for multi-jurisdictional watershed management. Expansion to Evans Creek and lower Bear Creek is recommended in future watershed planning efforts.

Efforts were made to reach a broad group of stakeholders and residents in the project area and to generate interest to partake in online forums, technical presentations, workshops, webinars, and community and public meetings included email notifications to group audiences, direct mailings, news releases, local print ads and notification through online webpages (articles, newsletters, event calendars, social media, and local news). Table 2 is a summary of these public engagement elements.

³ https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public3/BCP_public3_Notes.pdf

Table 2. Summary of public engagement elements.

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
PARTNER MEETINGS					
Partners: King County (KC), Snohomish County, City of Redmond, City of Woodinville, Washington State DOT	- Determine specific engagement goals and messaging for each of the meetings, based on stakeholder input and Bear Creek Watershed Management Study (Study) status - Ensure alignment and support for public and stakeholder engagement	Monthly, beginning 02/2015 – 3/27/2018	Partners	n/a	3-10
WEBINARS					
Technical Webinar #1 ⁴	- Update on existing conditions - Share study findings on watershed modeling, land-use conditions, regulations and existing stormwater infrastructure and juvenile salmon habitat use	11/15/2016	Partners, stakeholders (Bear Creek residents, NGOs ⁵ , tribes, state & local government)	Attendees mostly asked clarifying questions about technical and scientific data, methods to review and incorporate data, and understanding the differences between jurisdictions. There was a strong concern expressed about the methodology used on fish habitat survey and suggestions were given. Extensive follow up communication occurred post meeting on this topic.	45
Technical Webinar #2 ⁶	- Update on existing conditions - Share study findings on water quality, B-IBI, wetland and riparian land cover assessments	12/12/2016	As above	Attendees asked clarifying questions about technical and scientific data, methods to review and incorporate data, and expressed interest in being able to review data. All data is publically available online.	25

⁴ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopd>

⁵ non-governmental organizations

⁶ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshope>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
WORKSHOPS					
Technical Workshop #1 ⁷	• Introduce Study goals and the role of the Partners • To generate helpful information on the project goals and current conditions • To help build understanding among different perspectives among participants • Share information on Existing and Future Conditions, Regulations and Existing Stormwater Infrastructure, Strategies Under Consideration and Related Stormwater Management Efforts	11/4/2015	Partners, stakeholders (Bear Creek residents, NGOs, tribes, state & local government)	Attendees expressed high importance of the project to their work and the community. There were strong suggestions that the Study include more than just stormwater regulations/constructed BMP solutions and focus on fish recovery and that it have measurable goals. Attendees provided pros and cons on strategies. A detailed summary ⁸ is provided on the project document webpage.	27
Technical Workshop #2 ⁹	• Give update on example problems and solutions • Gather input from stakeholders through exercises	3/29/2017	As above	Attendees asked clarifying questions about technical information on the key findings and solutions (including the process and criteria used to identify solutions). Table discussions provided a wide range of comments. A detailed summary ¹⁰ is provided on the project document webpage.	36

⁷ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopa>

⁸ <https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/Tech1-Notes.pdf>

⁹ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopf>

¹⁰ https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/tech2/tech2_notes.pdf

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
PUBLIC MEETINGS					
Public Meeting #1 ¹¹	• Introduction to project • Introduce process for developing the Study, gathering community input, and evaluating current conditions • Brief introduction to strategies under considerations.	2/25/2016	Public, stakeholders and partners	Attendees asked clarifying questions about technical data and modeling methods. A few suggested more controls on development and clear cutting, having more stringent standards, and some had concerns about the costs. There was a suggestion towards more preservation and buffering of creeks. A detailed summary ¹² is provided on the project document webpage.	35
Public Meeting #2 ¹³	• Update on existing conditions • Share the study findings, i.e. specific water quality problems being addressed • Solicit input about potential toolbox of stormwater mitigation strategies	10/13/2016	As above	Attendees mostly asked clarifying questions about technical and scientific data, costs and technical details of different strategies and gave feedback on various approaches. Attendees generally favored effective and integrated approaches. There was strong support for preservation and a desire to continue public engagement. A detailed summary ¹⁴ is provided on the project document webpage.	36

¹¹ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopb>

¹² <https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/Public1-Notes.pdf>

¹³ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopc>

¹⁴ <https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/Public2/Public2-Notes.pdf>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
PUBLIC MEETINGS (continued)					
Public Meeting #3 ¹⁵	• Presentation of draft Study • Share recommendations • Provide time for public comments	3/7/2018	Public, stakeholders and partners	Attendees mostly asked detailed questions about recommendations (such as raingardens, drywells, ponds) and restoration methods, general questions about increased development and regulations, and generally gave favorable feedback on the outreach methods and recommendations. A summary of the themes of comments are presented in Table 1 of this Appendix. A detailed summary ¹⁶ of the comments and questions during the question and answer period of Public Meeting is provided on the project document webpage.	74
ONLINE FORUM					
KC County Online Forum ¹⁷	• Share Draft Study • Share recommendations • Seek comments on draft Study	2/15/2018 - 3/21/2018	All	The comments from this forum were included in the summary in Table 1 of this Appendix. A detailed listing ¹⁸ of the responses is provided on online forum webpage.	47 visitors, 3 responses

¹⁵ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopg>

¹⁶ https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public3/BCP_public3_Notes.pdf

¹⁷ <https://www.peakdemocracy.com/5976>

¹⁸ <https://www.peakdemocracy.com/5976>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
King County IN-PERSON PRESENTATIONS / CROSS PROMOTION EVENTS					
American Public Works Association Stormwater Managers Committee WA Chapter	Technical presentation	9/18/2015	Technical water experts	n/a	~30
American Water Resources Association WA Chapter	Technical presentation entitled "Using SUSTAIN (and HSPF) to Maximize Efficiencies in the Management of Stormwater."	5/16/2017	Scientists, planners, engineers	n/a	~30
Bear Creek /Sammamish Valley Community Service Area	Attended meeting and give short statement and share related handouts.	11/2015 6/05/2017	Bear Creek & Sammamish Valley residents	n/a	~30, 45
City of Redmond Public Meeting for Monticello Creek (Firehouse #17)	Attended meeting and give short statement about the upcoming Public Meeting 2 on October 13, 2016.	9/22/2016	Redmond residents	n/a	~30
DNRP WLRD Science Seminars	Gave presentations on the Study project and study findings: " Juvenile Chinook habitat use in the Bear Creek Watershed ¹⁹ "; Water Quality Status and Trends in Bear Creek ²⁰	11/7/2016 11/2/2017	Local government, utilities, universities, public, NGOs	n/a	80 plus

¹⁹ <http://your.kingcounty.gov/dnrp/library/water-and-land/science/seminar-2016/S1-2-Juvenile-Chinook-Habitat-Bear-Creek-Kubo.pdf>

²⁰ <http://your.kingcounty.gov/dnrp/library/water-and-land/science/seminar-2017/S1-2-bear-creek-watershed-clark.pdf>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
King County IN-PERSON PRESENTATIONS / CROSS PROMOTION EVENTS (continued)					
Upper Bear Creek Community Unincorporated Area Council (Woodinville Library)	Gave short announcements about upcoming public meetings and gave project status updates.	2/23/2016 9/27/2016 3/28/2017 3/13/2018	Upper Bear Creek residents and stakeholders	n/a	15, ~15, 15, ~15
KC Water and Land Resources Division Science Section meeting	Presentations on the Study project and study findings	1/4/2017	Science Section employees	n/a	45
WRIA 8 Implementation Committee Meeting	Technical presentation “Bear Creek Watershed Stormwater Management Study” and update on status of project	9/1/2015 3/6/2018	Scientists, planners		72, 19
WRIA 8 Technical Committee Meeting	Technical presentation “Bear Creek Watershed Stormwater Management Study” and update on status of project	9/1/2015 2/14/2018	As above	n/a	Less than 72
WRIA 8 Salmon Recovery Council Meeting	Technical presentation on “ Juvenile Salmon Habitat Use in the Bear Creek Watershed ” ²¹ ; “ Draft Bear Creek Watershed Management Study ” ²²	1/19/2017 3/15/2018	Scientists, planners, elected officials	n/a	41, 38

²¹ http://www.govlink.org/watersheds/8/committees/1701/W8_SRC_Bear_Creek_JK_1_19_17.pdf

²² http://www.govlink.org/watersheds/8/committees/1803/Bear_Creek_watershed_Plan_WRIA8Councilmeeting.pdf

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
PROJECT WEBPAGE UPDATES					
Bear Creek Watershed Management Study project webpage ²³ populated and maintained	• Update on process • Provide resources	2015 and ongoing	All	n/a	n/a
Handouts, Notes and Presentations from Technical Webinar #1 ²⁴ posted	• Inform all on presentations shared at event • Submit for recordkeeping in KC TDRC library for future access	11/15/2016	All	n/a	n/a
Handouts, Notes and Presentations from m Technical Webinar #2 ²⁵ posted	As above	12/12/2016	All	n/a	n/a
Handouts, Notes and Presentations from Technical Workshop #1 ²⁶ posted	As above	11/2015	All	n/a	n/a

²³ <http://www.kingcounty.gov/bearcreekstudy>

²⁴ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopd>

²⁵ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshope>

²⁶ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopa>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
PROJECT WEBPAGE UPDATES (continued)					
Handouts, Notes and Presentations from Technical Workshop #2 ²⁷ posted	• Inform all on presentations shared at event • Submit for recordkeeping in KC TDRC library for future access	3/29/2017	All	n/a	n/a
Handouts, Notes and Presentations from m Public Meeting #1 ²⁸ posted	As above	2/2016	All	n/a	n/a
Handouts, Notes and Presentations from Public Meeting #2 ²⁹ posted	As above	10/2016	All	n/a	n/a
Handouts, Notes and Presentations from Public Meeting #3 ³⁰ posted	As above	3/22/2018	All	n/a	n/a

²⁷ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopf>

²⁸ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopb>

²⁹ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopc>

³⁰ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopg>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
PROJECT WEBPAGE UPDATES (continued)					
<u>Current Conditions reports</u> ³¹ posted	Update the public with posted reports: • <u>Bear Creek Watershed-Scale Stormwater Plan: Existing Water Quality Conditions</u>³² • <u>Analysis of Long-term Trends in Bear Creek Water Quality</u>³³ • <u>Assessment of Bear Creek Watershed Riparian Areas</u>³⁴ • <u>Assessment of Bear Creek Watershed Wetlands</u>³⁵ • <u>Bear Creek Watershed Juvenile Salmon Habitat Use</u>³⁶ • <u>Benthic Macroinvertebrate Status and Trends in the Bear Creek Study Area</u>³⁷ • <u>Stormwater Regulations and History Report</u>³⁸	5/2017 6/2017 10/2017	All	n/a	n/a

³¹ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx>

³² <http://your.kingcounty.gov/dnrp/library/2017/kcr2874/kcr2873.pdf>

³³ <http://your.kingcounty.gov/dnrp/library/2017/kcr2875/kcr2874.pdf>

³⁴ <http://your.kingcounty.gov/dnrp/library/2017/kcr2876/kcr2875.pdf>

³⁵ <http://your.kingcounty.gov/dnrp/library/2017/kcr2876/kcr2876.pdf>

³⁶ <http://your.kingcounty.gov/dnrp/library/2017/kcr2877/kcr2877.pdf>

³⁷ <http://your.kingcounty.gov/dnrp/library/2017/kcr2878/kcr2878.pdf>

³⁸ <https://your.kingcounty.gov/dnrp/library/2017/kcr2937/kcr2937.pdf>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
PROJECT WEBPAGE UPDATES (continued)					
Draft Study posted	• Provide draft Study for public review • Inform on upcoming Public Meeting 3 date and location, share agenda, related FAQ • Submit for recordkeeping in KC TDRC library for future access	2/21/2018 - 4/4/2018	All	n/a	n/a
Final Study ³⁹ posted	• Notify public of submitted Study • Submit for recordkeeping in KC TDRC library for future access.	4/4/2018	All	n/a	n/a
EMAIL CAMPAIGNS					
KC employee email distribution list	Inform on Technical Workshop 2.	3/2017	KC employees	n/a	10,000 plus

³⁹ <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
EMAIL CAMPAIGNS (continued)					
Partners and stakeholders email list	Inform on project updates, meeting notifications, news items and other milestones through Save the Date, Invite and Reminder emails.	02/2016 10/2016 3/2017 4/2017 5/2017 2/15/2018 4/4/2018	Partners, stakeholders (Bear Creek residents, NGOs, tribes, state and local government)	n/a	160
KC DNRP Executive's Weekly Summary Report	Updates of significant milestones to the KC DNRP and WLRD management teams.	10/2016 11/2016 3/2017 2/13/2018 3/16/2018 4/3/2018	KC DNRP management team, WLRD staff	n/a	400 plus
KC EcoNet ⁴⁰ and STORM NET	As above	2/21/2018	Stakeholders that collaborate to improve environmental and community health	n/a	800 plus

⁴⁰ <http://www.kingcoconet.org/>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
HARD COPY DISTRIBUTION					
Direct mailer " How healthy is Bear Creek? ⁴¹ " and handout at Public Meeting 2	• Inform on watershed planning process and provide resources for all interested parties • Given to City of Redmond and Woodinville for distribution • Provided at: Woodinville Library, Woodinville City Hall, Redmond City Hall, Maltby Community Club, Redmond Senior Center, Kiosk–Redmond Watershed, KC Trails, Paradise Valley Conservation Area, and Equestrian trails • Posted online	9/26/2016 10/13/2016	Bear Creek residents and homeowners, Partners (for distribution within their communities)	n/a	11,039
Postcard mailer and "Save the Date" handout ⁴² at Public Meeting 2	As above	As above	As above	n/a	As above

⁴¹ <http://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/BCP-Brochure.pdf>

⁴² https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public2/BCP_Public-2_handout.pdf

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
HARD COPY DISTRIBUTION (continued)					
Postcard mailer "Save the Date" for Public Meeting 3	• Inform on Public Meeting information • Inform on public comment period • Inform on where to review draft Study and where to submit comments	2/16/2018	Bear Creek residents and homeowners, Partners (for distribution within their communities)	n/a	11,366
Bear Creek Watershed Management Study Summary ⁴³	Eight page summary of the Study shared with officials, public meeting attendees, and the online public	2/16/2018 3/7/2018	As above	n/a	100 plus
PRINT ADS					
Woodinville Weekly (English and Spanish) and posted in online newsletter	• Posting relevant and interesting project updates/meeting notices • Broadcasting updates to website	10/7/2016	All	n/a	22,537

⁴³ <https://your.kingcounty.gov/dnrp/library/2018/kcr2955.pdf>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
King County MEDIA RELEASE					
KC DNRP Media Release (Spanish for the 2018 releases)	• Posting relevant, and interesting project updates and meeting notices • Broadcasting updates to webpage • Encourage partners to reshare • Inform residents of upcoming events and deliverables • Notify through Redmond Reporter, Woodinville Weekly, Redmond Patch, Woodinville Patch, Seattle Times, Everett Herald, The Snohomish Tribune, City of Redmond, City of Woodinville, Snohomish County	10/2016 2/21/2018 ⁴⁴ 3/6/2018 ⁴⁵	All	n/a	All
King County ONLINE POSTINGS					
KC Main page and events calendar	As above	2/21/2018	All	n/a	n/a
KC DNRP Green Blog	As above	10/10/2016 ⁴⁶	All	n/a	50 views

⁴⁴ <https://www.kingcounty.gov/depts/dnrp/newsroom/newsreleases/2018/February/21-Bear-Creek-watershed-plan.aspx>

⁴⁵ <https://www.kingcounty.gov/depts/dnrp/newsroom/newsreleases/2018/March/06-bear-creek-espanol.aspx>

⁴⁶ <https://kingcountygreen.com/2016/10/10/how-healthy-is-bear-creek-its-time-to-find-out/>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
King County ONLINE POSTINGS (continued)					
KC Main and DNRP Twitter " What's Up with Stormwater " ⁴⁷ (2016) page postings	As above	10/10/2016 2/21/2018 ⁴⁸	All	n/a	n/a
KC DNRP Facebook English pages	As above	10/13/2016 ⁴⁹	All	n/a	n/a
KC DNRP Facebook Spanish pages	As above	10/13/2016 ⁵⁰	All	n/a	n/a
Puget Sound Starts Here online posting	As above	3/6/2018 ⁵¹	All	n/a	n/a
Unincorporated Areas (UA) Community News post	As above	10/2016 ⁵² 11/2016 ⁵³ 2/16/2018 ⁵⁴	Bear Creek residents	n/a	n/a

⁴⁷ <https://twitter.com/KCDNR/status/785614255106043905>

⁴⁸ <https://twitter.com/KCDNR>

⁴⁹ <https://www.facebook.com/events/1260259020672096>

⁵⁰ <https://www.facebook.com/events/261898370878291/>

⁵¹ <https://www.facebook.com/events/108969273246171/>

⁵² <http://your.kingcounty.gov/dnrp/newsletters/ua-news-102016.htm>

⁵³ <http://your.kingcounty.gov/dnrp/newsletters/ua-news-112016.htm>

⁵⁴ <https://aqua.kingcounty.gov/dnrp/newsletters/ua-news.htm>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
OTHERS ONLINE POSTINGS					
City of Redmond "Focus on Redmond" article	As above	10/20/2016 ⁵⁵	Redmond residents	n/a	n/a
NextDoor calendar posting	Inform on date and location of Public Meeting 2	10/20/2016	Bear Creek residents	n/a	n/a
Woodinville Weekly calendar posting	As above	2/15/2016 ⁵⁶ 10/05/2016 ⁵⁷ 10/10/2016 ⁵⁸ 2/13/2017 ⁵⁹ 2/21/2018 ⁶⁰	Woodinville residents	n/a	200-2000 weekly
Woodinville Wire News calendar posting	As above	10/1/2016 2/21/2018 ⁶¹	Woodinville residents	n/a	n/a

⁵⁵ <https://issuu.com/cityofredmond/docs/2016-fall-focus-web>

⁵⁶ <http://www.nwnews.com/index.php/news-features/news-2/12644-learn-about-the-bear-creek-watershed-scale-stormwater-plan>

⁵⁷ <http://www.nwnews.com/index.php/community/community-events/13710-bear-creek-watershed-water-quality-planning-public-meeting>

⁵⁸ <http://www.nwnews.com/index.php/community/community-events/13722-community-meeting-oct-13-on-bear-creek-watershed-stormwater-plan>

⁵⁹ <http://www.nwnews.com/index.php/news-features/news-2/14456-upper-bear-creek-community-council-public-forum>

⁶⁰ http://nwnews.com/index.php/community/events#/event/7018698-bear-creek-watershed-management-study-public-meeting?radius_miles=25&location=98072-woodinville§ions=all&date=2018-03-06

⁶¹ http://www.icontact-archive.com/OBEMGylzLCWqkIFL1bHj2u1_UNMkjiHs?w=3

APPENDIX F: Identified Structural Stormwater Strategies for Entire Study Area

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1.0 INTRODUCTION

The Permit-defined objective of watershed-scale stormwater planning is to identify a stormwater management strategy or strategies that would result in hydrologic and water quality conditions that fully support “existing uses,” and “designated uses,” as those terms are defined in WAC 173-201A-020, throughout the stream system. Poor water quality (temperature, dissolved oxygen, fecal coliform bacteria, turbidity, and toxicants) and altered hydrology in the Bear Creek study area are significant factors in causing the stream and its tributaries to not meet their designated uses (King County, 2017).¹ With the exception of temperature and dissolved oxygen, overall water quality in the Bear Creek watershed appears to be improving since the 1970s. Current fecal coliform concentrations indicate a potential risk to human health, but the concentrations have decreased over the past three decades. Temperature and dissolved oxygen levels are not conducive for salmonids (as represented by violations of the state water quality standards), and long-term trends have indicated that conditions have worsened over the past four decades. The average qualitative Benthic Index of Biotic Integrity (B-IBI) score in the study area is considered “fair.” The “flashiness” of a stream has been linked to poor macroinvertebrate health as measured by B-IBI. Both water quality and quantity concerns may be improved through stormwater management and treatment.

Stormwater best management practices (BMPs) include both low impact development (LID) type facilities, such as pervious pavement or bioretention systems, and more traditional facilities, such as stormwater detention and treatment. LID BMPs generally address stormwater impacts near the source, and traditional facilities are more regional in nature, serving larger areas further away from the source. The impacts of stormwater BMPs are most readily modeled and comprised the primary component of the SUSTAIN optimization model scenarios.

SUSTAIN optimization modeling was used to determine the number and type of structural strategies required to achieve instream targets (Table 7 in Section 2.2 of the main document) for water quality and flow metrics for all catchments (see King County [2018]² for a description of how the structural strategies were modeled). The structural stormwater strategies identified for the prioritized catchments and for the entirety of the study area are presented below.

¹ King County. 2017. Bear Creek Watershed-scale Stormwater Plan: Existing Water Quality Conditions. Prepared by Timothy Clark and Eric Ferguson, Water and Land Resources Division. Seattle, WA.

² King County. 2018. Watershed Model Development for Bear Creek Stormwater Retrofit Planning Project. Prepared by Scott Miller and Jeff Burkey, Water and Land Resources Division. Seattle, WA.

2.0 IDENTIFIED STRUCTURAL STRATEGIES FOR THE ENTIRE STUDY AREA

The modeled stormwater solution to meet Permit-defined objectives in the entire study area is estimated to cost about \$1.11 billion dollars or an average of \$43 million per square mile (dollar amounts are non-discounted 2017 dollars). This includes all costs incurred by public institutions and private firms and individuals. Tables 1 through 4 summarize the identified number of BMPs by jurisdiction and individual catchment. Table 5 summarizes a more detailed cost for each jurisdiction by categorizing types of expenditures into capital dollars, operation and maintenance dollars, and replacement dollars accounting for end-of-life in terms of both publicly-incurred and privately-incurred.

The total estimated costs (non-discounted 2017 dollars) for all catchments by expenditure are:

- Capital - \$710 million
- O&M - \$248 million (\$5.4 million per year when all facilities are in-place)
- Replacement - \$173 million over the course of 100 years

The stormwater costs are further differentiated between assumed burdens between public (dollars collected via taxes and fees) and private (expenses paid for by development and property owner LID maintenance).

- Public expense - \$781 million
- Private expense - \$350 million

Table 1. Summary of stormwater BMP type and storage identified by catchment for King County (Priority basins shown in bold).

Catchment	Cost (\$M)		Area	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
	Capital	O&M	(acres)	(inches of storage)				Units / acre	(inches of storage)		
BEA020	\$0.43	\$0.01	10.6	0.042	0.050	0.020	0.104	0.094	0.232	0.000	0.175
BEA030	\$5.48	\$0.07	135.3	0.047	0.023	0.015	0.110	0.118	0.128	0.132	0.124
BEA040	\$3.96	\$0.04	106.0	0.036	0.027	0.020	0.057	0.132	0.163	0.168	0.018
BEA050	\$4.96	\$0.07	147.7	0.010	0.060	0.013	0.123	0.183	0.000	0.040	0.151
BEA060	\$8.01	\$0.14	172.1	0.060	0.055	0.018	0.311	0.046	0.143	0.034	0.249
BEA070	\$1.81	\$0.04	45.6	0.114	0.050	0.014	0.181	0.110	0.054	0.000	0.041
BEA120	\$6.43	\$0.09	241.1	0.048	0.008	0.004	0.066	0.025	0.041	0.172	0.093
BEA130	\$2.81	\$0.05	60.9	0.086	0.055	0.018	0.172	0.164	0.041	0.000	0.183
BEA140	\$5.30	\$0.06	136.3	0.050	0.012	0.007	0.065	0.081	0.072	0.218	0.164
BEA150	\$3.03	\$0.03	119.1	0.030	0.009	0.008	0.051	0.059	0.041	0.149	0.094
BEA160	\$0.75	\$0.01	30.3	0.035	0.042	0.011	0.055	0.033	0.000	0.196	0.061
BEA170	\$4.64	\$0.06	129.3	0.031	0.031	0.018	0.162	0.093	0.134	0.046	0.158
BEA180	\$2.06	\$0.02	138.3	0.016	0.003	0.012	0.040	0.036	0.054	0.043	0.067
BEA200	\$13.88	\$0.18	321.0	0.033	0.025	0.018	0.256	0.022	0.100	0.314	0.133
BEA210	\$2.59	\$0.02	59.3	0.022	0.018	0.026	0.121	0.152	0.042	0.000	0.439
BEA220	\$0.96	\$0.02	196.5	0.009	0.007	0.031	0.003	0.010	0.000	0.030	0.000
BEA230	\$1.97	\$0.03	43.9	0.034	0.056	0.010	0.301	0.114	0.112	0.000	0.255
BEA240	\$5.68	\$0.11	99.8	0.061	0.096	0.023	0.309	0.040	0.025	0.416	0.149
BEA245	\$9.51	\$0.16	117.4	0.142	0.055	0.026	0.474	0.102	0.210	0.152	0.317
BEA250	\$43.42	\$0.59	493.3	0.011	0.096	0.017	0.768	0.187	0.000	0.505	0.336
BEA260	\$3.67	\$0.03	68.3	0.039	0.004	0.019	0.242	0.132	0.325	0.000	0.273
BEA270	\$2.21	\$0.02	115.5	0.014	0.015	0.021	0.038	0.078	0.021	0.051	0.097
BEA275	\$6.52	\$0.07	225.3	0.033	0.006	0.028	0.056	0.058	0.000	0.079	0.273
BEA280	\$7.90	\$0.14	125.5	0.152	0.026	0.006	0.198	0.056	0.216	0.236	0.119
BEA290	\$5.14	\$0.09	163.1	0.044	0.040	0.017	0.128	0.043	0.045	0.218	0.034

*APPENDIX F: Identified Structural Stormwater Strategies for Entire Study Area
Bear Creek Watershed Management Study*

Catchment	Cost (\$M)		Area (acres)	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
	Capital	O&M			(inches of storage)			Units / acre			
BEA300	\$2.04	\$0.03	62.7	0.049	0.013	0.007	0.105	0.048	0.315	0.000	0.030
BEA310	\$2.11	\$0.03	131.0	0.022	0.011	0.017	0.029	0.069	0.038	0.000	0.071
BEA315	\$1.34	\$0.01	175.6	0.002	0.004	0.003	0.013	0.034	0.042	0.034	0.000
BEA320	\$0.62	\$0.01	212.0	0.006	0.001	0.001	0.023	0.005	0.000	0.000	0.018
BEA325	\$0.66	\$0.01	195.4	0.005	0.002	0.001	0.011	0.005	0.025	0.000	0.010
BEA330	\$1.57	\$0.01	99.7	0.002	0.005	0.007	0.111	0.040	0.000	0.060	0.112
BEA335	\$2.07	\$0.02	127.3	0.008	0.010	0.006	0.065	0.047	0.000	0.047	0.132
BEA350	\$22.39	\$0.21	543.1	0.022	0.028	0.008	0.056	0.096	0.127	0.262	0.158
BEA360	\$4.52	\$0.08	184.1	0.035	0.041	0.060	0.081	0.033	0.013	0.064	0.142
BEA370	\$6.81	\$0.05	213.9	0.019	0.007	0.015	0.095	0.192	0.035	0.111	0.044
BEA380	\$7.22	\$0.07	99.9	0.075	0.010	0.014	0.094	0.030	0.049	0.773	0.317
BEA390	\$9.22	\$0.08	140.8	0.057	0.013	0.018	0.145	0.206	0.105	0.253	0.357
BEA400	\$2.60	\$0.04	86.1	0.069	0.021	0.018	0.058	0.070	0.086	0.069	0.065
BEA410	\$0.41	\$0.01	21.7	0.074	0.002	0.020	0.101	0.000	0.000	0.000	0.086
BEA420	\$3.76	\$0.04	155.0	0.019	0.020	0.007	0.032	0.039	0.080	0.153	0.096
BEA430	\$3.59	\$0.11	653.5	0.009	0.023	0.012	0.013	0.005	0.008	0.027	0.000
BEA450	\$3.42	\$0.04	363.6	0.016	0.003	0.011	0.017	0.014	0.000	0.098	0.005
BEA460	\$4.63	\$0.06	232.2	0.010	0.013	0.030	0.107	0.017	0.000	0.128	0.128
BEA480	\$2.34	\$0.02	130.5	0.010	0.006	0.006	0.025	0.000	0.038	0.136	0.143
BEA490	\$3.55	\$0.06	355.7	0.022	0.006	0.015	0.022	0.031	0.021	0.000	0.037
BEA500	\$15.35	\$0.12	251.2	0.071	0.005	0.012	0.033	0.287	0.177	0.024	0.326
BEA510	\$7.31	\$0.05	145.1	0.050	0.005	0.015	0.027	0.276	0.051	0.082	0.257
BEA525	\$9.87	\$0.07	132.8	0.038	0.013	0.011	0.058	0.121	0.186	0.849	0.112
BEA530	\$14.25	\$0.18	366.1	0.045	0.026	0.003	0.075	0.022	0.088	0.324	0.137
BEA540	\$7.14	\$0.08	124.1	0.052	0.025	0.019	0.098	0.048	0.139	0.144	0.585
BEA550	\$5.57	\$0.10	178.9	0.088	0.011	0.024	0.062	0.017	0.055	0.133	0.094

APPENDIX F: Identified Structural Stormwater Strategies for Entire Study Area
Bear Creek Watershed Management Study

Catchment	Cost (\$M)		Area	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
	Capital	O&M	(acres)	(inches of storage)				Units / acre	(inches of storage)		
BEA570	\$19.45	\$0.15	298.3	0.040	0.012	0.025	0.098	0.194	0.240	0.099	0.474
BEA580	\$7.58	\$0.07	175.3	0.010	0.031	0.016	0.031	0.046	0.225	0.135	0.372
BEA590	\$6.98	\$0.04	223.0	0.011	0.003	0.004	0.040	0.143	0.088	0.027	0.225
BEA600	\$7.70	\$0.05	202.9	0.029	0.006	0.005	0.008	0.138	0.000	0.205	0.248
BEA700	\$13.23	\$0.20	236.9	0.110	0.020	0.032	0.228	0.097	0.208	0.125	0.126
BEA710	\$12.90	\$0.22	187.3	0.139	0.048	0.027	0.294	0.096	0.026	0.317	0.229
BEA720	\$3.49	\$0.04	83.3	0.047	0.038	0.035	0.060	0.096	0.059	0.285	0.112
BEA725	\$4.47	\$0.07	62.3	0.166	0.035	0.028	0.186	0.177	0.040	0.190	0.269
BEA730	\$20.00	\$0.21	342.0	0.073	0.014	0.012	0.058	0.091	0.036	0.503	0.234
BEA740	\$10.88	\$0.15	160.5	0.045	0.075	0.032	0.340	0.118	0.015	0.444	0.278
BEA760	\$6.70	\$0.08	242.0	0.019	0.024	0.040	0.127	0.074	0.020	0.049	0.192
BEA770	\$10.79	\$0.16	217.8	0.064	0.050	0.043	0.132	0.069	0.170	0.245	0.128
BEA780	\$11.18	\$0.14	130.8	0.113	0.037	0.024	0.248	0.107	0.264	0.363	0.398
BEA800	\$5.08	\$0.03	352.5	0.008	0.001	0.002	0.020	0.057	0.042	0.101	0.016
BEA820	\$7.58	\$0.08	248.6	0.048	0.003	0.003	0.013	0.048	0.030	0.119	0.247
BEA830	\$1.74	\$0.02	253.0	0.010	0.004	0.005	0.015	0.012	0.059	0.000	0.015

All costs are in 2017 dollars, no discount or inflation rate applied.

Table 2. Summary of stormwater BMP type and storage identified by catchment for Snohomish County (priority basins shown in bold).

	Cost (\$M)		Area	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
Catchment	Capital	O&M	(acres)	(inches of storage)				Units / acre	(inches of storage)		
BEA610	\$4.17	\$0.02	212.9	0.013	0.005	0.003	0.021	0.160	0.023	0.028	0.017
BEA620	\$3.83	\$0.03	46.1	0.038	0.003	0.005	0.072	0.043	0.748	0.514	0.202
BEA625	\$3.88	\$0.02	103.5	0.009	0.002	0.005	0.016	0.135	0.024	0.401	0.072
BEA630	\$4.94	\$0.04	168.3	0.021	0.004	0.001	0.013	0.006	0.015	0.458	0.044
BEA640	\$2.32	\$0.01	55.2	0.009	0.005	0.008	0.020	0.145	0.313	0.215	0.034
BEA650	\$1.75	\$0.02	50.3	0.036	0.002	0.006	0.033	0.020	0.000	0.472	0.074
BEA660	\$16.81	\$0.09	1168.3	0.006	0.003	0.004	0.025	0.111	0.002	0.020	0.041
BEA665	\$3.03	\$0.03	184.8	0.027	0.001	0.003	0.009	0.016	0.000	0.161	0.060
BEA670	\$5.60	\$0.04	185.1	0.009	0.010	0.007	0.018	0.049	0.000	0.417	0.070
BEA690	\$4.18	\$0.02	175.6	0.005	0.007	0.001	0.047	0.159	0.042	0.068	0.053

All costs are in 2017 dollars, no discount or inflation rate applied.

Table 3. Summary of stormwater BMP type and storage identified by catchment for Redmond (priority basin shown in bold).

	Cost (\$M)		Area	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
Catchment	Capital	O&M	(acres)	(inches of storage)				Units / acre	(inches of storage)		
BEA010	\$25.06	\$0.07	44.2	0.198	0.068	0.154	0.212	0.158	0.167	0.000	0.463
BEA080	\$26.80	\$0.08	69.0	0.018	0.077	0.094	0.663	0.188	0.215	0.602	0.135
BEA100	\$21.88	\$0.07	62.9	0.129	0.034	0.029	0.324	0.048	0.000	0.283	0.237
BEA110	\$2.44	\$0.00	64.1	0.001	0.000	0.007	0.000	0.437	0.000	0.000	0.000
BEA190	\$47.53	\$0.20	169.5	0.148	0.026	0.075	0.397	0.147	0.000	0.350	0.132
MON	\$73.90	\$0.09	358.8	0.001	0.016	0.000	0.000	0.020	0.000	0.827	0.000

All costs are in 2017 dollars, no discount or inflation rate applied.

Table 4. Summary of stormwater BMP type and storage identified by catchment for Woodinville (priority basin shown in bold).

	Cost (\$M)		Area	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
Catchment	Capital	O&M	(acres)	(inches of storage)				Units / acre	(inches of storage)		
BEA840	\$3.87	\$0.06	255.1	0.034	0.003	0.010	0.035	0.024	0.068	0.047	0.022
BEA850	\$5.04	\$0.03	246.7	0.012	0.003	0.002	0.016	0.049	0.210	0.024	0.053
BEA860	\$6.21	\$0.05	242.0	0.018	0.010	0.003	0.041	0.066	0.173	0.123	0.023

All costs are in 2017 dollars, no discount or inflation rate applied.

Table 5. Summary of stormwater structural costs for identified BMPs in the entire study area.

Jurisdiction	Dollar Type	Source	Cost (\$M)			
			1-10 yrs	11-20 yrs	21-100 yrs	Total
King County	Capital	Private	\$0.5	\$3.5	\$27.8	\$31.8
		Public	\$7.9	\$45.3	\$362.2	\$415.4
	O & M	Private	\$0.2	\$1.8	\$135.5	\$137.5
		Public	\$0.1	\$0.7	\$69.7	\$70.4
	Replacement	Private	\$0.0	\$0.4	\$72.0	\$72.4
		Public	\$0.0	\$0.0	\$61.6	\$61.6
	Total Private		\$0.8	\$5.6	\$235.3	\$241.7
	Total Public		\$8.0	\$46.0	\$493.4	\$547.4
Snohomish County	Capital	Private	\$0.8	\$0.2	\$1.4	\$2.3
		Public	\$18.4	\$3.3	\$26.5	\$48.2
	O & M	Private	\$0.2	\$0.6	\$8.9	\$9.6
		Public	\$0.1	\$0.3	\$4.1	\$4.5
	Replacement	Private	\$0.0	\$0.5	\$3.7	\$4.2
		Public	\$0.0	\$0.0	\$17.1	\$17.1
	Total Private		\$0.9	\$1.2	\$14.0	\$16.2
	Total Public		\$18.4	\$3.6	\$47.8	\$69.8
Redmond	Capital	Private	\$54.5	\$1.0	\$7.7	\$63.2
		Public	\$19.4	\$12.8	\$102.2	\$134.4
	O & M	Private	\$0.0	\$0.2	\$13.4	\$13.7
		Public	\$0.1	\$0.3	\$5.6	\$6.0
	Replacement	Private	\$0.0	\$0.0	\$7.6	\$7.6
		Public	\$0.0	\$0.0	\$4.9	\$4.9
	Total Private		\$54.5	\$1.2	\$28.8	\$84.5
	Total Public		\$19.5	\$13.1	\$112.8	\$145.4
Woodinville	Capital	Private	\$0.3	\$0.0	\$0.3	\$0.6
		Public	\$4.8	\$1.1	\$8.7	\$14.5
	O & M	Private	\$0.0	\$0.2	\$4.3	\$4.6
		Public	\$0.0	\$0.1	\$1.6	\$1.7
	Replacement	Private	\$0.0	\$0.1	\$2.7	\$2.8
		Public	\$0.0	\$0.0	\$2.6	\$2.6
	Total Private		\$0.3	\$0.3	\$7.4	\$7.9
	Total Public		\$4.8	\$1.2	\$12.9	\$18.9
All Partners	Capital	Private	\$56.1	\$4.7	\$37.2	\$97.9
		Public	\$50.5	\$62.5	\$499.6	\$612.5
	O & M	Private	\$0.4	\$2.8	\$162.1	\$165.4
		Public	\$0.3	\$1.4	\$81.0	\$82.6
	Replacement	Private	\$0.0	\$1.0	\$86.0	\$87.0
		Public	\$0.0	\$0.0	\$86.2	\$86.2
	Total Private		\$56.5	\$8.3	\$285.5	\$350.3
	Total Public		\$50.7	\$63.8	\$666.9	\$781.4
	Total		\$107.2	\$72.1	\$952.4	\$1,131.7

All costs are in 2017 dollars, no discount or inflation rate applied.

APPENDIX G: Potential Strategy Implementation Schedule and Budget

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1.0 INTRODUCTION

The Study has identified a potential suite of strategies that if implemented are expected to result in achieving the targets for instream flow metrics and water quality as defined in the Permit. The Study has also identified several instream, riparian, and wetland habitat improvement strategies. The main body of the Study contains a schedule and cost estimates for potential near-term strategies. This appendix identifies the schedule and provides cost estimates for mid- and long-term strategies.

The schedule and budget below is organized by near-term, mid-term, and long-term actions within each of the partner jurisdictions. The identified suite of projects and programs in the Study, if fully implemented, are expansive and expensive. A 100-year horizon was selected in consideration of the financial and political feasibilities of the identified potential strategies. Yet, as the time horizon expands, so does uncertainty. New and improved technologies and techniques, shifting economic and political scenes, and changing individual behaviors and values are expected over a 100-year period. The long-term nature of the watershed management stresses the importance of adaptive management to better track, handle, and incorporate new information.

The first phase of the Study (first 10 years) initiates the non-structural programs expected to be maintained throughout the 100-year Study and, in many cases, beyond. The near-term phase also includes the many structural elements: stormwater control projects in the identified high priority catchments and habitat restoration projects throughout the watershed. Development and implementation of a monitoring program, a fecal bacteria source control study, an agricultural BMP assessment, and a flow-transfer feasibility study are also recommended for the near-term.

The mid-term phase (year 11 to 20) includes implementation of many of the structural strategies identified, as well as continuation of the non-structural strategies initiated in the near-term. The long-term phase (year 21 to 100) includes maintenance and enhancement of non-structural strategies and continued structural strategy construction as funding allows. Monitoring, evaluation, and strategy adaption are integrated throughout all phases of implementation.

The budgets detailed in this appendix represent costs associated with projects and programs in addition to those already in place. This is useful for defining the level of additional funding that would be needed if projects and programs were fully implemented to meet watershed goals.

The metric targets are expected to be achieved following the full implementation of the strategies identified in the Study (Table 1). Model output indicates that the targets for dissolved copper and zinc are met under with or without Study implementation, with the exception of one model domain for copper during one year where multiple exceedances were simulated. Construction of the structural stormwater strategies detailed in Section 4.3 is expected to result in meeting the B-IBI target. Riparian tree planting, as identified in

Section 7.3 and in the modeling report, is not expected to result in meeting the temperature target. Temperatures were found to exceed standards under the future mitigated and the fully forested scenarios, even with the adjustment for microclimate cooling. Tree shading, however, will provide substantial shading and result in colder water temperatures and is a recommended strategy.

Bacteria concentrations are extremely variable and difficult to predict. The calibration of the watershed model resulted in general agreement between the observed and simulated concentrations, although with a low bias. Under both the future built-out and the mitigated scenarios, water quality standards were not exceeded based on modeled results (i.e., less than 10 percent of the samples were above 100 CFU/100 mL and a geometric mean under 50 CFU/100 mL). However, given the known underestimation of the model and the number of the simulated storm events resulting in fecal coliform levels over 100 CFU/100 mL, the project team predicts, in spite of modeled results, that water quality standards will not be met in the future without mitigation. The Study recommends the non-structural source control strategy as defined in Section 4.4. The source control strategy is expected to result in more cost-effective and earlier mitigation than expected with future build-out and built stormwater infrastructure controls.

Table 1. Achievement of modeled metrics targeted with and without Study implementation.

Parameter	Future Build-out Under Current Code	Future Build-out with Study Implementation
Dissolved Copper	NO*	YES
Dissolved Zinc	YES	YES
Temperature	NO	NO**
Fecal Coliform	NO***	YES***
B-IBI	NO	YES

*Copper exceeded in one model domain over the course of one modeled year multiple times.

**Temperature exceeds thresholds under fully forested conditions and with consideration of microclimate cooling.

***Fecal coliform levels are expected to exceed standards without implementation of a source control program in addition to stormwater mitigation.

To meet the Permit-defined modeled targets, the analysis shows Partners could implement the identified structural stormwater strategies and the identified pollution source control nonstructural strategies. While not expected to result in full compliance with the water quality standards for temperature, temperature issues would be alleviated by planting the riparian area to at least a 65-foot buffer, totaling about 600 acres of new plantings on top of what identified in Section 7.3. Planting 600 acres is estimated to cost \$18.3 million without consideration of land acquisition or easement costs.

Instream habitat, 165-foot riparian corridor, and wetland restoration and preservation strategies would not affect the achievement of Permit-defined targets. These strategies

were not part of the modeled solutions needed to meet the NPDES permit targets. These strategies, however, are expected to result in the achievement of the watershed goals defined in Chapter 2 and the support the designated and existing uses of Bear Creek.

2.0 POTENTIAL SCHEDULE FOR SELECTED STRATEGIES

The identified schedule and cost for implementing the Study is summarized in Tables 2 to 5 for the respective partner jurisdictions: King County, Snohomish County, City of Redmond, and City of Woodinville.

In the mid-term phase (year 11-20), King County may focus on coordinating the implementation of projects associated with the prioritized stormwater catchments, instream habitat, riparian, and wetland projects. The remaining three prioritized stormwater catchments may be completed in the mid-term. Ten percent of the higher priority instream habitat projects may be completed. King County may plant trees on remaining half (50 percent) of the prioritized riparian corridors located on public land during the mid-term.

During the mid-term phase, the Snohomish County, Redmond, and Woodinville may continue focusing on the prioritized catchments (see Chapter 4 and *Appendix A: Prioritization: Water Quality and Quantity Strategies*) that total to approximately 10 percent of the total cost estimate for stormwater. The cities of Redmond and Woodinville may implement their tree planting incentive program, focusing on riparian corridors.

In the long-term phase (year 21-100), jurisdictions may continue to implement the programs initiated in the near-term, revising them as appropriate through adaptive management. The Study is expected to be notably different by the end of the proposed timeline from its initial conception. Incorporation of new technologies, new monitoring data, and changes in watershed goals are recommended as the Study is adaptively managed. The emphasis will be to ensure it is effective.

Table 2. King County Watershed Study potential implementation schedule.

Category	Description	Near-term Action (Years 1-10)	Mid-term action (Years 11-20)	Long-term action (Beyond 20)
Program	Public Engagement/ Education Program	Develop Public Engagement/ Education Program	Implement public engagement and education	
		\$100,000 over 2 years	\$50,000/year	\$50,000/year
	LID Incentive Program	Develop LID Incentive Program	Install LIDs on participating private properties	
		\$100,000 over 2 years to develop \$2M/year over 5 years to implement	\$9M/year	\$9M/year
	In-lieu fee Program	Develop In-lieu fee Program	Direct in-lieu fees to high priority projects	
		\$100,000 over 2 years	No Cost	No Cost
	Monitoring and Assessment Management Plan	Develop Monitoring Plan	Monitor and evaluate results	
		\$50,000 over 2 years	\$100,000/year	\$100,000/year
	Tree Planting Incentive Program	Tree Planting Incentive Program	Plant trees on willing private property	
		\$50,000 over 2 years	\$50,000/year	\$50,000/year
	Fish Passage Study	Complete Inventory of Fish Barriers		
		\$100,000 over 2 years		
Structural Projects	Construct Stormwater Facilities	Build new facilities in priority catchments	Build new facilities in priority catchments	Build new facilities in remaining catchments
		\$846,000/year	\$4.9M/year	\$4.9M/year
	Evaluate and Optimize Existing Stormwater Facilities	Evaluate/optimize in priority catchments	Evaluate/optimize in priority catchments	
		No Additional Cost	No Additional Cost	

Category	Description	Near-term Action (Years 1-10)	Mid-term action (Years 11-20)	Long-term action (Beyond 20)
	Instream Habitat Projects	Construct high priority projects	Construct high priority projects	Construct remaining priority projects
		\$343,000/year over 5 years	\$386,000/year	\$394,000/year
	Remove Fish Passage Barriers		Remove priority barriers	Remove remaining barriers
			\$50,000/year	\$50,000/year
	Riparian Restoration	Acquire/ease and preserve high priority areas		
		\$91,000/year over 5 years	\$235,000/year	\$235,000/year
	Wetland Restoration	Acquire/ease and preserve high priority areas		
		\$19,000/year over 5 years	\$32,000/year	\$32,000/year
Studies, Analyses	Flow Transfer Program (Done in First 5 Years)	Study program feasibility		
		\$50,000 over 2 years		
	Agricultural BMP Program	Assess existing regulation and incentive programs		
		\$50,000 over 2 years		
	Fecal Bacteria Source Tracking Study	Follow-up IDDE work for TMDL by King County SWS		
		\$60,000/year over 5 years		
Watershed Coordination and Strategy Administration	Program Management	Watershed Coordinator holds Committee meetings, prepares reports, oversees grants, and supervises staff		
		\$30,000/year	\$30,000/year	\$30,000/year
	Update Watershed Study	Update every 10 Years		
		\$200,000	\$200,000	\$200,000

All costs are in 2017 dollars, no discount or inflation rate applied.

Table 3. Snohomish County Watershed Study potential implementation schedule.

Category	Description	Near-term Action	Mid-term action	Long-term action
Structural Projects	Construct Stormwater Facilities	Build new facilities in priority catchments		
		\$1.9M / year	\$349,000 / year	\$349,000 / year
Studies and Analyses	MAMP (or equivalent)	Monitor and Evaluate Results		
		\$9,000 / year last 5 years	\$9,000 / year	\$9,000 / year
Watershed Coordination and Strategy Administration	Watershed Committee Participation	Participate in bi-annual watershed committee coordination meetings		
		\$10,000 / year	\$10,000 / year	\$10,000 / year
	Update Watershed Study	Update every 10 Years		
		\$9,000	\$9,000	\$9,000

All costs are in 2017 dollars, no discount or inflation rate applied.

Table 4. City of Redmond Watershed Study potential implementation schedule.

Category	Description	Near-term Action	Mid-term action	Long-term action
Structural Projects	Construct Stormwater Facilities	Complete Monticello Creek Restoration Plan	Build new facilities in priority catchments	
		\$7.3M / year	\$1.4M / year	\$1.4M / year
Implement Programs	Tree Planting Program	Plant trees on willing private property		
		\$7,000 / year	\$16,000 / year	\$16,000 / year
Studies and Analyses	MAMP (or equivalent)	Monitor and Evaluate Results		
		\$10,000 / year (last 5 years)	\$10,000 / year	\$10,000 / year
Watershed Coordination and Strategy Administration	Watershed Committee	Participate in bi-annual watershed committee coordination meetings		
		\$10,000 / year	\$10,000 / year	\$10,000 / year
	Update Watershed Study	Update every 10 Years		
		\$10,000	\$10,000	\$10,000

All costs are in 2017 dollars, no discount or inflation rate applied.

Table 5. City of Woodinville Watershed Study potential implementation schedule.

Category	Description	Near-term Action	Mid-term action	Long-term action
Structural Projects	Construct Stormwater Facilities	Build new facilities in priority catchments		
		\$500,000 / year	\$112,000 / year	\$112,000 / year
	Tree Planting Incentive Program	Program Development	Plant trees on willing private property	
		\$19,000 / year last 5 years	\$5,100 / year	\$5,100 / year
Studies and Analyses	MAMP (or equivalent)	Monitor and Evaluate Results		
		\$6,000 / year	\$6,000 / year	\$6,000 / year
Watershed Coordination and Strategy Administration	Watershed Committee	Participate in bi-annual watershed committee coordination meetings		
		\$10,000 / year	\$10,000 / year	\$10,000 / year
	Update Watershed Study	Update every 10 Years		
		\$6,000 / year	\$6,000 / year	\$6,000 / year

All costs are in 2017 dollars, no discount or inflation rate applied.

3.0 SUMMARY OF ESTIMATED COSTS FOR FULL IMPLEMENTATION OF SELECTED STRATEGIES

Table 6 summarizes the estimated costs of the Study's elements during the different phases of the Study if the recommendations were fully implemented. Cost estimates are based on based on the best available information for instream habitat project costs (\$3M per mile), tree planting costs (\$30K per acre), stormwater structural strategy (construction, maintenance, and replacement) costs, property acquisition costs, and program management costs.

Table 6. Watershed Study budget summary.

Jurisdiction	Expense Type	Cost Incurred by Juris. or Private Indiv./Entity	Near-Term Actions (\$M)	Mid-term Actions (\$M)	Long-term Actions (\$M)	Total Watershed Study (\$M)	
			Year	Year	Year	Year	
			10-Jan	20-Nov	21-100	1-100	
King County	Capital	Private	\$0.55	\$3.48	\$27.81	\$31.83	
		Public	\$7.91	\$45.28	\$362.21	\$415.40	
	O & M	Private	\$0.23	\$1.76	\$135.47	\$137.46	
		Public	\$0.09	\$1.04	\$100.06	\$101.20	
	Replacement	Private	\$0.00	\$0.36	\$72.03	\$72.39	
		Public	\$0.00	\$0.00	\$61.55	\$61.55	
	Habitat	Public	\$3.22	\$7.54	\$60.96	\$71.72	
	Programs		\$2.57	\$2.46	\$19.20	\$24.23	
	Studies		\$1.05	\$1.00	\$8.00	\$10.05	
	Acquisitions		\$8.39	\$26.51	\$218.86	\$253.75	
	Total Private		\$0.78	\$5.60	\$235.31	\$241.68	
	Total Public		\$23.23	\$83.83	\$830.83	\$937.90	
Snohomish County	Capital	Private	\$0.76	\$0.17	\$1.37	\$2.31	
		Public	\$18.36	\$3.32	\$26.52	\$48.20	
	O & M	Private	\$0.16	\$0.59	\$8.90	\$9.65	
		Public	\$0.12	\$0.44	\$8.18	\$8.74	
	Replacement	Private	\$0.00	\$0.48	\$3.73	\$4.21	
		Public	\$0.00	\$0.00	\$17.12	\$17.12	
	Habitat	Public	\$1.32	\$0.41	\$3.32	\$5.05	
	Programs		\$0.11	\$0.11	\$0.87	\$1.09	
	Acquisitions		\$9.22	\$0.88	\$7.06	\$17.17	
	Total Private		\$0.93	\$1.24	\$14.00	\$16.16	
	Total Public		\$29.13	\$5.17	\$63.08	\$97.38	
Redmond	Capital	Private	\$54.34	\$1.09	\$7.74	\$63.17	

*APPENDIX G: Potential Strategy Implementation Schedule and Budget
Bear Creek Watershed Management Study*

Jurisdiction	Expense Type	Cost Incurred by Juris. or Private Indiv./Entity	Near-Term Actions (\$M)	Mid-term Actions (\$M)	Long-term Actions (\$M)	Total Watershed Study (\$M)	
			Year	Year	Year	Year	
			10-Jan	20-Nov	21-100	1-100	
	O & M	Public	\$19.44	\$12.78	\$102.22	\$134.44	
		Private	\$0.16	\$0.64	\$17.10	\$17.89	
		Public	\$0.10	\$0.39	\$7.69	\$8.18	
	Replacement	Private	\$0.00	\$0.00	\$7.65	\$7.65	
		Public	\$0.00	\$0.00	\$4.93	\$4.93	
	Habitat	Public	\$0.05	\$0.17	\$1.37	\$1.59	
	Programs		\$0.16	\$0.21	\$1.68	\$2.05	
	Acquisitions		\$0.00	\$3.50	\$27.99	\$31.48	
	Total Private		\$54.50	\$1.72	\$32.49	\$88.71	
	Total Public		\$19.76	\$17.04	\$145.88	\$182.68	
	Woodinville	Capital	Private	\$0.25	\$0.04	\$0.30	\$0.59
			Public	\$4.79	\$1.08	\$8.66	\$14.54
		O & M	Private	\$0.04	\$0.18	\$4.35	\$4.57
Public			\$0.05	\$0.19	\$3.12	\$3.36	
Replacement		Private	\$0.00	\$0.06	\$2.72	\$2.78	
		Public	\$0.00	\$0.00	\$2.60	\$2.60	
Habitat		Public	\$0.09	\$0.07	\$0.57	\$0.73	
Programs			\$0.34	\$0.17	\$1.33	\$1.83	
Acquisitions			\$4.06	\$1.41	\$11.26	\$16.73	
Total Private		\$0.30	\$0.28	\$7.36	\$7.94		
Total Public		\$9.33	\$2.92	\$27.53	\$39.78		
ALL PARTNERS	Capital	Private	\$55.91	\$4.77	\$37.22	\$97.90	
		Public	\$50.51	\$62.45	\$499.61	\$612.57	
	O & M	Private	\$0.60	\$3.16	\$165.80	\$169.56	
		Public	\$0.36	\$2.06	\$119.05	\$121.48	
	Replacement	Private	\$0.00	\$0.90	\$86.13	\$87.03	
		Public	\$0.00	\$0.00	\$86.21	\$86.21	
	Habitat	Public	\$4.69	\$8.20	\$66.21	\$79.10	
	Programs		\$3.18	\$2.95	\$23.08	\$29.20	
	Studies		\$1.05	\$1.00	\$8.00	\$10.05	
	Acquisitions		\$21.66	\$32.30	\$265.17	\$319.13	
	Total Private		\$56.50	\$8.83	\$289.15	\$354.49	
	Total Public		\$81.45	\$108.96	\$1,067.33	\$1,257.74	

Public: Cost incurred by public institutions

Private: Cost incurred by private developers, firms, or individuals

All costs are in 2017 dollars, no discount or inflation rate applied.

APPENDIX H:

Permit Crosswalk

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Table H-1. Permit requirements crosswalk.

Permit Reference Number	Permit Requirement	How Addressed	Document(s) Location
S5.C.5.c.iv.(1)	An assessment of existing hydrologic, biologic, and water quality conditions and an assessment of the current status of the aquatic community in the study area.	King County met this requirement with is review of data; stormwater quality sampling of base flows and storm flows; continuous flow monitoring; macroinvertebrate data collection for the purposes of estimated current B-IBI scores, assessed the aquatic community conditions, assessed riparian corridor conditions, and assessed wetland conditions.	Summarized in Chapter 3 of this Study King County, 2017b King County, 2017c King County, 2017d King County, 2017e
S5.C.5.c.iv.(2)	A compilation and/or generation of maps of the study area to identify the existing distribution and totals of general soil types, vegetative land cover, impervious land covers, MS4s and non-regulated public stormwater systems (if applicable). Maps shall be sufficient to allow construction of a rainfall/runoff model representation of the study area. Maps must also identify areas within the study area appropriate for special attention in regard to hydrologic and water quality impacts.	King County met this requirement with its development and/or updating of existing maps to support hydrologic/hydraulic and water quality modeling of the study area.	King County, 2018
S5.C.5.c.iv.(3)	Permittee shall use the existing conditions assessment in S5.C.5.c.iv.(1) and the maps described in S5.C.5.c.iv.(2), and calibrate a continuous runoff model to reflect the existing hydrologic, water quality, and biologic (as represented by B-IBI score) conditions.	King County met this requirement with its development of a HSPF continuous hydrologic model that was calibrated to existing conditions.	King County, 2018

Permit Reference Number	Permit Requirement	How Addressed	Document(s) Location
S5.C.5.c.iv.(4)	Permittee shall use the calibrated model to estimate hydrologic changes from the historic condition; predict the future hydrologic, biologic, and water quality conditions at full build-out under the existing comprehensive land use management plan for the study area.	King County met this requirement with its use of the calibrated HSPF model to estimate changes in hydrologic conditions, B-IBI scores, and water quality concentration of the pollutant parameters listed in the Permit between historical forested conditions and future land use conditions. Future land use development was assumed to include stormwater mitigation BMPs meeting current standards. B-IBI correlation evaluation was conducted and DeGasperi metrics were used based on WRIA 8 dataset.	King County, 2018
S5.C.5.c.iv.(5)	If the estimation in S5.C.5.c.iv.(4) predicts water quality standards will not be met, the Permittee shall use the calibrated watershed model to evaluate stormwater management strategies to meet the standards.	King County met this requirement with its use of the calibrated HSPF model in combination with a SUSTAIN model, to evaluate a combination of structural and non-structural measures that if implemented were projected to meet water quality standards for bacteria, copper, zinc and turbidity. Even under modeled fully forested conditions, exceedances of the temperature standards were observed.	King County, 2018
S5.C.5.c.iv.(5) continued	Stormwater Strategies to be evaluated must include: • Changes to development-related codes, rules, standards, and plans	King County met this requirement with its evaluation of future (2050) land use development and evaluation of limiting the impervious area on developed lands. King County also evaluated strategies for implementing changes to exemption requirements, raising LID standards, and instating an in-lieu fee program.	Chapter 4 of this Plan and King County, 2018.
S5.C.5.c.iv.(5) continued	Stormwater Strategies to be evaluated must include: • Potential future structural stormwater control projects	King County met this requirement with its evaluation of strategies for implementing potential future structural control projects. SUSTAIN was used in combination with the calibrated HSPF model to optimize combinations of structural projects.	Chapter 4 of this Study.
S5.C.5.c.iv.(6)	An implementation plan and schedule, including: potential future actions to implement the identified stormwater management strategies, responsible parties, estimated costs, and potential funding mechanisms.	King County met this requirement in this Watershed Management Plan, which includes a implementation plan and schedule with the required elements: potential future action to implement the identified stormwater management strategies, responsible parties, estimated costs, and potential funding mechanisms. Also an adaptive management strategy is defined to guide implementation of the potential future actions under the proposed implementation plan.	Chapters 11 and 12 and Appendix G of this Study.

Permit Reference Number	Permit Requirement	How Addressed	Document(s) Location
S5.C.5.c.iv.(7)	A public review and comment process, at a minimum, focused on the draft watershed-scale stormwater plan. The public review must allow for public comment from all governmental entities with jurisdiction within the study area.	King County met this requirement with its planning process, which has included ongoing coordination with a technical stakeholder group, the Muckleshoot Indian Tribe, and members of the public. A public comment period was held from January 24 to February 14, 2018.	The public outreach process is summarized in Section 1.4 and Appendix E.
S5.C.5.c.v	The watershed-scale stormwater planning process, as documented in the scope of work and schedule, may include an evaluation of strategies to preserve or improve other factors that influence maintenance of the existing and designated uses of the stream.	King County has included several evaluations of current conditions and potential strategies to improve riparian, wetland, and instream habitat that are expected to influence maintenance of the existing and designated uses of Bear Creek.	King County, 2017c King County, 2017d King County, 2017e Chapters 4, 5, 6, 7, and 8 of this Study.

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APPENDIX I: Snohomish County Comments

The Coordination Plan developed by King County, Snohomish County, City of Redmond, City of Woodinville, and the Washington State Department of Transportation, requires that, if requested by a non-lead Permittee, King County will include additional information, dissenting opinions, conclusions, and/or alternative approaches submitted to King County by non-lead Permittees as appendices. Snohomish County has requested to submit this appendix to the Bear Creek Watershed Management Study.

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Bear Creek Watershed Management Study – Snohomish County Comments

Background of this Appendix

This Appendix was prepared by Snohomish County as part of its participation in the Bear Creek Watershed Management Study, in accordance with the Coordination Plan for the project that was adopted by all project partners.

This project was groundbreaking in its level of detail and technical specifications. All project partners understood from the outset that we needed an efficient decision-making process to complete the project on the tight schedule imposed by the NPDES Phase I municipal stormwater permit (the Permit). We also realized that there were going to be many important technical, planning, and policy issues on which reaching consensus would be at best a very slow process. At the same time, each project partner had to stand behind the final product as its own submittal to Ecology to satisfy its Permit requirement.

To meet all these constraints, the partners agreed, through the Coordination Plan, that King County would consider all input and comments provided by project partners, but that King County had “final and unilateral authority on decisions regarding implementation of the Scope of Work for the Bear Creek Watershed-Scale Stormwater Plan.” In exchange for this authority, King County would “include additional information, dissenting opinions, conclusions, and/or alternative approaches submitted to King County by non-lead Permittees as an appendix or appendices to the final watershed plan.”

Relationship of Permit requirement for watershed-scale stormwater planning to requirements for Structural Stormwater Controls Program (Permit Special Condition S5.C.6)

The 2013 Permit requirement for watershed-scale stormwater planning (Special Condition S5.C.5.c) is discussed in detail in the main body of this study. It is important to note that this Permit requirement derived from a previously existing Permit requirement: Special Condition S5.C.6 - Structural Stormwater Controls. This condition has appeared in continually refined forms in the 1995, 2007, and 2013 Permits. As currently set forth in the 2013 permit, its objective is to prevent or reduce impacts to waters of the state caused by discharges from the municipal separate storm sewer system (MS4), with the goal of addressing impacts that are not adequately controlled by the other required actions of the Stormwater Management Program (Special Conditions S5.C.1 – S5.C.5 and S5.C.7 – S5.C.10).

Under Special Condition S5.C.6 as it is written in the 2007 and 2013 Permits, a permittee is required to develop a list of projects that meet certain criteria, and report each year on the status of implementing those projects. However, these Permits did not establish a metric by which compliance would be measured, let alone establish a quantified minimum level of effort in terms of that metric. The watershed-scale stormwater planning under 2013 Permit Special Condition S5.C.5.c was created by Ecology as an initial means to determine the total level of Structural Stormwater Controls Program effort required in a watershed to meet, under future build-out conditions, water quality standards in the receiving water for

dissolved copper, dissolved zinc, temperature, and fecal coliform, and B-IBI scores that correlate to hydrologic metrics representing “the historic condition” in the watershed.

Snohomish County comments on the Bear Creek Watershed Management Study

Determining actions needed for NPDES Structural Stormwater Controls Program. As noted in the main body of the report, King County added some additional goals to the project beyond those set forth in the 2013 Permit, primarily restoration of salmonid habitat and wetland restoration / protection. These goals are reflected in the recommended actions. However, King County did not identify the subset of those actions that constitute the minimum needed to meet the environmental targets set forth in the 2013 Permit. This is not a flaw in the study results, but it adds a necessary additional step if one wanted to use the study to determine a long-term Structural Stormwater Controls Program for the Bear Creek watershed that would meet future iterations of Permit Special Condition S5.C.6.

Issues for use of questions for future consideration

Applicability of study results to other watersheds. The watershed-scale stormwater plans produced for Bear Creek and Little Bear Creek each cost over \$3M, required thousands of staff hours, and took over 3 years to complete. Snohomish County has well over a dozen watersheds that are similar to the watersheds studied. A key question since the outset has been “how applicable are such study results to other watersheds with similar characteristics?” Determining those results (and study methods) that are applicable among watersheds will save huge amounts of money and will accelerate the pace of watershed protection. A critical next step in the realm of watershed-scale stormwater planning is to determine those issues for which results from one watershed can be applied to other watersheds. As noted above, if one wanted to determine applicability of the Bear Creek Study to other watersheds vis a vis requirements of the NPDES Permit, one would first have to determine the set of study results and recommendations required for Permit compliance in the Bear Creek watershed.