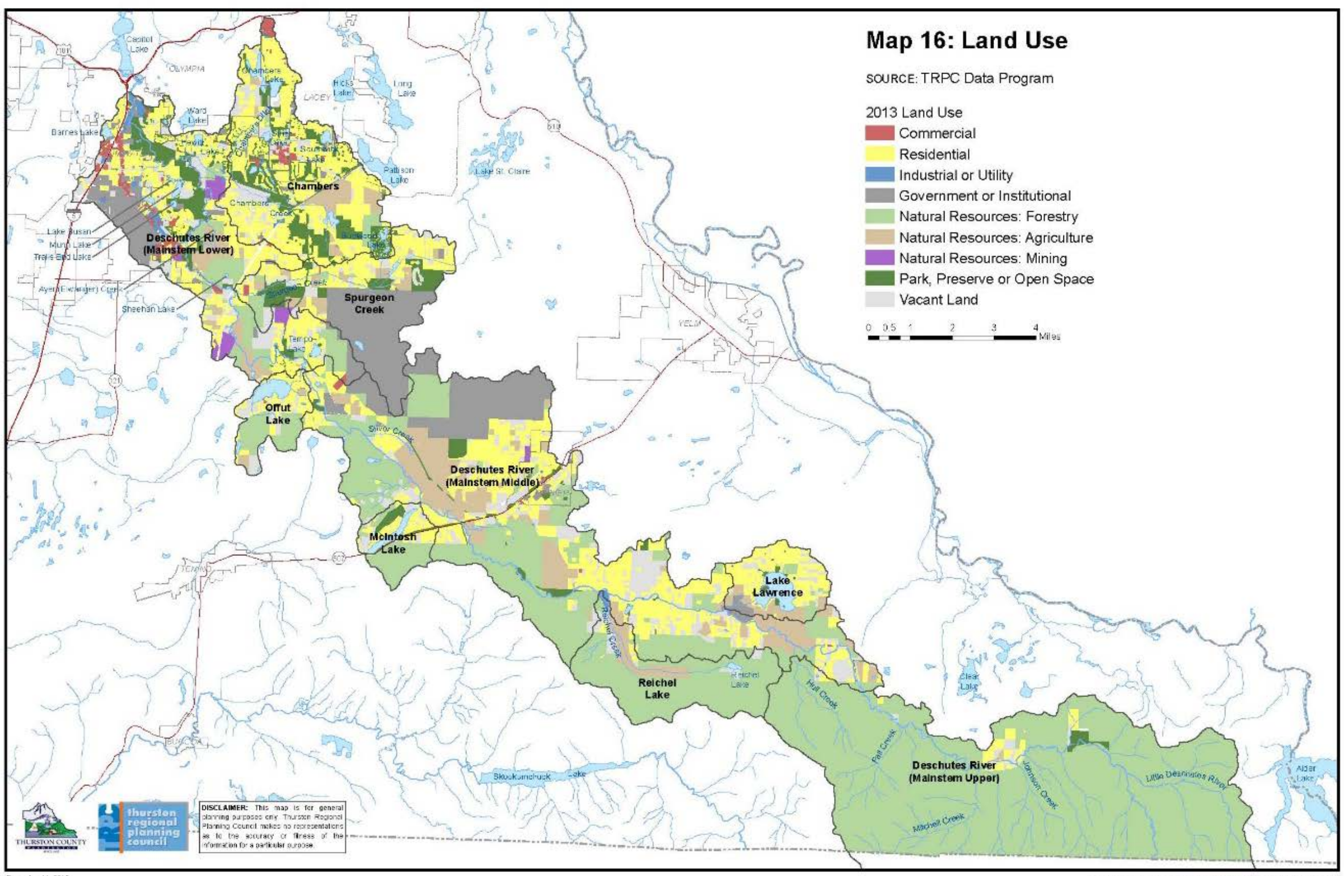
Deschutes Watershed Land Use Analysis: Current Conditions Report

December 29, 2015



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This project has been funded wholly or in part by a grant from the U.S. Environmental Protection Agency under Puget Sound Ecosystem Restoration and Protection Cooperative Agreement Grant PC-00J20101 with the Washington Department of Ecology. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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Executive Summary

The Deschutes River flows through Thurston County and is a regionally important water body that suffers from ongoing pollution concerns and intense growth pressure that is likely to exacerbate these issues. Anticipated development in the Deschutes Watershed will result in increases in impervious area and total number of residential units on septic systems while reducing the amount of tree cover – impacts that could exacerbate pollution loads, increase stream temperatures, and lead to loss of fish and wildlife habitat.

Thurston County, in partnership with Thurston Regional Planning Council (TRPC), received a grant through the National Estuaries Program to develop and implement changes to land use in the Deschutes Watershed to protect and improve water quality. The goal of this project is to reduce impacts to water quality and quantity from current and future residential development in the Deschutes Watershed by developing land use policy that directs growth away from areas with properly functioning ecological processes and lessens the impact on areas that do develop.

The information collected in this report is intended to inform the following questions:

1. What do we know about the current condition of the study area?
2. Which areas are at highest risk of development?
3. Which locations need protection from future development impacts to maintain water flow processes, water quality, and habitat?
4. Which areas can best accommodate future development without degrading ecologically sensitive processes and habitats?
5. Which areas would benefit most from restoration of ecological processes?

The project study area (Map 2) consists of the Deschutes River Basin mainstem and several smaller headwater basins including: Chambers Basin, Spurgeon Creek, Offut Lake, McIntosh Lake, Reichel Lake, and Lake Lawrence. The Deschutes River Basin mainstem has been broken into three sub-basins – lower, middle, and upper. The predominant land uses within the study area are timber/forest land, agricultural, and residential.

The Deschutes River is the primary stream draining the Deschutes Watershed, which contains many important areas for surface water storage such as depressional wetlands, wetlands, lakes, floodplain, and unconfined river channels, as well as critical habitat for state and federally listed priority species, including several species of salmon and prairie-associated species, such as the Mazama pocket gopher and streaked horned lark. Shorelines within the study area have been modified for human use, with channels straightened, wetlands drained for agricultural use, and riparian vegetation removed along many reaches, reducing shade cover. Thurston County's Environmental Health monitoring program ranks water quality as "Good" in the Deschutes River, Chambers and Spurgeon Creek, and "Fair" for Lake Lawrence; however, a number of waterbodies are included on the state 303(d) list of impaired waters. In 2003, the Washington Department of Ecology began a Total Maximum Daily Load (TMDL) project to address impairments to water quality in the Deschutes River, Capitol Lake, and Budd Inlet tributaries that is focused on improving temperature, dissolved oxygen, bacteria, pH, and phosphorus. Potential pollutant sources in the study area include a mixture of point sources and nonpoint sources, such as stormwater runoff, onsite septic systems, land use activities, agricultural and livestock activities, as well as natural sources. Thurston County conducted an assessment of urban septic systems that found several areas in the Chambers Basin and Deschutes Mainstem lower sub-basin where high-densities and poor soils could pose a risk to ground or surface water. Based on these and other current conditions, the basins within the study area were characterized as either "intact," "sensitive," "impacted," or "degraded."

The Deschutes River Watershed has been the subject of numerous past studies and evaluations that have identified management actions for the study location. The Puget Sound Watershed Characterization project developed by the Washington Department of Ecology is a regional-scale tool that highlights the most important areas to protect and restore, and identifies those most suitable for development. Using this analysis, most of the Upper and Middle Deschutes Mainstem Sub-basins are identified as priority areas for protection or conservation indicating that these areas are relatively intact and have relatively high importance for water flow processes. The middle watershed has a few areas where restoration is recommended, around Reichel Lake, Lake Lawrence, and Silver Creek. The areas recommended for restoration have high importance for water flow processes, but are moderately to highly degraded. The Lower Deschutes Mainstem Sub-basin is primarily recommended for restoration, and a small area in the Chambers Basin is recommended for development/restoration. These coarse-scale assessments can be further refined with consideration of the accompanying analyses for water quality processes, salmonid and terrestrial habitats.

In 2015, Ecology released a draft Water Quality Improvement Report / Implementation Plan for the Deschutes TMDL area that contains numeric load allocations for temperature, bacteria, dissolved oxygen, pH, and fine sediment as well as specific implementation actions. The most important implementation actions identified in the freshwater TMDL are to establish forested riparian buffers and conserve existing buffers on the Deschutes River and other streams. Additional management actions include reducing fecal coliform bacteria during the summer months, stabilizing channels that contribute sediment, reducing nutrient sources, and quantifying water withdrawals in the watershed. The TMDL recommendations focus on restoration of degraded functions and do not consider in detail the impact of future growth in the watershed, nor does the TMDL set aside a reserve for anticipated growth-related impacts in its load allocations.

Understanding the type and extent of future growth in Thurston County’s basins is key to developing management strategies that can be incorporated into land use planning. Specific management strategies include:

1. Guiding growth away from sensitive areas
2. Encouraging growth in areas where redevelopment is desired and that are least susceptible to new impacts
3. Reducing the impacts of growth, where and when it does occur
4. Restoring ecological functions that have been degraded by existing development

Projected development could intensify impacts to water quality in the watershed by increasing impervious surfaces from new buildings and roads, adding septic systems on poor soils, reducing tree cover in the watershed, and converting more open space and forestlands to residential uses. Within the study area, all basins were identified as having some vulnerability to projected growth. The Deschutes Mainstem (middle sub-basin) was identified as being the most sensitive to these impacts from future growth, in part because, although it is not heavily developed now, it could see a high number of new dwelling units added under current land use regulations (2,330) and has a moderate percentage of forestlands that are vulnerable to conversion. Offut Lake basin was identified as at high risk from several factors related to its projected growth, including increased impervious surfaces and stormwater runoff and loss of forested lands.

While changes to land-use regulations can help to protect ecological functions from the impacts of new growth, such changes do not address legacy issues caused by existing development that was constructed prior to current regulations related to stormwater, critical area protections, and growth management. Improvement to existing land use can involve retrofitting stormwater infrastructure to provide additional flow control and treatment, conducting outreach to landowners to ensure septic systems are properly maintained, or providing incentives for best management practices on agricultural lands. Restoration opportunities exist in all basins within the study, particularly within heavily impacted urban areas, but the potential benefits of restoration for the watershed as a whole are greatest in areas where other impacts are minimal. Such restoration potential is concentrated in the Deschutes Mainstem (middle sub-basin), as well as Lake Lawrence.

This report recommends that future phases of the Deschutes Watershed Land Use Analysis project focus primarily on areas where changes to land use regulations, such as zoning and development standards, can have the greatest effect in reducing new impacts to ecological functions within the watershed. As a secondary consideration, the project should also focus on areas where strategic restoration actions could provide substantial benefit in basins that are characterized as “sensitive,” or where restoration may enable a basin to improve from “impacted” to “sensitive.” This area largely corresponds to that identified by the Puget Sound Watershed Characterization for protection/conservation as well as areas identified for restoration that are upstream of regions identified for protection, but excludes areas that are designated as Long-Term Forestry under Thurston County’s zoning code. This focus area largely corresponds to the central portion of the study area, including the Deschutes River (mainstem middle) sub-basin, Offut Lake, McIntosh Creek, Reichel Lake, and Lake Lawrence basins. Recommended study focus areas are shown in Map 38. These are the areas where actions that protect and restore ecological functions will be the most efficient and are likely to provide the greatest ecological benefit to the watershed as a whole. Once a focus area is selected, the project team will investigate the impact of different management scenarios, and identify recommendations that support reductions in pollutants and improved water quality.

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1. Introduction

1.1 Project Purpose and Goals

The Deschutes River flows through Thurston County and is a regionally important water body that suffers from ongoing pollution concerns and intense growth pressure that is likely to exacerbate these issues. The river is on the Clean Water Act Section 303(d) list of impaired waters developed by Ecology and approved by the U.S. Environmental Protection Agency. Projected development in the Deschutes Watershed will result in increases in impervious area and total number of residential units on septic systems while reducing the amount of tree cover – impacts that could exacerbate pollution loads, increase stream temperatures, and lead to further loss of fish and wildlife habitat in the Deschutes Watershed.

The goal of this project is to reduce impacts to water quality and quantity from current and future residential development in the Deschutes Watershed by developing land use policy that directs growth away from areas with properly functioning ecological processes and lessens the impact on areas that do develop. Thurston County, in partnership with Thurston Regional Planning Council (TRPC), received a grant through the National Estuaries Program to develop and implement changes to land use in the Deschutes Watershed to protect and improve water quality. Additional project partners include the cities of Olympia, Lacey, Rainier, and Tumwater, and the Squaxin Island Tribe.

This project takes a proactive watershed-based approach to reducing nutrient loads by identifying areas that are at highest risk from future development and areas that can benefit most from protection and restoration of ecological functions, and adjusting current regulations accordingly. The results of this work will inform a suite of recommended land use policies for the watershed, which could include changes to Urban Growth Area (UGA) boundaries and zoning, as well as new requirements and incentives for low-impact development, tree retention, and restoration. This information will be incorporated into the County's Comprehensive Plan as part of the scheduled 2016 update.

The expected short-term outcomes of this project are that important, ecologically functional areas within the Deschutes Watershed will be identified and protected through regulatory changes or voluntary programs, and that new development within the basin will be built to minimize impacts to water resources. In the long-term, this project will help keep water quality in the Deschutes River from deteriorating further and improve conditions over time as a result of protecting and restoring sensitive lands and ecological functions.

1.2 Project Background and Study Location

This project is focused on the Deschutes Watershed, including tributaries and lakes that drain directly to the Deschutes River. The study area stretches from Thurston County's southern border in the headwaters of the Deschutes River, to the northern end of the

Deschutes River Basin, south of Capitol Lake, and is contained within Water Resource Inventory Area (WRIA) 13.[1]

The Deschutes River is one of Thurston County's major waterways and portions of the river run through urbanized and urbanizing areas of the cities of Olympia and Tumwater. Portions of the cities of Lacey and Rainier and their associated urban growth areas are also located within the Deschutes Watershed. The river has a number of water quality violations that have placed it on the federal Clean Water Act Section 303(d) list of impaired waters for dissolved oxygen (DO), fecal coliform, temperature, pH, and fine sediment since 1998. This listing means that the beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. Waters on the 303 (d) list of impaired waters fall short of state surface water quality standards and are not expected to improve within the next two years.

Nutrient levels in the Deschutes River contribute to pollution issues in Capitol Lake, and its discharge is considered a major contributor to low DO in Budd Inlet. According to the *Puget Sound Dissolved Oxygen Model Nutrient Load Summary, 1999-2008* (2011), the Budd/Deschutes Watershed is one of the top 20 contributors of dissolved inorganic nitrogen (DIN) to Puget Sound and one of the single highest contributors relative to its size. Total Maximum Daily Load (TMDL) or Water Quality Improvement (WQI) projects are required for water bodies listed on the 303 (d) list of impaired waters. The Washington State Department of Ecology has been developing a water cleanup plan to establish Total Maximum Daily Loads for key pollutants in the Deschutes River since 2003, and in 2015 the agency released a draft Water Quality Improvement Report/Implementation Plan (Wagner and Bilhimer, 2014).

According to a recent assessment by Thurston Regional Planning Council: *Estimates of Current and Future Impervious Area and Forest Lands Vulnerable to Urban Conversion* (2015), under current land use regulations, total impervious area could increase from 5.5 percent to 6.5 percent of the total study area over the next few decades, and to over eight percent at buildout. Under current zoning, nearly 2,240 additional acres of impervious surfaces and more than 13,300 new dwelling units could be added in the full study area at buildout. Although some of this development will occur in urban areas served by sewer, current zoning and development standards mean many of these units are likely to be built in rural areas using septic systems. Even a house with a properly functioning septic system releases around eight times more nitrogen than a home connected to a wastewater treatment plant (Thurston County Environmental Health). Thus, the cumulative impact of additional housing units with septic systems will be considerable.

The *Deschutes TMDL Water Quality Technical Report* (2012) identifies urbanization as a key potential contributor of excess nutrients. The report advises: "With no change in development from previous practices, future growth is expected to reduce riparian vegetation further, increase impervious surfaces, and increase the demand for groundwater. All of these factors will worsen existing temperature, DO, and pH impairments in the Deschutes River Watershed." A variety of potential management activities were recommended to mitigate low dissolved oxygen levels in the watershed and limit nutrient and sediment sources, including implementing low-impact development techniques, managing the operations of onsite septic systems in sensitive areas, and restoring riparian vegetation. It is essential and timely to address land use in the

[1] The study area for this project does not include Capitol Lake because the Washington State Department of Ecology (Ecology) will not be finished with its Water Quality Improvement Report and Implementation Plan for Capitol Lake and Budd Inlet within the timeframe of this project. In addition, because Percival Creek drains to Capitol Lake and not directly to the Deschutes River, Percival Creek basin is not included as part of the study area.

Deschutes Watershed now, before projected growth further contributes to water quality degradation and loss of habitat.

1.3 Why This Matters

The Deschutes Watershed offers many water-related recreation activities, as well as wildlife habitat and beautiful scenery. Unfortunately, the quality of water in some areas of the Deschutes River, Capitol Lake and Budd Inlet are below state standards. In order to return the river to a healthy condition, it is necessary to reduce and limit the level of pollutants in the water. A state-led coordinated TMDL has begun. In addition, local governments will need to take proactive steps to plan for future development to occur in a way that will maintain and improve water quality.

Urbanization and the water quality problems created by polluted stormwater are affecting the rivers, creeks, and lakes within the Deschutes TMDL Boundary and this study area. Polluted stormwater runoff can send nutrients, sediments, bacteria, toxic substances, oil, and grease into surface waters. The water in the rivers and creeks within this study area is also influenced by nonpoint source pollution outside of the Olympia, Lacey, and Tumwater urbanized areas (Wagner and Bilhimer, 2014).

Table 1: Pollutants included in the Deschutes River freshwater TMDL

Pollutants
Fecal coliform - Fecal coliform bacteria (hereafter referred to as “bacteria”) are common in nonpoint source pollution as well as in stormwater. Many kinds of bacteria, viruses or other pathogens that can make people sick are common in human and animal waste. Fecal coliform bacteria in water indicates that human or animal waste (feces) may also be in the water. Our waters can get bacteria from untreated or partially treated discharges from wastewater treatment plants, improperly functioning sewage systems, pets, domestic animals, and wildlife (Wagner and Bilhimer, 2014).
Dissolved oxygen - oxygen dissolved in water - is essential for fish and aquatic life to “breathe” and survive. Salmonids and other aquatic organisms can be stressed or killed by low levels of dissolved oxygen. Ecology is required to protect salmonids listed as threatened or endangered under the Endangered Species Act (ESA). Ecology is also required to protect fish, shellfish, and wildlife as a beneficial use in our state water quality standards. Dissolved oxygen is used up when organic matter decomposes in the water and sediments. Dissolved oxygen is also needed for other chemical and biological processes (Wagner and Bilhimer, 2014). Nutrients from human activities can lead to excess plant growth that decreases dissolved oxygen.
Temperature – impacts the types of organisms that can live in a water body. Cooler water can hold greater levels of dissolved oxygen necessary for fish and other aquatic life to breathe. As water temperatures increase, the water holds less dissolved oxygen. Threatened and endangered salmon as well as other aquatic organisms require cold, clean, oxygenated water for survival (Wagner and Bilhimer, 2014).
pH – is the measure of the acidity or alkalinity of the water body. The optimal pH for fish and other aquatic species to thrive is between 6.5 and 8.5 (7 is neutral). When pH values are higher or lower than this range, other contaminants in the water may become more harmful to aquatic life (Wagner and Bilhimer, 2014). Excess plant growth from human activities can also further impair pH conditions.
Fine sediment – Fine sediment can carry harmful chemicals, such as pesticides or other toxics, into the water. Fine sediment can also create cloudy or muddy water, which can irritate fish gills and reduce a fish’s ability to find food. In addition, once fine sediment settles to the bottom of a water body, it can suffocate spawning nests (called redds) of threatened and endangered salmon (Wagner and Bilhimer, 2014).

1.4 Report Purpose

The first step of the Deschutes Watershed Land Use Analysis project is to gather and review all relevant data on current conditions for the study area that could be used to inform the development of different land use management options. Many relevant studies on the Deschutes Watershed have been conducted over the years, including through the Deschutes TMDL, the Puget Sound Watershed Characterization Project, and a septic assessment study conducted by Thurston County's Environmental Health department. Existing information about the Deschutes Watershed will be summarized in this report and used to focus this study by informing the following questions:What do we know about the current condition of the study area?

1. Which areas are at highest risk of development?
2. Which locations within the study area need protection from future development impacts to maintain water flow processes, water quality, and habitat?
3. Which areas can best accommodate future development without degrading ecologically sensitive processes and habitats?
4. Which areas would benefit most from restoration of ecological processes?

This analysis will help to identify focus areas for further study. Once a focus area is selected, the project team will investigate the impact of different management scenarios, and identify recommendations that support a reduction in nutrients and improved water quality.

1.5 Regulatory Overview

Several federal and state laws regulate the maintenance of clean water, protection of species, and critical environmental areas. These policies provide a framework that local planners work within to develop land use policies and development regulations. The policies listed below support efforts to maintain and improve water quality and salmonid habitat within the Deschutes Watershed.

1.5.1 Federal

a. Clean Water Act

The federal Clean Water Act (CWA), requires all states to restore their waters to be "fishable and swimmable." Section *303(d)* of the CWA established a process to identify and clean up impaired waters. Each state must have its own water quality standards designed to protect, preserve, and restore water quality. Water quality standards consist of designated uses for protection, such as drinking water supply and cold water biota, numeric and narrative criteria to achieve those uses, and an antidegradation policy to protect high-quality waters that exceed these conditions. Every two years, all states are required to perform a *water quality assessment* of the quality of surface waters in the state, including all the rivers, lakes, and marine waters where data are available. In Washington State, this assessment is administered by the Department of Ecology (Ecology), and is guided by federal laws, state water quality standards, and the Policy on the Washington State Water Quality Assessment (Susewind, 2012). The assessed waters are placed in five categories that describe the status of water quality.

Category 1 – Waters that met standards for parameter(s) for which they have been tested
Category 2 – Waters of concern
Category 3 – Waters with insufficient data available
Category 4 – Impaired waters that do not require a TMDL because they:
- 4a. – Have an approved TMDL being implemented
- 4b. – Have a pollution-control program in place that is expected to solve the problem
- 4c. – Are impaired by a non-pollutant that cannot be addressed through a TMDL such as low water flow, dams, or culverts

Category 5 – Impaired waters that require a TMDL – the 303(d) list

Category 5 is impaired waters that under the federal CWA, require a Total Maximum Daily Load (TMDL) or other Water Quality Improvement (WQI) project and collectively become the *303(d)* list. The *303(d)* list is waters whose beneficial uses – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These water bodies fall short of state surface water quality standards and are not expected to improve within the next two years (Ecology, 2015a).

The federal CWA requires that a TMDL, also referred to as a water cleanup plan, be developed for each of the water bodies on the 303(d) list of impaired waters. A TMDL study identifies pollution problems in the watershed and identifies how much pollution needs to be reduced or eliminated to achieve clean water. Ecology then develops a plan, with the assistance of local governments, agencies, and the community, which describes actions to control the pollution and a monitoring plan to assess the effectiveness of the water quality improvement activities. The water quality improvement report/implementation plan (WQIR/IP) consists of the TMDL technical study findings and implementation actions and goals (Roberts et al., 2012; Wagner and Bilhimer, 2014). Ecology is currently working on a TMDL for the Deschutes River.

b. National Pollutant Discharge Elimination System (NPDES)

The National Pollutant Discharge Elimination System (NPDES) is a permit program created under the CWA aimed at controlling and regulating point sources (discrete conveyances such as pipes or man-made ditches) of discharge of pollutants to waters within each state. The intent of the CWA is to protect and restore waters for “fishable, swimmable” uses.

In the state of Washington, the federal Environmental Protection Agency (EPA) has delegated permit authority to Ecology. Ecology issues NPDES Phase I and II permits including the municipal stormwater general permit (MSWGP), the industrial stormwater general permit (ISWGP), the sand and gravel general permit (SGGP), and the construction stormwater general permit (CSWGP). In general, Phase I communities are municipalities with populations of 100,000 or more that own and/or operate a municipal separate storm system (MS4), while Phase II communities are those that operate an MS4 and have a population less than 100,000 but more than 1,000 people per square mile.

The Phase II Western Washington Municipal Stormwater Permit went into effect in 2003 (and has been updated several times) and applies to small urban areas such as northern Thurston County’s urban core. Olympia, Tumwater, Lacey and Thurston County are all considered Western Washington Phase II Municipal Stormwater general permittees and were first issued permits in January 2007. The City of Rainier has not triggered the threshold to require a stormwater permit.

The Permit allows municipalities to discharge stormwater runoff from municipal drainage systems into the state's waterbodies (i.e., streams, rivers, lakes, wetlands, etc.) as long as municipalities implement programs to protect water quality and natural resources.

As an NPDES Phase II community, Thurston County is required to:

- reduce the discharge of pollutants to the "maximum extent practicable;"
- protect water quality; and
- satisfy the appropriate water quality requirements of the Clean Water Act.

This is accomplished through a series of prescribed minimum control measures that the county is required to engage in including public outreach and education, public participation and involvement, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control, and pollution prevention and good housekeeping.

In order to comply with the requirements of the Phase II permit requirements, as well as provide safe and reliable drinking water, and protect and enhance aquatic habitat, Thurston County currently employs a suite of programs and activities to reduce flooding, erosion and pollution caused by stormwater runoff. The county maintains a robust environmental outreach and education program and engages in long-range planning activities such as the development of basin plans and watershed characterizations. In addition, the county manages stormwater runoff from development by publishing and enforcing the Drainage Design and Erosion Control Manual, inspecting stormwater facilities at neighborhoods and businesses to make sure the facilities work properly; providing on-site consultation on drainage issues; providing free workshops to teach residents how to maintain stormwater ponds and meet reporting requirements; and constructing and maintaining stormwater facilities to help reduce flooding and erosion in older neighborhoods that were built before development rules were in effect.

While the NPDES permit program directs many of the county's current activities as they relate to stormwater and point-source pollution, the county was actively engaged in efforts to address flooding and runoff issues before it went into effect. In 1991, the Thurston County Storm and Surface Water Program adopted the 1991 Drainage Design and Erosion Control Manual as an ordinance stating the requirements and standards for the design of stormwater systems and control of erosion on construction sites within the cities of Olympia, Lacey, Tumwater, and unincorporated Thurston County. The City of Olympia Public Works Department lead an inter-jurisdictional effort to update and revise the manual, which was updated and adopted in 1994.

As noted above, the Phase II Western Washington Stormwater Permit went into effect in 2003. Olympia, Tumwater, Lacey, and Thurston County were first issued permits in January 2007. Based on requirements in Ecology's 2005 Permit and guidance in the Stormwater Manual 2005, an update of local regulations followed, with updated Drainage Design and Erosion Control Manuals adopted by affected local governments in 2009 (Thurston County) and 2010.

The 2009 Drainage Design and Erosion Control Manual for Thurston County greatly expanded the detail for construction stormwater pollution prevention, as well as expanded the section on Best Management Practices (BMPs), including greater design detail for each BMP. Furthermore, the 2009 manual included a volume related to source control and preparing a source control plan, and included BMPs and site planning practices related to Low-impact Development (LID).

Ecology updated their Phase II Western Washington Municipal Stormwater Manual in 2012 and amended it in 2014. Phase II jurisdictions are required to adopt updated regulations by December 31, 2016. Thurston County and the City of Olympia updated their Stormwater Management Program Plans in 2014 and an update to the 2009 Drainage Design and Erosion Control Manual for Thurston County is anticipated for 2016. The updated manual will include new requirements for LID, revised guidelines for wetlands, new and revised construction BMPs, revised guidance on calculating infiltration rates, and revised guidance for modeling in the Western Washington Hydrology Model.

c. Safe Drinking Water Act

In 1974, Congress passed the Safe Drinking Water Act (SDWA). The SDWA calls for EPA to protect public health by developing federal requirements for Underground Injection Control (UIC) programs to prevent injection wells from contaminating underground sources of drinking water. The federal regulations for the UIC Program are found in Title 40 of the Code of Federal Regulations.

d. 1854 Treaty of Medicine Creek

The tribes of the 1854 Treaty of Medicine Creek ceded land encompassing the Deschutes Watershed to the United States while reserving tribal rights to take fish in their “usual and accustomed” areas and hunt on “open and unclaimed land” within their traditional hunting territories. The Deschutes River and watershed is within the Squaxin Island Tribe’s treaty “usual and accustomed” fishing area and aboriginal hunting grounds (Roberts et al., 2012)

e. Endangered Species Act

The Endangered Species Act (ESA) was passed in 1973 to protect and recover imperiled species and the ecosystems upon which they depend. Under the ESA, species may be listed as either endangered or threatened. Ecology is required to protect salmonids listed as threatened or endangered under the Endangered Species Act and identified as a beneficial use in our state water quality standards.

1.5.2 State

a. Shoreline Management Act

In 1972, voters approved the State Shoreline Management Act through public referendum. This state law required local governments to adopt plans and standards for development along the large bodies of waters to prevent harm from uncoordinated and piecemeal development on the state’s shorelines. In a state where comprehensive planning and zoning had been optional, shoreline master programs required local planning for the small ribbon of land along designated shorelines.

The Washington Legislature directed Ecology in 1995 to update guidelines for developing shoreline master programs (a requirement of the Shoreline Management Act). The update of the guidance was completed in 2003. Lacey and Tumwater have completed their updates; Olympia’s locally approved updated plan is under review by the Department of Ecology, and Thurston County is in the midst of its update (Local planning staff, March 2015).

b. Growth Management Act

The Growth Management Act (GMA) (1990) is a state law that requires state and local governments to manage Washington’s growth by identifying and protecting critical areas and natural resource lands, designating urban growth areas, preparing comprehensive plans and implementing them through capital investments and development regulations. The GMA was adopted because the Washington State Legislature found that uncoordinated and unplanned growth posed a threat to the environment, the quality of life in Washington, and sustainable ecologic development. Olympia completed the update of its Comprehensive Plan in 2014. Lacey, Tumwater, Rainier, and Thurston County are expected to complete their updates in 2016.

In 1995, the state amended the Growth Management Act to require counties and cities to include the "best available science" in developing policies and development regulations to protect the functions and values of critical areas. These policies were updated between 2005 and 2012 – depending on the jurisdiction (TRPC and Thurston County, 2013). Local governments are required to protect five types of critical areas: important fish and wildlife habitat areas, wetlands, critical aquifer recharge areas, frequently flooded areas, and geologically hazardous areas (such as bluffs).

c. Chapter 90.48 Revised Code of Washington

Washington State has a water pollution control law (Chapter 90.48 RCW) "to maintain the highest possible standards to insure the purity of all waters of the state consistent with public health and public enjoyment thereof, the propagation and protection of wild life, birds, game, fish and other aquatic life, and the industrial development of the state, and to that end require the use of all known available and reasonable methods by industries and others to prevent and control the pollution of the waters of the state of Washington." The law requires the state to use its powers to maintain and secure high quality for all waters of the state.

1.6 Watersheds, Basins, Sub-basins, Assessment Units

The terms watershed, basin, sub-basin and assessment unit are used throughout this document. A watershed consists of all land area that "sheds" water to the outlet during a rainstorm (Figure 1).

Within this broader watershed are smaller watersheds, which are described in this study as basins. These might be described as the area draining to Point B in Figure 1.

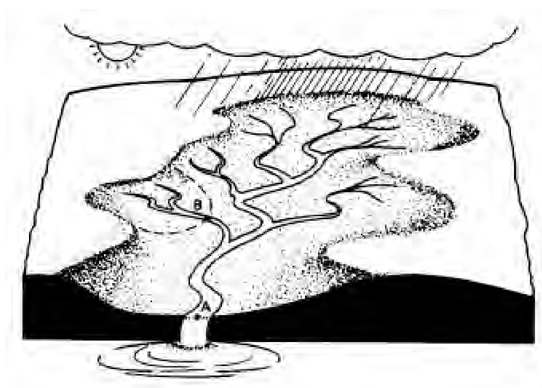

Figure 1: Delineation of a watershed boundary
Source: Michigan State University Engineering Department

Thurston County basin boundaries were defined several decades ago based on U.S. Geological Survey topographic maps. Basins were delineated for lakes and streams. These basins became the basis for a series of basin plans developed in the 1990s as collaborative interjurisdictional efforts between the county and cities. Over time, these basin boundaries have been adjusted slightly as better topographic data has emerged to delineate drainage areas. Drainage area refers to all the land that drains to a common body of water.

The boundary of the Deschutes River watershed and the basins within it was created using aggregations of the Puget Sound Watershed Characterization assessment units. These units are in turn aggregations of smaller catchments derived from the Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP). SSHIAP units were developed by the Northwest Indian Fisheries Commission to reflect the processes that form and maintain stream segments. They are based primarily on gradient and confinement, and, secondarily, on habitat types (Stanley, 2010).

Efforts have been made in this study to ensure that information collected from previous reports is consistent with the basin boundaries shown in this report. It should be noted that not all of the basins in this report are headwater basins, as the boundaries were meant to approximately correspond with existing reports.

The project study area (Map Folio Map 1; Map 2) consists of the Deschutes River Basin mainstem and several smaller headwater basins including: Chambers, Spurgeon Creek, Offut Lake, McIntosh Lake, Reichel Lake, and Lake Lawrence. In order to ease geographic descriptions, for this report, the Deschutes River Basin mainstem has been broken into three sub-basins – lower, middle, and upper – based on natural geomorphic breaks (Raines, 2007).

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2. Current Conditions

2.1 Deschutes River Watershed Overview

The 128-square-mile study area extends northwest from the forested foothills along the southern Thurston County border northeast to an area south of Capitol Lake (Map Folio Map 1). The Deschutes River flows into Budd Inlet via Capitol Lake, although Capitol Lake, Percival Creek Basin, and Budd Inlet are not included in the study area. The study area includes the following basins: the Deschutes River Basin [broken into the Deschutes River Mainstem Lower Sub-basin, Deschutes River Mainstem Middle Sub-basin, and Deschutes River Mainstem Upper Sub-basin], Chambers Creek Basin, Spurgeon Creek Basin, Offut Lake Basin, McIntosh Lake Basin, Lake Lawrence Basin, and Reichel Lake Basin. The study area includes portions of Thurston County, the cities of Olympia, Lacey, Tumwater, and Rainier. The upper watershed is primarily in forest land use; the middle watershed is a mix of agricultural, forest, rural, and residential land use; and the lower watershed is mainly urban land use. The study area faces growth pressure, particularly in the lower section.

2.1.1 Climate

The climate within the study area is characterized by generally warm-dry summers and mild-wet winters. Throughout much of the study area, winter air temperatures rarely drop below freezing due to the moderating effects of the Pacific Ocean and the area's relatively low elevation (from sea level to roughly 2,200 feet). During most years, summer daily maximum air temperatures are typically in the mid-to-high 70s (21-26°C) and rarely surpass 80°F (26.7°C) for more than a few days at a time. Roughly 80% of Olympia's annual precipitation falls in the winter between October and March. The wettest month is typically December, with an average rainfall of 8.23 inches. July is usually the driest month, with an average rainfall of 0.73 inches. Due to the relatively low elevation of the Deschutes headwaters, nearly all precipitation falls as rain, reflected in streamflow patterns where the highest discharges occur following large winter storms (Roberts et al., 2012).

Global climate change effects in the study area are likely to increase the number of high precipitation events during winter and spring months. Increases in air temperatures will result in more precipitation falling as rain rather than snow and earlier melting of the winter snowpack. More precipitation in winter with less snowpack in the headwaters will mean higher winter flows and runoff. Summer streamflow will still depend on groundwater stored in the system during the wet season. Higher summer temperatures will raise instream temperatures particularly in the event of a relatively dry water year (Wagner and Bilhimer, 2014).

2.1.2 Topography

The Deschutes River enters Thurston County from the south, surrounded by hills that rise up to approximately 2,200 feet in elevation. The river winds down from the hills in a northwest direction, to its drainage point in Budd Inlet.

2.1.3 Geology and Soils

The hills in the southern portion of the study area are composed primarily of erosion-resistant andesite flows that yield little groundwater. The remainder of the study area is covered with glacially-derived Vashon age deposits of glacial outwash gravel and sand that are highly permeable, interspersed with islands of low permeability Vashon glacial till and glacial drift. The outwash gravels and sands are both capable of yielding significant groundwater volumes (Roberts et al., 2012; Thurston County, 2013).

The hills in the southern portion of the study area in the Deschutes River Mainstem Upper Sub-basin, Reichel Lake Basin, and along the western side of the Deschutes River in the Deschutes River Mainstem Middle Sub-basin and Offut Lake Basin are composed primarily of group C soils with low infiltration rates. The eastern side of the Deschutes River Mainstem Middle Sub-basin and several sizable areas in the Deschutes River Mainstem Lower Sub-basin are composed of Group A and B soils with moderate to high infiltration rates. The Deschutes River Mainstem Lower Sub-basin also contains many interspersed areas of Group C and D soils with low to very low infiltration rates (Map 3).

Hydrologic Soil Group Classifications - defined by the Natural Resources Conservation Service (NRCS). (Thurston County Drainage Design and Erosion Control Manual, 2009).

A = (low runoff potential). Soils having low runoff potential and high infiltration rates, even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission (greater than 0.30 in/hr.).

B = (moderately low runoff potential). Soils having moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.3 in/hr).

C = (moderately high runoff potential). Soils having low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine textures. These soils have a low rate of water transmission (0.05-0.15 in/hr).

D = (High runoff potential). Soils having high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a hardpan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

2.1.4 Hydrology/Surface Water Features

The southern part of the study area in the foothills contains large areas mapped as “rain-dominated zones” as well as areas of “rain-on-snow zones.” Much of the precipitation that falls in this area runs off because of the impermeable andesite flow that dominates the landform (Thurston County, 2013).

The Deschutes River is the primary stream draining the Deschutes Watershed. Within the study area, there are also many small tributaries to the Deschutes River, including (from upstream to downstream): Little Deschutes River, Johnson Creek, Mitchell Creek, Fall Creek, Hull Creek, Pipeline Creek, Lake Lawrence Creek, Reichel Creek, Silver Creek, Offut Lake Creek, Tempo Lake Outlet Creek, Spurgeon Creek, Ayer (Elwanger) Creek, and Chambers Creek (see Map 2).

The study area contains many important areas for surface water storage such as depressional wetlands, wetlands, lakes, 100-year floodplain, and unconfined river channels. Lakes within the study area include: Barnes Lake, Hewitt Lake[2], Munn Lake, Lake Susan, Trails End Lake, Sheehan Lake, Sunwood Lake, Smith Lake, Southwick Lake, Tempo Lake, Offut Lake, McIntosh Lake, Reichel Lake, and Lake Lawrence (Map 2). There are numerous small, Palustrine wetlands and depressional wetlands scattered throughout the study area, with concentrations within the cities of Tumwater, Olympia, and Lacey, around Chambers and Spurgeon Creeks, and around Lake Lawrence. The 100-year floodplain is mapped around most of the Deschutes River, Chambers Creek, Spurgeon Creek, Silver Creek, Reichel Lake Creek, and the lakes. Unconfined stream channels are found along portions of Chambers Creek, Spurgeon Creek, Silver Creek, the majority of the Deschutes River and numerous unnamed tributaries (Thurston County, 2013).

Munn Lake and Susan Lake are connected open-water wetlands via an unnamed stream and associated wetlands. Trails End Lake is connected to Munn Lake via an unnamed stream; however, this stream flows through a culvert under 73rd Avenue SE (Thurston County, 2013).

Tempo Lake is a human-made reservoir created in 1962 from an area that was originally an alder farm. Tempo Lake does not have an inlet stream. It drains via an unnamed stream to the Deschutes River. The lake level is controlled by the residents of the Tempo Lake subdivision through a dam/control structure located at the Tempo Lake outlet (Thurston County, 2013).

Chambers Basin

Chambers Basin contains Chambers Lake, Little Chambers, Smith Lake, Chambers Ditch, and Chambers Creek. Chambers/Little Chambers Lake complex is the largest waterbody in Chambers Basin. It does not have a feeder system, but Little Chambers Lake does form the headwaters for Chambers Ditch. Smith Lake is a 12-acre, groundwater-fed lake (Thurston County, 1995a). See note regarding Hewitt Lake above. The lakes within Chambers Basin have no feeder streams. The only surface water feeders to the lakes are stormwater systems from surrounding developments in Olympia and Lacey. Chambers Lake flows into Little Chambers Lake via a 500-foot-long channel. Little Chambers Lake is the headwaters of Chambers Ditch. Chambers Ditch meets the South Tributary when it flows into Chambers Creek (Thurston County, 1995a). Chambers Ditch is a seasonal stream that was ditched for most of its length early in the century. Chambers Ditch flows from Chambers Lake south to its juncture with Chambers Creek and the South Tributary upstream of Rich Road. Chambers Creek is a natural stream with year-round flow through most of its length. Chambers Creek flows into the Deschutes River. The South Tributary is a network of natural channels, artificial ditches, and poorly defined wetlands, which flows intermittently and remains dry most of the year (Thurston County, 1995a). Some wetlands in the basin have been filled for development. Construction of Chambers Ditch reduced the extent and affected the quality of wetlands in this

[2] Hewitt Lake is included within the Deschutes basin boundary in this study to maintain consistency with the Ecology sub-watershed boundaries. Hewitt Lake is a small pothole kettle lake of 32 acres with no surface inflow or outflow.

area. The changes to the natural wetlands have altered the hydrology of the basin (Thurston County, 1995a).

Spurgeon Creek Basin

Spurgeon Creek Basin contains Sunwood Lake, which drains via an unnamed stream to Spurgeon Creek within its upper reaches. Spurgeon Creek is a low gradient, unconfined, small tributary to the Deschutes River. There are several unnamed tributaries which drain to Spurgeon Creek. There are wide associated wetlands for most of the creek, particularly in the upper reaches of shoreline jurisdiction (Thurston County, 2013).

Offut Lake Basin

Offut Lake is approximately 200 acres with a mean depth of 15 feet and a maximum depth of 25 feet. It is located at roughly 230 feet elevation. Offut Lake is fed by an unnamed tributary which flows into the southeast corner of the lake. An unnamed stream drains the northeast corner of Offut Lake to the Deschutes River. Offut Lake is mapped as an open-water wetland. There is an associated Palustrine forested wetland on its southwest side, and an associated Palustrine emergent/Palustrine scrub/shrub wetland complex on its east side (Thurston County, 2013).

McIntosh Lake Basin

McIntosh Lake is located four miles east of Tenino. It is 93 acres, with a mean depth of 8 feet, and a maximum depth of 11 feet. It is located at approximately 336 feet elevation. McIntosh Lake has no surface inlets and drains via an unnamed outlet to the Deschutes River (Thurston County, 2013).

Reichel Lake Basin

Reichel Lake Basin contains Reichel Lake and Reichel Creek. Reichel Lake has no surface water inlet. Its outlet is Reichel Creek which drains the lake via a large wetland to the Deschutes River. Reichel Lake is an open-water wetland with extensive associated wetlands to the south and southeast. Reichel Creek is a low-gradient, primarily unconfined small tributary (Thurston County, 2013).

Lake Lawrence Basin

Lake Lawrence is located in close proximity to the Deschutes River at an approximate altitude of 421 feet. The lake is 330 acres, with a mean depth of 13 feet and maximum depth of 26 feet; it has a large basin on the east side and a smaller basin on the west side. There is no surface water inlet. Water enters Lake Lawrence via direct precipitation, groundwater seeps, or stormwater runoff. Under normal conditions, Lake Lawrence discharges to the Deschutes River via an unnamed, seasonally or intermittently flowing stream (January to June) on the western shore of the west basin (Thurston County, 2014). The small outlet channel goes through a control structure across the Deschutes River floodplain to the Deschutes River. However, in extreme flooding conditions, the river water backs up to the lake (Thurston County, 2014). The lake water is in continuity with the shallow groundwater (Thurston County, 2013).

2.1.5 Groundwater

Seepage surveys were conducted on reaches of the Deschutes River as part of the Deschutes River Temperature TMDL Study, based on earlier studies by Thurston County (2002) and others (Map 4). Losing reaches are where a portion of river goes subsurface (into the riverbed) thus contributing to near surface groundwater and hyporheic flow; these reaches have net seepage values that are negative (less than zero). Gaining reaches are where a portion of near surface groundwater moves up into the river, thus gaining streamflow; these reaches have net seepage values that are positive (greater than zero) (Sinclair and Bilhimer, 2007).

Deschutes River (Mainstem Lower)

The Deschutes River between RK 54 and RK 58 is a losing reach. The remainder of the Deschutes River in the Mainstem Lower Sub-basin consists of gaining reaches.

Deschutes River (Mainstem Middle)

The area of the Deschutes River near Lake Lawrence until the confluence of Reichel Creek is a losing reach. Another losing reach occurs near State Route 507. The remainder of the Deschutes River within the Mainstem Middle Sub-basin are gaining reaches.

Deschutes River (Mainstem Upper)

The portion of the Deschutes River in the Mainstem Upper Sub-basin consists of losing reaches.

2.1.6 Critical Areas

Thurston County's Critical Areas Ordinance (TCC 24) was updated in 2012; it includes protective policies for five types of critical areas: important fish and wildlife habitat areas (including riparian corridors), wetlands, critical aquifer recharge areas, frequently flooded areas (including channel migration hazard areas), and geologically hazardous areas (including steep slopes and bluffs). A variety of critical areas are located within Deschutes River watershed (Map 5).

Deschutes River (Mainstem Lower)

The Deschutes River in this sub-basin has very wide areas of frequently flooded areas mapped around the river. There are numerous areas mapped as wetlands that are primarily concentrated around the river and include the Ayer Creek wetlands. Some important habitat areas are mapped in this basin. Geologic hazard areas are mapped around Tempo Lake and the Deschutes mainstem.

Chambers Basin

Chambers Basin contains several large areas mapped as wetlands, including Chambers Lake and Chambers Creek. There are few areas of mapped geologic hazard areas in this basin. Some small areas of important habitat are mapped in this basin. Chambers Creek and Chambers Lake are mapped as frequently flooded areas.

Spurgeon Creek Basin

Spurgeon Creek is a low-gradient, unconfined, small tributary. Spurgeon Creek Basin has geologic hazard areas mapped, primarily in the southern basin. Spurgeon Creek has wide, frequently flooded areas mapped for its length. There are wide associated wetlands along most of the creek, particularly in the upper reaches (Thurston County, 2013). Areas of important habitat are mapped in Spurgeon Creek Basin.

Offut Lake Basin

The Offut Lake Basin is mapped with geologic hazard areas in the southern half. The entire lake and its associated wetland on the east side are located within a frequently flooded area. Wetlands are mapped in numerous places within the basin. Important habitat areas are mapped in the basin. Potential channel migration may occur at the east side of the lake along the outlet stream (Thurston County, 2013).

McIntosh Lake Basin

Most of the McIntosh Lake Basin is mapped with geologic hazard areas. The lake itself is mapped as a wetland, and there are several additional wetlands located within the basin.

Deschutes River (Mainstem Middle)

The Deschutes mainstem in this sub-basin has wide areas mapped as frequently flooded areas, particularly around Offut Lake, Silver Creek, and Lake Lawrence. The basin contains scattered wetlands, with most concentrated in the southern half of the basin. Areas mapped as geologic hazard areas are most concentrated along the western side of the basin, although there are areas located throughout the basin. Some areas of important habitat are located in this basin.

Reichel Lake Basin

Reichel Creek is a low-gradient, primarily unconfined small tributary that drains Reichel Lake via a large wetland to the Deschutes River. Geologic hazards are mapped in the majority of the basin. The entire creek is mapped as a frequently flooded area. Reichel Lake is an open water wetland with extensive associated wetlands to the south and southeast. Reichel Lake has steep slopes and slide hazard areas mapped along its north shore (Thurston County, 2013).

Lake Lawrence Basin

Lake Lawrence is considered an open-water wetland. There is a large associated emergent and scrub/shrub wetland at the southern end of the eastern lake basin. Potential channel migration may occur around the outlet stream. The Deschutes mainstem is mapped as having a very wide frequently flooded area near Lake Lawrence that extends almost to the lake. The perimeter of the lake is mapped as containing geologic hazard areas (Thurston County, 2013).

Deschutes River (Mainstem Upper)

The Deschutes River Mainstem Upper Sub-basin is almost entirely covered with geologic hazard areas. It contains few wetlands, although some of located along the Deschutes mainstem, Hull Creek, and Huckleberry Creek. Frequently flooded areas are mapped along the Deschutes mainstem.

2.1.7 Federal, State, and County Listed Priority Habitat and Species

Deschutes River Mainstem

The Deschutes River is mapped as supporting resident and sea-run cutthroat trout, coho, fall Chinook salmon, sea-run and winter steelhead. The river is also mapped as supporting the spawning and rearing of fall Chinook, winter steelhead, and coho salmon. The Deschutes did not historically have native salmon runs because the falls in Tumwater acted as a natural barrier to upstream migration. However, a fish ladder was constructed in 1954. Artificial runs of coho and Chinook salmon have been established since the 1950's by the WDFW hatchery program (Thurston County, 2013). The lower and middle mainstem of the Deschutes River is primarily used by Chinook salmon. Coho salmon, steelhead trout, and sea-run and resident cutthroat trout use the middle and upper reaches of the watershed. The tributaries above barriers to anadromous salmonids are used by resident trout (Roberts et al., 2012).

The Deschutes Basin contains priority habitats for Mazama pocket gopher, streaked horned lark, elk, Taylor's checkerspot butterfly, wood duck, osprey, wild turkey, and Oregon vesper sparrow, as well as critical oak and grasslands. The following priority species are also mapped within this basin: waterfowl concentrations, western blackbirds, western bluebirds, and Oregon lamprey (Thurston County, 2013).

Chambers Basin

Chambers contains habitat for wood duck, Mazama pocket gopher, as well as oak and grasslands. Since the fish ladder was developed at Deschutes Falls, Chambers Creek and Chambers Ditch now contain coho and coastal resident cutthroat. Historically, cutthroat trout inhabited Chambers and Little Chambers Lakes, however in recent years, cutthroat have mostly disappeared. Triploid grass carp were introduced to Chambers Lake in 1990 in an effort to control weed growth. Chambers Lake is blocked to anadromous fish passage by screens meant to keep in the grass carp (TRPC and Thurston County, 2013).

Spurgeon Creek Basin

Spurgeon Creek provides habitat for Chinook and coho salmon, reticulate sculpin, Olympic mudminnow, wood duck, and waterfowl overwintering (Thurston County, 2013).

Offut Lake Basin

Offut Lake is mapped as supporting resident cutthroat as well as rainbow trout, largemouth bass and perch. The WDFW stocks Offut Lake with cutthroat trout, rainbow trout and triploid rainbow trout. Offut Lake's outflow acts as a fish barrier due to insufficient flow and a screen (WDFW). Downstream of the outflow barrier, the unnamed stream draining Offut Lake to the Deschutes River is mapped as supporting winter steelhead, coho salmon, and resident cutthroat and sea-run cutthroat trout. Offut Lake Basin may also provide habitat for wood duck and bald eagle. Urban oak canopy and oak-conifer forest is associated with Offut Lake along the north and southwest sides (Thurston County, 2013).

McIntosh Lake Basin

WDFW stocks McIntosh Lake with rainbow and triploid rainbow trout. Wood duck habitat is associated with McIntosh Lake Basin (Thurston County, 2013).

Reichel Lake Basin

Reichel Creek is mapped as supporting coho salmon, sea-run and resident cutthroat trout, winter steelhead, and waterfowl species. Reichel Lake is mapped as supporting resident cutthroat trout. This basin may contain areas of conifer/deciduous oak habitat, habitat for wood ducks, waterfowl concentrations, and prairie soils (Thurston County, 2013).

Lake Lawrence Basin

The WDFW stocks Lake Lawrence with rainbow trout, triploid rainbow trout, and cutthroat trout. The stream that flows out of Lake Lawrence is mapped as supporting winter steelhead, coho salmon, sea-run cutthroat, and resident cutthroat trout. These fish are blocked from entering Lake Lawrence by the presence of the Lake Lawrence outflow structure and a fish screen. Waterfowl concentrations and prairie soils are associated with Lake Lawrence. Blue heron, bald eagle, and waterfowl overwintering habitat are located within this basin (Thurston County, 2013).

2.1.8 Riparian Habitat

Riparian vegetation helps to maintain healthy stream conditions and water quality in several important ways. Near-stream vegetation intercepts shortwave radiation and reduces solar heat flux to the water's surface. Riparian vegetation creates a cooler microclimate around the water and stabilizes stream banks (Wagner and Bilhimer, 2014).

The riparian conditions and functions of the Deschutes River mainstem have been significantly impaired. Riparian vegetation has been altered over time, typically associated with the adjacent land use. Riparian buffer disturbance and removal has occurred in all land use categories, urban and suburban, agriculture, and forest management. The Thurston Conservation District completed a riparian assessment that identified specific degraded riparian area locations so revegetation efforts can be implemented where needed (Kutel, 2007) (Map 6).

Deschutes River (Mainstem Lower)

Many locations along the lower mainstem Deschutes River were identified as having moderate-to-poor existing shade conditions (Kutel, 2007) (Map 6). Ayer (Elwanger) Creek has poor riparian condition (Haring and Konovsky, 1999; TRPC and Thurston County, 2013).

Along the lower mainstem Deschutes River, south of the Tumwater UGA, the riparian vegetation returns to a mix of land cleared for agricultural purposes, fragmented forest associated with low-density residential development, and some remaining intact forested areas. Along the City of Tumwater's UGA boundary, the riparian vegetation is a mix of intact forested and wetland areas, mixed with areas of fragmented and cleared forest cover (Thurston County, 2013).

The riparian vegetation around Tempo Lake has been cleared and fragmented for residential development to the waterline in places (Thurston County, 2013).

Around Munn and Susan Lakes, vegetation is a mix of shrub and forest. The eastern side of Munn Lake's shoreline has unmodified forest cover however the remainder of riparian vegetation has been fragmented and cleared in areas for residential development (Thurston County, 2013).

Around Hewitt Lake vegetation is fragmented shrub and forest cover including residential plantings. There has been significant clearing of the native forest cover for residential use (Thurston County, 2013).

Chambers Basin

Chambers Creek and Ditch have long stretches of poor riparian shade cover (Kutel, 2007) (Map 6). Haring and Konovsky (1999) classified Chambers Creek as having inadequate riparian vegetation.

Spurgeon Creek Basin

Spurgeon Creek has a long stretch of poor existing riparian shade cover (Kutel, 2007) (Map 6). Haring and Konovsky (1999) classified Spurgeon Creek as having poor riparian condition with agricultural impacts and direct livestock access to the river channel.

The shoreline along upper Spurgeon Creek appears cleared for agriculture with little observable riparian vegetation. The majority of the middle creek appears to have unmodified forested riparian vegetation. The right bank (N) has a few areas of wetland scrub-shrub fragmentation due to agricultural clearing and utilities. The lower portion of Spurgeon Creek is primarily fragmented vegetation with a narrow riparian buffer, due to agricultural clearing and residential land use (Thurston County, 2013).

Offut Lake Basin

The Thurston Conservation District riparian shade cover study did not map this area (Kutel, 2007).

Riparian vegetation around Offut Lake is primarily intact on the west and east sides of the lake, and fragmented for residential development on the north and south sides of the lake. The west side of Offut Lake shoreline jurisdiction contains intact forest cover. The eastern side of the lake contains emergent and shrub vegetation upland. Portions of the associated wetland have been cleared and contain agricultural plantings. The residential areas on the north and south side of the lake contain fragmented native forest cover and residential plantings. Vegetation in these developed areas is cleared to the waterline in places (Thurston County, 2013).

McIntosh Lake Basin

The Thurston Conservation District riparian shade cover study did not map this area (Kutel, 2007) (Map 6). Shoreline vegetation on the south and east sides of the lake is primarily unaltered. Along the north shore, vegetation has been cleared extensively for residential development, in places close to the waterline. Plantings exist in areas containing residential development (Thurston County, 2013).

Deschutes River (Mainstem Middle)

Existing riparian shade cover varies from low to moderately high. Many areas on the Deschutes mainstem near Lake Lawrence have low-to-moderate shade cover, including the area around Highway 507. Silver Creek has low shade cover. There are some areas upstream and downstream of the Reichel Creek confluence that have moderately high riparian shade (Kutel, 2007) (Map 6).

The Deschutes River middle reaches are zoned a mix of Rural Residential Resource 1/5 and Long Term Agriculture. Riparian vegetation within shoreline jurisdiction changes notably with this change in zoning. The riparian vegetation along these reaches is a mix of land cleared for agricultural purposes, fragmented forest associated with low-density residential development, and some remaining intact forested areas. Between Reichel Lake Creek and south of State Highway 507, the zoning returns to Long Term Forestry and the shoreline riparian area is primarily forested again. North of State Highway 507, the Silver Creek arm of shoreline jurisdiction and the right bank (east) of the Deschutes contain large areas cleared for agriculture. The left bank (west) of the Deschutes is primarily intact forest in this section. North of the Silver Creek confluence to the northern boundary of the Deschutes River Mainstem Middle Sub-basin, the riparian vegetation returns to a mix of land cleared for agricultural purposes, fragmented forest associated with low-density residential development, and some remaining intact forested areas (Thurston County, 2013). A portion of the riparian area near the Lake Lawrence outlet that had been cleared for agricultural activity was replanted in 2015 as part of an ongoing water rights mitigation project on property owned by the cities of Olympia, Yelm, and Lacey.

Reichel Lake Basin

The Thurston Conservation District riparian shade cover study did not map this area (Kutel, 2007) (Map 6). Reichel Creek's most upstream reach is primarily forested but has the potential to be heavily forested or clear-cut, based on usage as Long Term Forestry zoning. The lower reaches are extensively cleared and modified for agricultural use. Very little riparian vegetation remains in these reaches. The left bank (west) of the lowest reach is a mix of intact forest cover and a large area cleared for commercial use (Thurston County, 2013).

Along Reichel Lake and its associated wetlands the riparian vegetation is forested, with large areas completely cleared for timber harvest. Native forested or shrub vegetation exists immediately around the lake, however, the vegetated buffer is very thin in areas. The lake's north shore has a wide area of intact forest cover. The east side of the lake is intact emergent wetland. The south and west sides of the lake exhibit extreme loss of forest cover, with minimal vegetated buffer left around the lake (Thurston County, 2013).

Lake Lawrence Basin

There is low riparian shade cover where the outlet meets the Deschutes River (Kutel, 2007) (Map 6). Riparian vegetation along the outlet channel is planned to be restored as part of an ongoing water rights mitigation project on property owned by the cities of Olympia, Yelm, and Lacey.

Shoreline vegetation has been extensively altered around portions of Lake Lawrence, particularly around the west basin and the northern half of the east basin. Much of the shoreline vegetation has been cleared and fragmented for residential development, in many places to the lake edge. However, there are several places along the shoreline with unmodified vegetation. Two state-listed noxious weeds, fragrant waterlily (*Nymphaea odorata*) and yellow flag iris (*Iris pseudacorus*), have been discovered in Lake Lawrence (Thurston County, 2013).

Deschutes River (Mainstem Upper)

There is one small area of low percent shade cover at the mouth of Johnson Creek (Kutel, 2007) (Map 6).

The Deschutes River upper reaches are primarily zoned Long Term Forestry and are surrounded by intact forested buffers for the most part, although in some areas timber harvest has encroached.

The riparian vegetation surrounding Mitchell Creek is primarily intact. Riparian vegetation for the Little Deschutes River is primarily intact; however, the upper and lower left bank (south) include areas entirely cleared of vegetation for timber harvest (Thurston County, 2013).

2.1.9 In-stream and Wetland Habitat

Many of the freshwater shorelines within the study area have experienced human alteration. Much of the floodplain and many of the wetlands associated with the

Deschutes River have been modified. Many of the areas adjacent to the rivers within the study area are utilized for agriculture, which has altered natural shoreline vegetation, associated habitat and occasionally water courses (Thurston County, 2013).

Deschutes Mainstem

In-stream and wetland habitat conditions vary for the Deschutes Mainstem and its tributaries. Haring and Konovsky (1999) classified the Deschutes mainstem (within this study area) as having: inadequate instream flow; lack of off-channel habitat; insufficient LWD; high levels of fine sediment; and elevated summer water temperature in the river. However, they pointed out that the mainstem Deschutes contains good spawning habitat between the mouth of Spurgeon Creek and Offut Lake outlet that warrants special consideration for protection (Haring and Konovsky, 1999).

Ayer (Elwanger) Creek suffers from agricultural impacts and high levels of fine sediment. Mitchell Creek contains low levels of LWD, high mass wasting, and high in-stream bank erosion. Johnson Creek exhibits bank erosion, lack of LWD, and the presence of fine sediments in the gravel (Haring and Konovsky, 1999).

A 2004 study of the Deschutes River by Konovsky and Puhn (2005) found four out of five sampled sites had fine sediment levels >17% and were rated as poor for salmonid spawning habitat based on Appendix F of the Timber, Fish, and Wildlife Watershed Analysis Manual (Washington Forest Practices Board, 1997) (Roberts et al., 2012).

Efforts to limit erosion upstream from Tumwater Falls has inhibited river channel migration, which has reduced off-channel areas for salmonid rearing in the lower reaches. However, in the middle and upper reaches, wetlands and off-channel areas exist in several locations (TCDLE, 2005).

Fine sediments have been introduced to the Deschutes River system through managed forestlands in the upper watershed and tributaries. This problem was accentuated by several significant forest road failures in recent years during abnormally high precipitation events (TCDLE, 2005).

Taylor (1999) inventoried off-channel habitat in the Deschutes River to assess their availability for use by salmonids. Juvenile salmonids, particularly coho, use off-channel habitats extensively in western Washington. Off-channel habitats may be used in winter to avoid storm events and freezing temperature. Salmonids may move into off-channel ponds and springs in the summer to escape increasing temperatures, avoid predators, or find a change in food sources. Floodplain development and channelization of the Deschutes River have been identified as decreasing off-channel habitat and limiting coho production. Ditching and draining of floodplains, artificial bank protection, and channelization reduce connectivity between the river and its floodplain and limit the availability of off-channel habitat for juvenile salmonids (Collins, 1994).

The Taylor (1999) study identified 1.3 miles of overflow channels, meander bends, and oxbows as potential off-channel rearing areas. The study found that fish could potentially access 82.2 acres of wetlands. Ponded habitats such as oxbows and wetlands are crucial for coho rearing; however, these habitats are relatively rare in the watershed compared to what historically may have existed along the Deschutes River. Approximately 9 to 19% of off-channel habitats within the mainstem Deschutes River corridor are associated with reaches with more than 50% modification of the right or left bank. Roughly 23 acres of potential wetland habitat are characterized by the National Wetlands Inventory as modified by farming or excavation. Aerial photography has identified several areas where wetlands and sloughs appear to have been filled or modified. Riparian loss, bank erosion, and bank hardening are the main threats to overflow channels and backwaters along the mainstem Deschutes River corridor. In addition to structural modifications of channel banks, fine sediment inputs can also threaten the quality of off-channel habitats by filling pools used by juvenile salmonids or by burying redds. Schuett-Hames and Child (1996) found mid-high levels of fine sediments in spawning gravels in five sections of the Mainstem, two of which corresponded to off-channel areas located in the inventory (Taylor, 1999).

Chambers Creek Basin

Haring and Konovsky (1999) classified Chambers Creek as having inadequate spawning gravel and low summer flows.

Chambers Creek offers three types of coho habitat. The segment near the mouth contains a few spawning sites. The lower section provides year-round rearing habitat from the springs below Rich Road to the mouth. The portion from the springs below Rich Road up to a point below Yelm Highway provides winter habitat as long as the creek is flowing. The area near the mouth of Chambers Creek is the best remaining habitat for anadromous fish in Chambers Basin with relatively clean gravel, large trees, and a well-developed understory near the creek that provides shading. Upstream from the mouth, the habitat quality declines. The riparian cover gives way to open fields south of the creek below Rich Road (Thurston County, 1995).

The lower quarter mile of the South Tributary upstream of Rich Road contains viable seasonal habitat for migrating fish, with fair overhanging cover and in-stream woody debris. However, upstream, it has been channelized through agricultural lands, and disappears frequently in the wetlands. There is poor substrate and very little large organic debris in the channel (Thurston County, 1995).

Chambers Ditch dries up between Rich Road and Little Chambers Lake for most of the year. The ditch provides some rearing habitat when it is flowing, but not enough pools, riparian vegetation, or cover to offer good habitat (Thurston County, 1995).

Spurgeon Creek Basin

Spurgeon Creek's substrate is primarily sand and there has been a conversion of wetlands to agricultural uses along the creek (Haring and Konovsky, 1999).

Offut Lake Basin

No limiting factors have been noted for the Offut Lake Basin (Haring and Konovsky, 1999).

Reichel Lake Basin

Reichel Creek is impaired by agricultural activities including direct animal access to the creeks. In addition, run-off from a former log yard discharges fine sediment and contaminants to Reichel Creek (Haring and Konovsky, 1999).

2.1.10 Water Quality

Water quality in the study area was assessed using four main resources and summarized in Table 2. Thurston County Environmental Health and Thurston County Water Resources, in cooperation with the cities of Olympia, Lacey, and Tumwater, write bi-annual water quality monitoring reports. These reports provide an overall water quality rating, describe water quality issues within the monitored water bodies in the basin, and summarize results from benthic macroinvertebrate monitoring. The Washington Department of Ecology provides a map and list of waterbodies on Washington State's Water Quality Assessment 303(d) list of impaired water bodies list (Ecology, 2012) (Map 7).

In addition, the Department of Ecology has established a long-term ambient monitoring site on the Deschutes River at the E Street bridge in the lower Deschutes River watershed (Ecology, 2015). The data are used in the Section 303(d) assessment but also provide a long-term record of conditions at the site. Monitoring includes monthly grab samples analyzed for temperature, dissolved oxygen, nutrients, fecal coliform and other constituents as well as summer continuous monitoring for temperature and dissolved oxygen. Hallock (2009) used the data to assess trends in nitrogen in Puget Sound rivers and found that the Deschutes River shows a consistent upward trend in nitrogen concentration.

Monitoring of benthic macroinvertebrates has been conducted since the late 1990's in Thurston County's Puget Sound lowland basins. These samples are collected by South Sound Green and Stream Team volunteers, and Thurston County Environmental Health staff. The samples are compiled into a Benthic Index of Biotic Integrity (B-IBI) and provide a quantitative method for determining and comparing the biological conditions of streams. Thurston County Environmental Health and Thurston County Water Resources provided results of benthic macroinvertebrate monitoring between 2002 and 2012 and also post these results on the Puget Sound Benthos website: www.pugetsoundstreambenthos.org. Sampling for benthic macroinvertebrates occurs at only two locations within the study area: the Deschutes River at Pioneer Park, and Chambers Basin at the end of 58th Avenue (Table 3).

Table 2: Summary of water quality monitoring in the study area basins

Basin Name	Thurston County Rating	Issues	303(d) listed waterbodies in basin*	B-IBI
Deschutes River (Mainstem Lower)	Good (Deschutes mainstem)	High winter turbidity, summer temperature violations, habitat deficiencies and low-instream flow. High density septics in urban areas pose risk to groundwater and surface water. Nitrogen increasing since 2001 at the E Street bridge.	• Deschutes River – Temperature, Fine Sediment, Dissolved Oxygen, Bacteria Category 4C (impaired by a non-pollutant) - Large Woody Debris, Instream Flow • Ayer (Elwanger) Creek – Bacteria, pH, dissolved oxygen • Tempo Lake Outlet - Temperature • Munn Lake - Category 4C (impaired by a non-pollutant): Invasive exotic species	Moderate biologic integrity
Chambers	Good	Nitrate contaminated groundwater. High density septics in urban areas pose risk to groundwater and surface water.	Chambers Creek - Fecal Coliform bacteria	High biologic integrity
Spurgeon Creek	Good	Non-point pollution from rural residential and agricultural activities	Fecal Coliform bacteria	—
Offut Lake	—	—	PCB's in fish tissue	—
McIntosh Lake	—	—	PCB's in fish tissue	—
Deschutes River (Mainstem Middle)	Good (Deschutes mainstem)	High winter turbidity, summer temperature violations, fecal coliform bacteria, habitat deficiencies and low-instream flow.	• Deschutes River – Temperature, Fine Sediment, Dissolved Oxygen, Bacteria Category 4C (impaired by a non-pollutant) - Large Woody Debris, Instream Flow • Unnamed Creek (Tributary to Deschutes River) (near State Highway 507)– Temperature	—
Reichel Lake	—	—	Fecal coliform bacteria, temperature, and dissolved oxygen	—
Lake Lawrence	Fair (Lake Lawrence)	Eutrophic conditions, occasionally impaired uses from excessive algae and plant growth. High in nutrients.	• Lake Lawrence – Total Phosphorus • Lake Lawrence Creek – Dissolved Oxygen	—
Deschutes River (Mainstem Upper)	Good (Deschutes mainstem)	High winter turbidity, summer temperature violations, fecal coliform bacteria, habitat deficiencies and low-instream flow.	Fine sediment, dissolved oxygen, temperature, pH, and fecal coliform bacteria	—

*All are Category 5 listings except as specified.

Table 3: Benthic Index of Biotic Integrity (B-IBI) results within the study area, 2002-2001

Site Name	Site Location	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Range	Average
Chambers Creek	End of 58th Avenue*	40	44	44	42	36	42	42	38	38	36	38	36-44	40.0 high biotic integrity
Deschutes River	Pioneer Park	n/a	n/a	n/a	n/a	42	32	36	30	34	38	36	30-42	35.4 moderate biotic integrity

Source: Thurston County, 2015

Deschutes Mainstem

The Deschutes River water quality is categorized as 'Good' due to failing part 2 of fecal coliform standard for water year 2009/10 but meeting both parts in 2010/11. Turbidity is often high in winter and temperature violations occur in summer. Habitat deficiencies and low instream flow are a cause of concern for fisheries resources (Thurston County, 2012).

The Deschutes River is on the Washington State Water Quality Assessment 303(d) list of impaired water bodies for: fine sediment, dissolved oxygen, temperature, pH, and bacteria. It is also listed on the Clean Water Act Section 303(d) list as Category 4C (impaired by a non-pollutant) for lack of large woody debris and instream flow.

From 1988-2007, peak water temperature within the Deschutes River occurred in July and was well above the numeric criteria. Maximum peak temperatures occurred between 1000 Road and Vail Cutoff Road, where the valley slope decreases and widest channel widths occur. Temperatures cool downstream where groundwater enters the river (Roberts et al., 2012).

A longitudinal study in August 2003 when the Deschutes River flows were 76 cfs at E Street found temperature, DO, and pH generally increased during each day as expected with increasing solar radiation and primary productivity, but also areas with decreases in DO and pH associated with groundwater inputs. Total nitrogen and nitrate+nitrite increase between 1000 Road and State Route 507, then slightly rise to the E Street bridge. Total phosphorus and orthophosphate increase gradually between 1000 Road and E Street (Roberts et al., 2012; Wagner and Bilhimer, 2014).

Potential pollutant sources in the study area include a mixture of point sources and nonpoint sources. Point source discharges include combined sewer, domestic wastewater, and separate storm sewer systems operating under NPDES permits. Other potential permitted discharges include those operating under general permits for municipal stormwater, construction stormwater, industrial stormwater, and sand and gravel operations. Nonpoint sources are those traditionally more diffuse in origin that cannot be pinpointed to a discrete discharge location. Examples of nonpoint sources can include onsite sewage systems (OSS), domestic animals, fertilizers, land use activities, recreational users, roads, and culverts, in addition to natural sources (Roberts et al., 2012; Wagner and Bilhimer, 2014).

Chambers Basin

Water quality in Chambers Creek is rated as ‘Good.’ The creek meets water quality standards although nitrate concentrations are very high due to contamination of the groundwater. Most of the basin is within the urban growth area, and continued development can be expected to have an increasing effect on stream quality (Thurston County, 2012). Chambers Creek is listed on Washington State’s Water Quality Assessment 303(d) list of impaired water bodies for fecal coliform (Ecology, 2012).

Spurgeon Creek Basin

Water quality in Spurgeon Creek is rated as ‘Good.’ This rating is based on the creek meeting both parts of the fecal coliform standard in 2009/10 but failing part 2 in 2010/11. There was one turbidity violation in November 2009. Spurgeon Creek’s nutrient levels are fairly low. Thurston County identifies non-point pollution from rural residential and agricultural activities, and encroachment on wetland and riparian areas for livestock grazing as potential threats to water quality (Thurston County, 2012). Spurgeon Creek is listed on Washington State’s Water Quality Assessment 303(d) list of impaired water bodies for fecal coliform (Ecology, 2012).

Offut Lake Basin

Offut Lake is listed on Washington State’s Water Quality Assessment 303(d) list of impaired water bodies for PCBs in fish tissue (Ecology, 2012).

McIntosh Lake Basin

McIntosh Lake is listed on Washington State’s Water Quality Assessment 303(d) list of impaired water bodies for PCBs in fish tissue (Ecology, 2012).

Reichel Creek Basin

Reichel Creek is listed on Washington State’s Water Quality Assessment 303(d) list of impaired water bodies for bacteria, temperature, and dissolved oxygen (Ecology, 2012).

Lake Lawrence Basin

Lake Lawrence is rated ‘Fair’ for water quality due to eutrophic conditions and occasional impaired uses from excessive algae, aquatic plant growth, and toxic algae blooms. Lake Lawrence is high in nutrients and contains extensive plant and algae growth. Toxic blue-green algae blooms occurred in 2004 and 2010/11. Lake Lawrence is on Washington State’s Clean Water Act Section 303(d) list of impaired water bodies for total phosphorus (Ecology, 2012). The west basin appears to have slightly higher phosphorus levels than the east basin (Thurston County, 2014).

Lake Lawrence has had an active lake management district since 1986, which supports fisheries management and aquatic weed control activities. The Lake

Management District is currently implementing the “Lake Lawrence Integrated Aquatic Vegetation Management Plan.” Activities include: 1) pursuing a multi-faceted strategy to eradicate noxious aquatic plants, reduce native and non-native nuisance aquatic plants to improve recreational and aesthetic conditions, while maintaining fish and wildlife habitat; and, 2) providing public education opportunities to the lake area residents, focusing on nutrient reduction, maintaining and improving the lake’s water quality (Thurston County, 2014).

Thurston County monitors temperature, dissolved oxygen, pH, and conductivity for Lake Lawrence. The lake is thermally stratified in the summer with two distinct layers of water in the lake, a cold bottom layer and a warmer upper layer. When the lake is stratified, dissolved oxygen concentrations at the bottom were near zero in both basins. Under those “no oxygen,” or anoxic conditions, phosphorus is released from bottom sediment into the water column in a soluble form readily used by algae cells. During periods of thermal stratification, sample results typically show higher phosphorus concentrations at the lake bottom than at the surface. In 2014, the algae bloom began in August and peaked in October and produced the poorest water clarity since 1998 (Thurston County, 2014).

In 2014, the individual monthly phosphorus level was greater than the action level for surface water quality standards established by WAC 173-201A, every month except May and July in the big basin and July in the west basin. Higher total phosphorus concentrations can lead to undesirable algae growth that interferes with the recreational uses of the lake. The west basin has consistently higher nutrient levels than the big basin. In 2014, levels for both phosphorus and nitrogen were some of the highest on record. In 2014, Lake Lawrence was eutrophic in both lake basins, indicating high productivity. A eutrophic lake is generally considered to have poor water quality and undesirable characteristics, such as excess plant and algae growth (Thurston County, 2014).

The algae present in Lake Lawrence is often dominated by blue-green algae which can impair recreational activities and cause illness in people, pets, and wildlife if ingested. Dominance by blue-green algae is a sign of nutrient-rich conditions. Toxic algae blooms have occurred in Lake Lawrence in 2004, 2010, and 2013.

2.1.11 Septic System Analysis

High-density septic systems in the urban areas of Thurston County in conjunction with geologic and soil conditions are degrading water resources by polluting surface and ground water, causing loss of shellfish harvest areas, drinking water supplies, and water recreation. In 2011, the cities of Lacey, Olympia, and Tumwater, as well as LOTT and Thurston County formed a regional septic workgroup to identify how to address this problem. This group undertook a project called the “*Urban Septic System Analysis: Protecting Public Health and Water Quality*” (Map 8). The purpose of the Urban Septic System Analysis and “risk” ranking project was to identify areas within the urban area where septic systems pose a threat to public health and water resources (Davis, 2014).

Approximately half of the Thurston County urban area is located over areas with extremely coarse glacial outwash soils that are identified as having “extreme” vulnerability to contamination from land use activities. Groundwater in Thurston County urban areas have nitrate concentrations above background levels, indicating contamination from land uses. Some public water supply wells have had to be abandoned and an alternative source found because they exceeded the drinking water standard for nitrate. One home served by a septic system releases as much nitrogen into the environment as 10 households connected to sewer (Davis, 2014).

There is a greater risk of groundwater contamination in locations where the soils are coarse sand and gravel, because they have less ability to filter out and decompose contaminants than finer textured soils. Thurston County has widespread areas of coarse glacial outwash soils that are vulnerable to contamination. These areas are identified as critical aquifer recharge areas. The Thurston County Critical Areas Ordinance establishes more restrictive land uses within these areas to prevent contamination of drinking water aquifers. While the coarse glacial outwash soils quickly allow some contaminants to reach the ground water, they also pose a threat to surface water quality because the base flow for most Thurston County streams and lakes comes from shallow groundwater (Davis, 2014).

When nutrient-rich septic effluent reaches the shallow groundwater system and then seeps into a surface water body, the nutrients contained in that water can stimulate aquatic plant and algae growth. That plant and algae growth can reach nuisance proportions that cause an imbalance in the ecologic system and impair recreational and domestic uses (Davis, 2014).

In places where soils have very fine texture or there is a shallow restrictive layer limiting downward water movement, there is a greater risk that septic systems will fail to the surface. Septic systems that fail to the surface of the ground can discharge untreated or only partially treated sewage into nearby drainages, streams, or lakes, degrading water quality and posing a health risk to humans and animals who may come in contact with the polluted water. Sewage can contain bacteria, viruses and other organisms that cause illness if contacted or consumed (Davis, 2014).

As freshwater flows into Puget Sound, either through surface water or groundwater, the quality of that water impacts the marine environment. In many regions of South Puget Sound, septic systems are a major source of nutrient pollution. Algae blooms stimulated by excessive nitrogen are becoming more frequent and are contributing to low dissolved oxygen levels in Budd, Eld, and Henderson Inlets (Davis, 2014).

The Regional Septic Work Group developed criteria to identify priority areas to convert from septic to sewer in areas where ground water is at risk and areas where surface water is at risk. The criteria for groundwater risk included: high-density septic systems, very coarse soil, and in a wellhead protection area (Map 9). The criteria for surface water risk included: high-density septic systems, slowly permeable soils, and within 100 feet of surface water or stormwater system (Map 10). A neighborhood septic density analysis was conducted (Map 11) and combined with the groundwater risk scores (Map 12) and separately with the surface water risk scores (Map 13). The hotter the color on the Risk Category maps, the greater the risk to groundwater or surface water (Davis, 2014).

Within the study area there are numerous urban area septic systems that pose a risk to either groundwater or surface water quality. Several areas with higher risk to groundwater (categories 5 and 6) are located within the Deschutes Mainstem Lower Sub-basin and Chambers Basin, including: the eastern UGA of Tumwater that is currently proposed for annexation, Olympia’s southern UGA; and, Lacey’s UGA (Map 12). Within the study area, there are fewer neighborhoods categorized as higher risk to surface water. Those neighborhoods are primarily located within Olympia's southern UGA within the Chambers Basin, as well as one neighborhood within the city of Tumwater in the Deschutes Mainstem Lower Sub-basin (Map 13). Although some areas are categorized as posing higher risk to ground or surface water, it should be noted that all areas with septics pose some level of risk (Davis, 2014).

2.1.12 Water Availability for New Uses

There is limited water available for new uses in the Deschutes Watershed, particularly given that river levels need to be maintained to ensure adequate water quality and fish migration. The annual precipitation ranges from 40 inches to over 80 inches per year with most of the precipitation arriving during the winter months when overall water demands are the lowest. During the summer, when the snowpack is gone and there is little rain, naturally low stream flows are dependent on groundwater inflow. The demand for water for human uses, including irrigation, is at its annual peak in the summer. This means that when water demands are the highest, groundwater and surface water are least available. There has also been a significant population increase in the study area over the last 20 years, with almost 9,500 homes added in that time period (TRPC Data Program, 2015).

Most of the water in the Deschutes River watershed has already been claimed. Increased demands from population growth, low summer and early fall streamflow levels, and impacts from climate change exacerbate the difficulty of finding new water supplies, particularly during the summer months (Ecology, 2012b).

WAC 173-513, adopted in 1980, is the instream flow rule for the Deschutes Watershed, including Spurgeon Creek. The rule closes and partially closes the following streams to new surface water use:

- The Deschutes River below Deschutes Falls (RM 41) is closed to new surface water withdrawals from April 15 to November 1.
- The Deschutes River above Deschutes Falls (RM 41) and all tributaries of the Deschutes River are closed to new surface water withdrawals all year.

However, domestic use of surface water for a single residence and stock watering is exempt from WAC 173-513 if no alternative water source is available.

In Washington State, prospective water users must obtain authorization from the Department of Ecology before using surface or groundwater. Authorization is granted in the form of a water right permit or certificate (Ecology, 2013). Applicants seeking new water appropriations will likely need mitigation for the impacts their use of water will have on surface water bodies and on groundwater.

Areas of potential water supply in the Deschutes River watershed include various municipal sources and private water supply companies. Municipalities plan for future growth by implementing conservation measures to make their existing supply stretch further, and applying for new water rights years in advance of when they are needed. At this time all municipalities in the study area are able to accommodate new urban growth.

In rural areas, water rights are generally transferred from agricultural uses to residential to provide water for larger residential developments. However, the “groundwater permit exemption” allows certain users of small-quantities of groundwater to construct wells and develop their water supplies without first obtaining a water right permit from Ecology. They are generally referred to as exempt wells. Much of rural development occurs on exempt wells.

The groundwater-permit exempt uses include:

- Providing water for a single home or group of homes (limited to 5,000 gallons per day). (A group of homes *collectively* cannot use more than 5,000 gallons per day.
- Providing water for industrial purposes, including irrigation (limited to 5,000 gallons per day but no acre limit).
- Providing water for livestock (no gallon per day limit or acre restriction).
- Watering a non-commercial lawn or garden one-half acre in size or less (no gallon per day limit) (Ecology, 2013).

The Squaxin Island Tribe is concerned about maintaining flows and fish habitat in the watershed. Water right applications and mitigation plans are routinely sent to the Tribe for their review (Ecology, 2012b).

Map 14 shows the well logs for the study area.

2.1.13 Land Use/Land Cover

The upper watershed is dominated by forest cover, scrub/shrub, and grassland. The central watershed is covered by a mix of forest cover, scrub/shrub, pasture, and grasslands. The lower watershed is covered with low- and medium-intensity development, developed open space, forest, pasture/hay, and grassland (NOAA, 2011) (Table 4; Map 15).

Table 4: Land cover by basin within the Deschutes study area (land cover in acres)

Land cover	DESCHUTES RIVER LOWER			DESCHUTES RIVER MIDDLE					UPPER
	Chambers	Deschutes (Mainstem Lower)	Spurgeon Creek	Deschutes (Mainstem Middle)	Lake Lawrence	McIntosh Lake	Offut Lake	Reichel Lake	Deschutes (Mainstem Upper)
Bare Land	52	132	7	146	5	2	27	14	1,324
Cultivated	205	35	10	258	4	0	8	13	0
Deciduous Forest	377	789	277	888	79	72	129	153	246
Developed Open Space	1,152	1,446	93	384	164	28	65	14	0
Evergreen Forest	564	1,308	2,490	7,405	521	987	466	2,078	9,408
Grassland	346	761	378	3,555	96	26	214	317	3,790
High Intensity Developed	165	357	2	23	3	0	0	9	1
Low Intensity Developed	1,873	1,916	192	659	224	49	103	66	151
Medium Intensity Developed	1,192	908	38	117	11	2	8	13	6
Mixed Forest	590	1,080	818	2,407	306	136	188	290	1,515
Palustrine Aquatic Bed	42	59	0	0	10	3	6	0	0
Palustrine Emergent Wetland	139	244	250	144	74	3	37	60	42
Palustrine Forested Wetland	364	373	247	393	20	26	101	91	297
Palustrine Scrub/Shrub Wetland	114	214	204	239	28	27	39	87	99
Pasture/Hay	847	888	580	2,729	235	6	20	199	0
Scrub/Shrub	318	617	464	3,829	266	162	200	1,054	5,557
Unconsolidated Shore	0	1	1	1	0	4	1	0	9
Water	136	92	0	11	286	88	182	10	4

Source: NOAA C-CAP / Ecology 2011

2.1.14 Current Land Use

The predominant land uses within the study area are timber/forest land, agricultural, and residential (Table 5; Map 16). Timber/forest land is concentrated around the southern headwaters of the Deschutes, along the southern county border, and north along the southwest side of the river until just south of Offut Lake. The southern part of the watershed, primarily the mainstem upper portion of the study area, includes lands that are actively managed for commercial timber production as well as rural residential and agricultural uses. Weyerhaeuser Company, the Washington State Department of Natural Resources (DNR), and the U.S. Forest Service (USFS) own and manage public and private timberlands primarily in the southern headwaters.

The majority of agriculture is located along the Deschutes River north of Falls Creek, and south of Chambers Creek in most of the mainstem middle sub-basin and the southern portions of the mainstem lower sub-basin. This area has concentrations of commercial and non-commercial agricultural operations, including dairy and other livestock, poultry, food and other crops, hay, and Christmas tree plantations. The Thurston County Farmland Inventory Report (2009) estimated a total of 15,781 acres of farmland in the Deschutes watershed. A more recent study also estimated agricultural activities in the watersheds of

Thurston County using a variety of data sources from 2011.[3] In mapping agricultural activities, a variety of data sources were used in an attempt to understand not only the designated agricultural lands in Thurston County (as previously mapped) but the overall estimated areas with agricultural activities. Using the results from this study, an estimated 17,773 acres of agricultural activities were found in the entire project study area of the Deschutes Basin (Map 37).

The central watershed's primary land uses are agriculture, rural residential, timber/forest land, and undeveloped. It includes the city of Rainier. A large area of federally owned land that is part of Joint Base Lewis-McChord is located in the central watershed, east of Offut Lake and south of Spurgeon Creek. One major highway, State Route 507, traverses the study area through the town of Rainier (Thurston County, 2013).

The northern study area is urbanized and within incorporated city boundaries and the urban growth areas of Olympia, Tumwater, and Lacey (Wagner and Bilhimer, 2014; Thurston County, 2013). The northern watershed contains urban levels of residential land use and other urban land use within the cities and their urban growth areas.

The study area's largest population centers include portions of Olympia, Tumwater, Lacey, and Rainier. All of these municipalities rely on groundwater systems for drinking water sources, and with the exception of Olympia's nearby McAllister Springs source, the groundwater sources are within the Deschutes River watershed.

Table 5: Land use by basin in the Deschutes Watershed study area

	DESCHUTES RIVER LOWER			DESCHUTES RIVER MIDDLE					UPPER
Land Use	Chambers	Deschutes (Mainstem Lower)	Spurgeon Creek	Deschutes (Mainstem Middle)	Lake Lawrence	McIntosh Lake	Offut Lake	Reichel Lake	Deschutes (Mainstem Upper)
Commercial	177	374	26	60	1	0	4	0	1,324
Residential	3,881	3,288	1,432	5,618	986	372	468	59	0
Industrial	23	242	1	5	1	0	0	45	246
Government/ Institutional	117	1,226	2,908	2,468	116	1	2	0	0
Forestry (public & private)	174	1,411	115	6,814	130	1,100	773	3,756	9,408
Agriculture	649	807	460	3,431	334	0	60	428	3,790
Mining	2	421	0	29	0	0	0	0	1
Parks, Preserves, & Open Space	1,485	1,217	702	463	50	162	4	0	151
Vacant	929	1,288	528	2,512	243	188	274	236	6

Source: Thurston Regional Planning Council Data Program

Areas of Special Interest

[3] Agriculture extent was determined by combining (through an additive process, i.e. using everything classified as agriculture in at least one source): National Agricultural Statistics Service (NASS) Cropscape data from 2011; USGS GAP land cover data from 2011; National Land Cover Database (NLCD) 2011 land cover data; and windshield survey and mailing lists from the Thurston Conservation District, as well as by selecting parcels from Thurston County parcel data owned by entities including the word "Farm".

An area of interest is the Ron Smith Farm, located along the Deschutes River Mainstem near the Lake Lawrence outlet channel. The cities of Olympia, Yelm, and Lacey, recently purchased the water rights from the 197-acre farm and are completing riparian restoration improvements along the river shoreline. This is part of the “out of kind” mitigation the cities’ agreed to when their respective applications for new water rights were approved. The restoration projects will include reshaping a tributary stream channel, replanting riparian buffers, installing a live cribwall along the river, and reestablishing a wetland on site (Gallagher, 2012).

In January of 2015, the City of Tumwater began the annexation process for an area east of the City limits which is currently in the Tumwater Urban Growth Area (UGA) of Thurston County. The annexation will become effective on January 1, 2016, which will expand the City limits to include this area of approximately 2.5 square miles (City of Tumwater, 2015a).

LOTT has acquired some of the Deschutes River floodplain and has plans for restoration, trail development, and potential plans for wastewater infiltration.

2.1.15 Wastewater Treatment

The Lacey, Olympia, Tumwater, and Thurston County (LOTT) Clean Water Alliance provides secondary wastewater treatment before discharging to Budd Inlet, as well as advanced treatment (nitrogen removal) from April through October.

Outside of the area serviced by LOTT, the rest of the watershed is served by onsite sewage systems. The city of Rainier does not have a wastewater treatment plant (Map 17).

2.1.16 Thurston County Basin Evaluation

In 2013, Thurston County and Thurston Regional Planning Council developed a report called *Basin Evaluation and Management Strategies for Thurston County: WRIAs 13 and 14*. Basins within the study area were characterized for current conditions (Map 18), and evaluated for risks of future growth or loss of forest cover. Map 19, Map 20, and Map 21 show impervious area by basin. Map 22 shows forest canopy by basin. Basins were grouped into one of five current conditions based on the following criteria:

Table 6: Measures used to group current conditions of basins

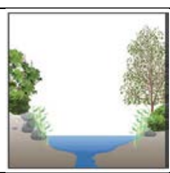
Overall Current Conditions		**Level of Urbanization**	**Basin and Riparian Conditions**			**In-Stream and Wetland Habitat Conditions**	**Aquatic Biota**
			Hydrology		**Riparian Corridor**	**Water Quality**	
Groups		**Total Impervious Area**	**Percent Canopy**	**Percent Unmodified Wetlands**	**Forest, scrub/shrub or wetlands in 250 ft. riparian corridor**	**Overall rating**	**Average B-IBI 2002-2012 (mouth of basin)**
Intact		<2%	>80%	>15% may increase hydrology stabilization	>90%	Excellent (from Thurston County monitoring) Streams: No water quality standard violations; Lakes: Classified as Oligotrophic; Uses not impaired. If no monitoring by Thurston County, then use 303d list. Excellent = no parameters on 303d list.	>41
Sensitive		2-10%	65-80%		75-90%	Good (from Thurston County monitoring) Streams: Usually meets water quality standards; Lakes: Classified as Mesotrophic; Uses not impaired. If no monitoring by Thurston County, then use 303d list. Good = one parameter on 303d list.	36-41
Impacted		10-25%	45-65%	>10% to 15% may stabilize hydrology	60-75%	Fair (from Thurston County monitoring) Streams: Frequently fails one or more water quality standards; Lakes: Classified as Eutrophic; Uses sometimes impaired. If no monitoring by Thurston County, then use 303d list. Fair = two parameters on 303d list.	28-35
Degraded		25-40%	30-45%	Values less than 10% may not be predictive and were not used	30-60%	Poor (from Thurston County monitoring) Streams: Routinely fails water quality standards by a large margin; Lakes: Classified as Eutrophic; Uses impaired during most of the summer season by excess algae and/or aquatic macrophyte (plant) growth. If no monitoring by Thurston County, then use 303d list. Poor = three or more parameters on 303d list.	0-27
Highly Degraded		>40%	0-30%		<30%		

Table 7: Basins characterized by current conditions

	Level of Urbanization	Basin and Riparian Conditions			In-Stream and Wetland Habitat Conditions		Current Conditions Category
		Hydrology		Riparian Corridor	Water Quality	Aquatic Biota	
Basin	**Total Impervious Area (2010)**	**Percent Canopy (2006)**	**Percent Unmodified Wetlands**	**Forest, scrub/shrub or wetlands in 250-ft riparian corridor**	**Overall Rating**	**Average B-IBI 2002-2012 (mouth of basin)**	
Chambers	19.4%	32.3%	8.9%	54.2%	Good	40.2	Impacted
Deschutes River (Lower)	15.1%	41.8%	6.8%	63.3%	Good	35.4	Impacted
Deschutes River (Middle)	2.0%	52.9%	4.5%	82.2%	Good	No data	Sensitive
Deschutes River (Upper)	0.9%	71.2%	1.2%	95.4%	Good	No data	Sensitive
Lake Lawrence	4.9%	44.6%	15.8%	18.0%	Fair	No data	Impacted
McIntosh Lake	2.2%	80.6%	12.9%	No sig riparian	303d: one parameter	No data	Sensitive
Offut Lake	2.9%	61.2%	22.7%	76.4%	303d: one parameter	No data	Sensitive
Reichel Lake	1.5%	62.3%	4.1%	67.1%	303d: three parameters	No data	Impacted
Spurgeon Creek	1.6%	69.4%	5.6%	75.2%	Good	No data	Sensitive

The results of the 2013 Basin Current Conditions from the *Evaluation and Management Strategies for Thurston County Report for WRIAs 13 and 14* are presented below.

Chambers Lake					
Current Aquatic Habitat Conditions					
Level of Urbanization	**Basin and Riparian Conditions**		**In-Stream and Wetland Habitat Conditions**		**Aquatic Biota**
	Hydrology	**Riparian Corridor**	**Physical Conditions**	**Water Quality**	
• Basin area 8,480 acres; urban growth area 55%; rural 45% • Total Impervious Area Estimate 1991: 10.2% 2010: 19.4% 2035: 22.3% Buildout: 23.5%	• Effective Impervious Area: 2006: 14.7% • Forest Cover 32.3% • Unmodified Wetlands: 15.6% • Miles of Stream: 1.8 • Lakes: Chambers, 128.0 ac; Southwick, 36.0 ac; Sunwood, 26.0 ac; Smith, 19.6 • Areas of high ground water flooding: 3.3% of basin	• Coniferous forest cover in 250 stream riparian corridor: 2006: 12.8% • Forest, scrub/shrub vegetation and wetlands in stream riparian corridor: 150 ft: 0.0% 250 ft: 0.0% 1000 ft: 91.1% • # of road crossings per mile of creek: 2.3 • Inadequate riparian vegetation	• Inadequate spawning gravel • Low summer flows • Some wetlands filled	<u>Chambers Creek:</u> • Monitoring results: good water quality • The creek meets water quality standards. • Nitrate concentrations are very high: contaminated groundwater • Most of the basin is in the urban growth area, and continued development can be expected to increasingly effect stream quality. • 303(d): fecal coliform • Part of Budd-Deschutes TMDL	• B-IBI average 2002-2012: 40 • B-IBI Range 2002-2012: 36-44 • Coho, Coastal resident cuttroat

Deschutes River (Mainstem)

Current Aquatic Habitat Conditions

Level of Urbanization	Basin and Riparian Conditions		In-Stream and Wetland Habitat Conditions		Aquatic Biota
	Hydrology	Riparian Corridor	Physical Conditions	Water Quality	
<u>Lower</u> • Basin area 11,220 acres; urban growth area 53%; rural 47% • Total Impervious Area Estimate 1991: 10.6% 2010: 15.4% 2035: 18.6% Buildout: 20.3% <u>Middle</u> • Basin area 23,180 acres; urban growth area 5%; rural 95% • Total Impervious Area Estimate 1991: 1.0% 2010: 2.0% 2035: 2.9% Buildout: 4.5% <u>Upper</u> • Basin area 42,110 acres; 100% rural • Total Impervious Area Estimate 1991: 0.2% 2010: 0.9% 2035: 0.9% Buildout: 2.9%	<u>Lower</u> • Effective Impervious Area: 2006: 12.0% • Forest Cover 41.8% • Unmodified Wetlands: 6.9% • Miles of Stream: 27.7 • Lakes: Barnes, 34.8 ac; Munn, 32.9 ac; Tempo, 32.0 ac; Hewitt, 29.1 ac; Trail's End, 12.4 ac; Lake Susan, 10.9 ac; Sheehan, 4.8 ac • Areas of high ground water flooding: 2.0% of basin <u>Middle</u> • Effective Impervious Area: 2006: 1.3% • Forest Cover 52.9% • Unmodified Wetlands: 4.5% • Miles of Stream: 100.3 • Areas of high ground water flooding: • 4.1% of basin <u>Upper</u> • Effective Impervious Area: 2006: 0.5% • Forest Cover 71.2% • Unmodified Wetlands: 1.9% • Miles of Stream: 599.9 • Areas of high ground water flooding:1.8% of basin	<u>Lower</u> • Coniferous forest cover in 250 stream riparian corridor: 2006: 20.5% • Forest, scrub/shrub vegetation and wetlands in stream riparian corridor: 150 ft: 63.6% 250 ft: 54.6% 1000 ft: 34.8% • # of road crossings per mile of creek: 1.1 <u>Middle</u> • Coniferous forest cover in 250 stream riparian corridor: 2006: 29.5% • Forest, scrub/shrub vegetation and wetlands in stream riparian corridor: 150 ft: 65.7% 250 ft: 61.3% 1000 ft: 44.7% • # of road crossings per mile of creek: 1.0 <u>Upper</u> • Coniferous forest cover in 250 stream riparian corridor: 2006: 36.7% • Forest, scrub/shrub vegetation and wetlands in stream riparian corridor: 150 ft: 24.2% 250 ft: 18.0% 1000 ft: 20.7% • # of road crossings per mile of creek: 1.1 • Riparian buffer significantly impaired	• High levels of fine sediment • Inadequate instream flow • Lack of off-channel habitat • Insufficient LWD • Pool habitat limiting • Significantly impaired riparian condition and functions • Elevated summer water temperature in the river • Bank stability limiting • Altered estuary conditions	• Monitoring results: good water quality • Fecal coliform standard met for 2007-2009. • Turbidity sometimes high in winter • Summer temperature violations occur. • Low in-stream flow and habitat deficiencies are concern for fisheries resources • 303(d): Dissolved Oxygen, temperature, fecal coliform, fine sediment • TMDL drafted in 2008 for 1998 listing 303(d) listing for temperature, pH, fecal coliform, in-stream flow, fine sediments, and large woody debris deficiencies.	• B-IBI average 2002-2012: 35 • B-IBI Range 2002-2012: 30-42 • Coastal resident cuttroat, coho, fall Chinook salmon, winter steelhead.

Lake Lawrence

Current Aquatic Habitat Conditions

Level of Urbanization	Basin and Riparian Conditions		In-Stream and Wetland Habitat Conditions		Aquatic Biota
	Hydrology	Riparian Corridor	Physical Conditions	Water Quality	
• Basin area 2,330 acres; 100% rural • Total Impervious Area Estimate 1991: 1.6% 2010: 4.9% 2035: 5.8% Buildout: 6.7%	• Effective Impervious Area: 2006: 3.3% • Forest Cover: 44.6% • Unmodified Wetlands: 15.8% • Miles of Stream: 4.2 • Lakes: Lawrence, 333.6 ac • Areas of high ground water flooding: 0.8% of basin	• Coniferous forest cover in 250 stream riparian corridor: 2006: 5.5% • Forest, scrub/shrub vegetation and wetlands in stream riparian corridor: 150 ft: 67.0% 250 ft: 67.1% 1000 ft: 78.2% • # of road crossings per mile of creek: 1.7	• Lake Lawrence outflow acts as a lake level control structure and fish passage barrier.	Lake Lawrence: • Monitoring results: fair water quality • Lake is eutrophic resulting in algal blooms that impair uses • 303(d): total phosphorus Lake Lawrence Creek: • 303(d): dissolved oxygen • Part of Budd-Deschutes TMDL	• Benthic levels unknown • Stream flowing from Lake Lawrence to the Deschutes River contains coastal resident cutthroat

McIntosh Lake

Current Aquatic Habitat Conditions

Level of Urbanization	Basin and Riparian Conditions		In-Stream and Wetland Habitat Conditions		Aquatic Biota
	Hydrology	Riparian Corridor	Physical Conditions	Water Quality	
• Basin area 1,620 acres; 100% rural • Total Impervious Area Estimate 1991: 0.8% 2010: 2.2% 2035: 2.5% Buildout: 4.4%	• Effective Impervious Area: 2006: 1.3% • Forest Cover: 80.6% • Unmodified Wetlands: 12.9% • Miles of Stream: 14.0 • Lakes: McIntosh, 128.5 ac • Areas of high ground water flooding: 0.6% of basin	• Coniferous forest cover in 250 stream riparian corridor: 2006: 33.3% • Forest, scrub/shrub vegetation and wetlands in stream riparian corridor: 150 ft: 59.5% 250 ft: 51.5% 1000 ft: 36.6% • # of road crossings per mile of creek: 3.1	• No Data	• 303(d): PCB contamination in fish • Part of Budd-Deschutes TMDL	• Benthic levels unknown • McIntosh Lake stocked with rainbow and triploid rainbow trout

Offut Lake

Current Aquatic Habitat Conditions

Level of Urbanization	Basin and Riparian Conditions		In-Stream and Wetland Habitat Conditions		Aquatic Biota
	Hydrology	Riparian Corridor	Physical Conditions	Water Quality	
• Basin area 1,790 acres; 100% rural • Total Impervious Area Estimate 1991: 1.4% 2010: 2.9% 2035: 3.9% Buildout: 6.0%	• Effective Impervious Area: 2006: 2.0% • Forest Cover: 61.2% • Unmodified Wetlands: 22.7% • Miles of Stream: 9.8 • Lakes: Offut, 193.0 ac • Areas of high ground water flooding: 1.2% of basin	• Coniferous forest cover in 250 stream riparian corridor: 2006: 12.8% • Forest, scrub/shrub vegetation and wetlands in stream riparian corridor: 150 ft: 79.3% 250 ft: 75.2% 1000 ft: 61.1% • # of road crossings per mile of creek: 0.4	• Fish passage limited	• 303(d): PCB contamination in fish • Part of Budd-Deschutes TMDL	• Benthic levels unknown • Unnamed stream connecting Offut Lake to Deschutes River contains winter steelhead, coho, and coastal resident cutthroat trout, Fish end at the barrier between Offut Lake and stream. • Offut Lake contains coastal resident cutthroat.

Reichel Lake

Current Aquatic Habitat Conditions

Level of Urbanization	Basin and Riparian Conditions		In-Stream and Wetland Habitat Conditions		Aquatic Biota
	Hydrology	Riparian Corridor	Physical Conditions	Water Quality	
• Basin area 4,470 acres; 100% rural • Total Impervious Area Estimate 1991: 0.7% 2010: 1.5% 2035: 1.6% Buildout: 3.6%	• Effective Impervious Area: 2006: 1.0% • Forest Cover: 62.3% • Unmodified Wetlands: 4.1% • Miles of Stream: 49.7 • Lakes: Reichel, 22.8 ac • Areas of high ground water flooding: 1.0% of basin	• Coniferous forest cover in 250 stream riparian corridor: 2006: 17.4%% • Forest, scrub/shrub vegetation and wetlands in stream riparian corridor: 150 ft: 65.4% 250 ft: 60.5% 1000 ft: 51.5% • # of road crossings per mile of creek: 0.9 • Lack of functional riparian zones	• High fine sediments • Run-off from former log yard discharges fine sediment and contaminants. • Impaired by agricultural activities including direct animal access to the creeks	Unnamed Creek between Reichel Lake and the Deschutes River: • 303(d): dissolved oxygen, fecal coliform, temperature • Part of Budd-Deschutes TMDL	• Benthic levels unknown • Unnamed stream between Reichel Lake and Deschutes River: coho, coastal resident cutthroat trout, winter steelhead.

Spurgeon Creek					
Current Aquatic Habitat Conditions					
Level of Urbanization	**Basin and Riparian Conditions**		**In-Stream and Wetland Habitat Conditions**		**Aquatic Biota**
	Hydrology	**Riparian Corridor**	**Physical Conditions**	**Water Quality**	
• Basin area 6,050 acres; 100% rural • Total Impervious Area Estimate 1991: 0.7% 2010: 1.6% 2035: 2.3% Buildout: 2.8%	• Effective Impervious Area: 2006: 1.0% • Forest Cover: 69.4% • Unmodified Wetlands: 5.6% • Miles of Stream: 17.0 • Areas of high ground water flooding: 0.8% of basin	• Coniferous forest cover in 250 stream riparian corridor: 2006: 12.1% • Forest, scrub/shrub vegetation and wetlands in stream riparian corridor: 150 ft: 76.8% 250 ft: 76.4% 1000 ft: 70.4% • # of road crossings per mile of creek: 1.4 • Poor riparian condition	• Direct livestock access to channel • Substrate is primarily sand • Conversion of wetlands to agricultural use	• Monitoring results: good water quality • All water quality standards met in years 07/08 and 08/09 and nutrient levels fairly low. • Non-point pollution from rural residential and agricultural activities. • Encroachment on wetlands and riparian areas by livestock for grazing may impact water quality. • 303(d): fecal coliform • Part of Budd-Deschutes TMDL	• Benthic levels unknown • Coho, and fall Chinook salmon

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3. Management Issues and Opportunities

The Deschutes River Watershed has been the subject of numerous past studies and evaluations that have identified management actions for the area. This section compiles and summarizes those recommendations.

3.1 Overview of Management Strategies and Tools

A variety of strategies and tools can be used to achieve water resource and habitat management goals and objectives. Although federal and state regulators establish the framework for environmental protection, as discussed in section 1.5 above, many strategies are employed at the local level including:

- Development review and regulations (including critical area ordinances, zoning, stormwater management requirements, low-impact development ordinances, shoreline master program, and county-wide planning policies)
- Land acquisition and conservation easements
- Land stewardship and landowner education
- Restoration projects and capital improvements
- Regional planning and coordination
- Public involvement and education
- Operation and maintenance programs
- Monitoring and research

These strategies and tools can be applied to address specific management objectives. Four such objectives are:

1. Guiding growth away from sensitive areas
2. Encouraging growth in areas where redevelopment is desired and that are least susceptible to new stormwater or habitat impacts
3. Reducing the impacts of growth
4. Restoring ecological functions that have been degraded by existing development

3.1.1 Guiding Growth Away from Sensitive Areas

Thurston County is one of the fastest-growing counties in the Puget Sound region. Where that growth occurs will have a lasting impact on the Deschutes River watershed and will help determine whether water quality continues to get worse in the years to come. One of the key steps that a local government can undertake is to identify areas that currently provide important ecological functions, and establish regulations that protect those functions. Protecting intact and functioning areas can serve multiple purposes. Depending on their size, preserve sites can serve as seasonal refuges for local wildlife while protecting the wellhead of a local water supply and allowing limited recreational opportunities. Preservation is easier and far less expensive than attempting to restore functions that have already been degraded.

One of the regulatory tools that can be used to guide growth away from sensitive areas is to limit how much development can occur in an area through zoning rules. Zoning establishes land use densities and separates high-intensity land uses from low-intensity uses, such as agriculture and forestry. Zoning densities have a strong relationship to basin current conditions. In general, it will be extremely difficult to maintain a basin rating of “intact” or “sensitive” if zoning allows for significant urban uses, and even moderately rural density (such as one dwelling unit per five acres) can add up to a significant impact at a cumulative basin scale. A reduction of the land use intensity or zoning density (units per acre) is a traditional approach to avoid future growth in a given location. Such "rezones" maintain the same land use (residential) but reduce the density, which in turn minimizes new development impacts. This strategy is generally only effective in areas that are not already subdivided into small lots (lots smaller than the proposed density) or vested for future development. In highly sensitive regions development moratoriums can be a short term strategy to protect areas in which urban growth is not compatible with achieving fish and wildlife habitat management goals and objectives.

There are a number of non-regulatory tools that can protect areas containing high-quality sites or habitats. Fee simple acquisitions are the most direct approach, with a public entity purchasing the property. Such a purchase will normally be "at fair market value." As a public asset, these sites will require yearly management and operation costs, even in a natural condition.

A less-costly non-regulatory approach can include the acquisition of "development rights," or conservation easements. These may be donated or purchased at a reduced rate. The land remains in private ownership with the future development potential strictly limited or removed entirely. Management of the land would remain with the property owner, with the holder of the conservation easement or similar being a public entity, a resource stewardship entity (e.g., The Nature Conservancy), or a local land trust (e.g. Capitol Land Trust, Nisqually Land Trust, etc.).

In the mid-1990's Thurston County adopted a Transfer of Development Rights (TDR) program for select agricultural lands within the county. The TDR program was applied to all areas zoned Long Term Agriculture areas. The intent of the TDR program is to provide an opportunity for working-land owners to sell their development rights without having to sell their entire property for development. With this approach, the rural character and agricultural economy of Thurston County can be preserved, and working-land owners have the opportunity to realize some of the true market value of their land without having to sell the land altogether for urban development. The program could be extended to cover lands identified to be of ecological importance. Under such a program, and with the collaboration of local municipalities, growth would be redirected from these areas into urban areas that are already degraded.

3.1.2 Encouraging Growth in Areas Where Redevelopment is Desired

Attracting growth to existing city centers and transit corridors will help to focus development in areas that are already impacted by urbanization, and protect undeveloped and rural areas. In 2011, the region embarked on an effort to develop a regional plan for sustainable development as part of the *Sustainable Thurston* planning process. The project focused on creating places and preserving spaces, as well as implementing sustainability efforts related to other topic areas such as water quality and energy. A summary of management recommendations and targets from that plan that are applicable for this study is included in Section 3.5.

3.1.3 Reducing the Impacts of Growth

Where development does occur, the impacts of that growth can be mitigated using a variety of regulatory and non-regulatory tools.

Regulatory Tools

Regulatory tools commonly used to reduce the impacts of future growth on ecological functions are:

- Development regulations
- Critical areas regulations
- Stormwater management regulations

All three regulatory tools can address some – but not all – of the impacts of new development. Development regulations guide how new construction gets built – they cover everything from clearing and grading of a site, to building codes, to parking and landscaping requirements. Critical areas regulations focus on the most unstable or vulnerable areas of the landscape, such as steep slopes or wetlands. Stormwater regulations address a local jurisdiction's obligations under the NPDES Permit to reduce the discharge of pollutants to surface waters by requiring strategies that control and treat runoff from the developed site. Critical areas are generally located within a defined area, whereas development and stormwater regulations are generally tailored to levels and types of land development regardless of location – although some development standards are specific to certain zones. Specific regulatory tools include:

Low Impact Development Techniques: Low Impact Development (LID) covers a wide variety of practices intended to mimic natural hydrologic patterns and reduce the negative impacts development has on hydrology and water quality. The key to effective LID implementation is to determine the desired functions to be maintained or restored. The application of LID techniques can offer a number of advantages over traditional, engineered stormwater drainage approaches. LID can be encouraged or mandated through development or stormwater regulations, or in critical area ordinances.

Cluster Development: The clustering of residential subdivisions has been a part of the regulatory tool box for several decades. Clustering provides for the development of a part of a parcel with a significant portion set aside in an "open space tract," "tree tract," or "rural reserve tract," which would have little or no future development potential. Cluster development is noted as an LID technique to reduce hydrologic impact in the Puget Sound Action Team *Low Impact Development Technical Guidance Manual for Puget Sound* (Puget Sound Action Team, 2005).[4]

Tree Retention and Impervious Surface Limits: A typical development in Western Washington converts a forested area to one covered by hard surfaces (such as roofs, paved areas, and even lawn) and limited vegetation. Regulations that require the preservation of trees and other native vegetation, and that limit the amount of new impervious surface, can help to maintain the hydrology of a

[4] It should be noted that there are also some negative impacts from cluster development. Clustering is largely the arrangement of given number of dwelling units. It does nothing to change the underlying density, which may be too intense for the local conditions. Further, cluster ordinances with density bonuses only compound this condition. There is also a design issue when accomplished in a rural setting. Without architectural controls and alternative site-layout designs to create something like a "village" community, a clustered development can end up looking like a traditional subdivision inserted into the countryside and looking very much out of place.

site, reduce impacts to nearby waterbodies and provide habitat for a variety of wildlife. Impervious surface limits are found in Thurston County's zoning code (Title 20) for various sensitive areas, basins, or zoning districts.

Compensatory Mitigation: A compensatory mitigation program could address unavoidable development impacts to wetlands that cannot be addressed by on-site mitigation. A system of fees and credits would be created for restoration of an off-site parcel (generally located within the same watershed.) Off-site compensatory mitigation is included as a recommendation in both federal and state regulatory guidance on wetland protection. At the present, Thurston County does not have an off-site compensatory mitigation program, however, the Thurston County Resource Stewardship Department, Water Resources Program is exploring a pilot in-lieu fee program within the Deschutes Watershed.

Since these tools target new development, they are generally not very effective at addressing already impacted environmental and hydrologic systems, which are referred to as "legacy impacts." However, some wetland mitigation banks may be able to address these impacts depending on the location and specific actions taken for their establishment.

Non-Regulatory Tools

There are also non-regulatory tools that may reduce the impacts of development, including outreach to landowners and other users within the watershed that focuses on informing people about best practices for land stewardship to protect water quality and wildlife habitat. Such outreach may include educating homeowners on how to properly maintain a septic system or landscape with native vegetation; or could involve working with farmers to develop a Stewardship Plan that provides protection to critical areas. The Voluntary Stewardship Program is a new, alternative approach for Thurston County to protect and voluntarily enhance critical areas where agricultural activities are taking place as well as improve the long-term viability of agriculture. Instead of enacting further critical areas regulation for agricultural activities, the VSP works with individuals to develop site-specific Stewardship Plans. The VSP Work Plan is currently being developed by the Watershed Work Group, which includes a broad representation from agricultural, tribal, and environmental groups. The Thurston Conservation District was appointed as Technical Assistance Provider and, once implementation begins, will be working directly with agricultural operators to develop Stewardship Plans to protect and voluntarily enhance critical areas.

Another tool is to provide financial incentives that help offset the costs and inconvenience of implementing practices that can protect water quality and habitat, such as providing low-cost loans or grants to replace failing septic systems, install manure storage facilities, or restore riparian habitat. Many of these incentive-based programs are available through the USDA Natural Resources Conservation Service or the Washington State Conservation Commission and the Thurston Conservation District.

3.1.4 Restoring Areas that Have Been Degraded by Existing Development

While the tools and strategies identified above can be effective at preventing new impacts, they do not address existing or "legacy" impacts from past development. As noted in Section 2, the Deschutes River watershed is already considered impaired in many areas. Restoration of ecological functions may be the only way to improve water quality and restore critical habitats that were not sufficiently protected under regulations that existed in the past. The restoration of degraded sites can be tricky. A key step is to identify sites with the highest potential for achieving full or nearly full ecosystem function. This usually requires that the attributes of degradation be neither numerous nor so irreversible as to make restoration infeasible. Once priority areas for restoration are identified, restoration can include a wide array of activities, including upgrades and retrofits of existing stormwater infrastructure, revegetation of shoreline corridors, removal of hard shoreline armoring and fish barriers, or engineered replacement of stream channels and large wood.

3.2 Puget Sound Watershed Characterization

This section presents the results of the Puget Sound Watershed Characterization (PSWC) project for the study area. The PSWC is a regional-scale tool that highlights the most important areas to protect and restore, and identifies those most suitable for development. The characterization program covers the entire Puget Sound drainage area and is a collaborative effort between the Department of Ecology, the Puget Sound Partnership, the Department of Commerce, and the Washington Department of Fish and Wildlife. The characterization includes watershed assessments of:

- Water flow processes (delivery, surface storage, recharge, and discharge)
- Water quality processes (sediment, nutrients, pathogens, and metals)
- Terrestrial wildlife habitat and freshwater habitat

The assessments prioritize small watersheds, or habitat areas, relative to one another for their protection and restoration value. Integrating the information from several environmental assessments provides an ecosystem view of the landscape. A characterization combined with other science-based information can be useful for helping local governments develop protection and restoration strategies, land-use plans, designations and regulations, and development standards (Ecology, 2015b).

3.2.1 Water Flow Assessment

The overall restoration and protection results of the PSWC for water flow assessment, integrate relative rankings of importance and degradation for key watershed processes, and prioritize a management approach for each Assessment Unit (AU). This includes management actions that will protect the most important/less-degraded areas of a watershed and focus more intense land use (e.g., development) into areas that are relatively less important/more degraded.

In consultation with Ecology staff, the water flow and water quality assessment results were computed for the entire Deschutes Watershed, without consideration of landscape groups, so that results for each assessment unit could be compared to all other assessment units within the study area. Map 23 represents approximately the upper two-thirds of the watershed, which is the focus for this study, but the PSWC assessment represents a comparison of all the AUs in the Deschutes basin. In addition, Ecology staff reviewed the results of each water flow sub-process. Based on the distribution of results, staff suggested re-binning the results of two of the sub-processes: “Importance to Delivery” and “Degradation to Recharge.” Based on Ecology staff recommendations, the “Importance to Delivery” was re-classified into new bins using Jenks natural breaks, instead of quartiles, and the results were slightly adjusted to include two assessment units which contain significant Rain-on-Snow areas. “Degradation to Recharge” was re-classified into new bins using Jenks natural breaks (Hume, personal communication, March 6, 2015). The updated categorizations changed the protection/restoration results for those two sub-processes. However, the overall water flow restoration/protection results were not impacted by the binning changes.

The priority management recommendation is determined by the overall level of importance for water flow processes in each AU. The highest priority is given to AUs with a high level of importance to water flow processes. In general, if the level of importance is medium-high to high the AU will be a priority restoration or protection area, depending on the level of degradation. If the level of degradation is also medium-high to high the management recommendation will be restoration or development/restoration. If the level of degradation is medium to low the management recommendation will be protection/conservation (Figure 2).

For the water flow recommendations (Table 8), the specific strategy identified to focus on is defined by the level of degradation for each water flow process. In general, restoration or development/restoration strategies are listed for the priority water flow processes (medium-high to high level of importance) that are either medium-high or highly degraded. Protection/conservation strategies are identified as the focus for the priority water flow processes that have a medium to low level of degradation. However, there are often a combination of restoration and protection needs in an AU. For example, if the overall water flow management priority is protection there may still be specific water flow processes that are degraded, and would benefit from restoration. For a complete description of the analysis and methods used in the Puget Sound Watershed Characterization, please see Stanley et al., 2012.

Under this management approach, areas with medium-high to high importance and low to medium existing degradation (categorized for “Highest Protection” and “Protection”) may need little or no active management (i.e. restoration or other “active” management efforts) but warrant a high level of protection to maintain existing, important ecological functions (see Figure 2).

Areas of low to medium importance but also low to medium degradation (categorized for “Protection/Conservation” and “Conservation”) likely require a much lower level of management attention. The greatest level of management action (categorized for “Highest Restoration” and “Restoration”) applies to areas with medium-high to high importance and medium-high to high existing degradation. Areas with a low to medium level of importance and medium-high to high level of degradation can be lowest in priority ranking for protection, conservation, or restoration. These low priority areas with low importance and medium-high to high degradation are categorized for “Development/Restoration,” which indicates that development will have the lowest overall impact to water-flow processes in these areas.

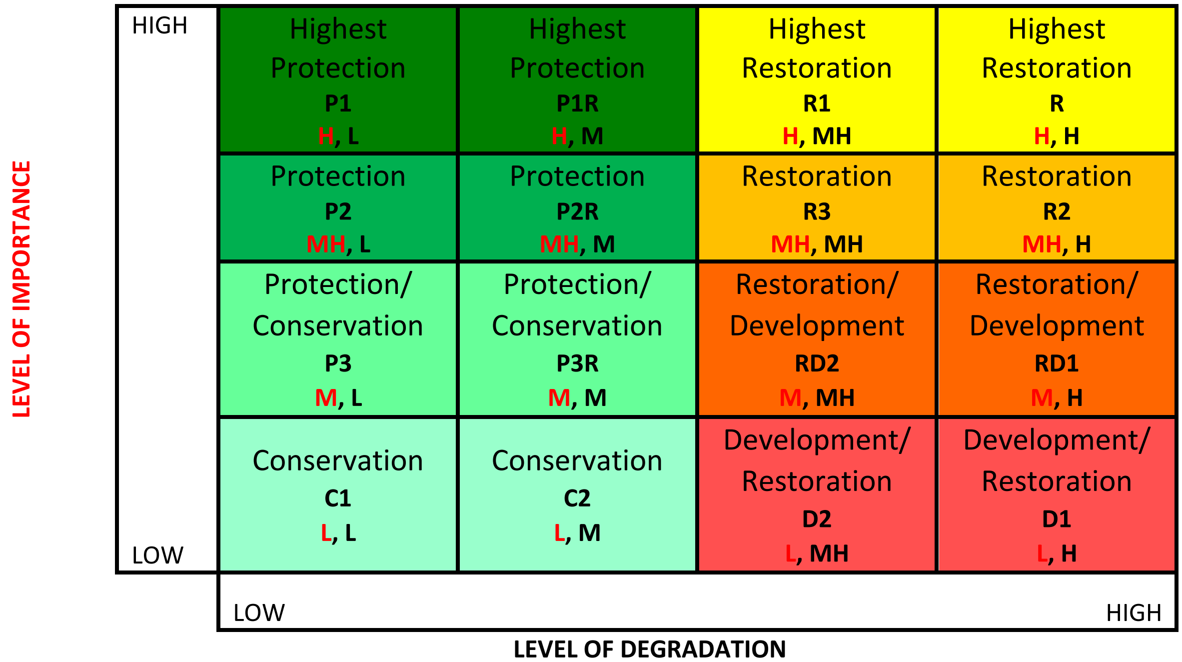

Figure 2: Management matrix for restoration and protection of water flow processes
Source: Stanley et al., 2012

Water Flow Assessment Results

In general, the Upper and Middle Deschutes Mainstem Sub-basins are recommended for protection or conservation indicating that these areas are relatively intact and have varying importance for water flow processes. This suggests that future development in these areas must be carefully planned to keep these processes intact. The middle watershed does have a few areas where restoration is recommended, around Reichel Lake, Lake Lawrence, and Silver Creek. The areas recommended for restoration have medium-high to high importance for water flow processes but are moderately-high to highly degraded. The Lower Deschutes Mainstem Sub-basin is primarily recommended for restoration with one assessment unit recommended for restoration/development. The area recommended for restoration/development has medium importance for water flow processes and high degradation. Compared to other parts of the watershed, development in this area would have less adverse consequences for water flow processes.

For details by assessment unit and basin on condition of water flow sub-processes, overall water flow restoration/protection priority, and water flow management recommendation, please see Map 23 and Table 8.

Table 8: Water flow assessment results and recommendations by basin and assessment unit

Basin Name	Assessment Unit ID	Importance to Water Flow Processes				Degradation to Water Flow Processes				Overall Water Flow Restoration and Protection Priority	Water Flow Recommendation
		Delivery	Discharge	Recharge	Surface Storage	Delivery	Discharge	Recharge	Surface Storage		
Chambers	13026	M	M	H	H	H	H	MH	H	Highest Restoration (R)	Least suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's high importance and high level of degradation. Focus on restoration of surface storage and recharge processes.
Chambers	13028	L	L	MH	M	H	MH	MH	M	Restoration/ Development (RD1)	May be suitable for more intense development with BMPs and development standards which restore water flow processes due to the area's medium and high level of degradation. Focus on restoration of recharge processes.
Chambers	13047	L	M	M	MH	H	MH	M	H	Restoration (R3)	Less suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's medium-high importance and medium-high level of degradation. Focus on restoration of surface storage processes.
Deschutes River (Mainstem Lower)	13018	M	MH	H	MH	H	H	H	H	Restoration (R2)	Less suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's medium-high importance and high level of degradation. Focus on restoration of discharge, recharge, and surface storage processes.
Deschutes River (Mainstem Lower)	13027	M	H	H	H	H	H	MH	MH	Highest Restoration (R)	Least suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's high importance and high level of degradation. Focus on restoration of discharge, recharge, and surface storage processes.
Deschutes River (Mainstem Lower)	13029	M	H	MH	MH	H	MH	M	H	Restoration (R3)	Less suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's medium-high and medium-high level of degradation. Focus on restoration of discharge, recharge, and surface storage processes.
Deschutes River (Mainstem Lower)	13032	L	H	M	H	M	MH	L	H	Highest Protection (P1R)	Not suitable for development due to the area's high importance for water flow processes and medium level of degradation. Focus on

Basin Name	Assessment Unit ID	Importance to Water Flow Processes: Delivery	Discharge	Recharge	Surface Storage	Degradation to Water Flow Processes: Delivery	Discharge	Recharge	Surface Storage	Overall Water Flow Restoration and Protection Priority	Water Flow Recommendation
											restoration of surface storage and discharge processes. Focus on protection of delivery and recharge processes.
Spurgeon Creek	13030	L	H	M	H	M	MH	L	H	Highest Restoration (R1)	Least suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's high importance and medium-high level of degradation. Focus on restoration of surface storage and discharge processes.
Spurgeon Creek	13031	L	M	M	MH	L	L	L	L	Protection/ Conservation (P3)	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's medium importance and low level of degradation. Focus on protecting/conserving surface storage processes.
Offut Lake	13033	L	H	L	H	M	MH	L	MH	Highest Protection (P1R)	Not suitable for development due to the area's high importance for water flow processes and medium level of degradation. Focus on restoring discharge and surface storage processes.
McIntosh Lake	13039	M	M	L	MH	L	M	L	M	Protection (P2)	Not suitable for intense development or in need of BMPs and development standards which protect water flow processes due to the area's medium-high importance and low level of degradation. Focus on protecting surface storage processes.
Deschutes River (Mainstem Middle)	13034	L	L	MH	L	M	L	L	M	Conservation (C1)	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's low importance and low level of degradation. Focus on conserving recharge processes.
Deschutes River (Mainstem Middle)	13035	L	H	M	H	L	M	L	M	Highest Protection (P1)	Not suitable for development due to the area's high importance for water flow processes and low level of degradation. Focus on protecting discharge and surface storage processes.
Deschutes River (Mainstem Middle)	13036	M	H	L	H	L	L	L	MH	Highest Protection (P1)	Not suitable for development due to the area's high importance for water flow processes and low level of degradation. Focus on protecting discharge and restoring surface storage processes.

		Importance to Water Flow Processes				Degradation to Water Flow Processes					
Basin Name	**Assessment Unit ID**	**Delivery**	**Discharge**	**Recharge**	**Surface Storage**	**Delivery**	**Discharge**	**Recharge**	**Surface Storage**	**Overall Water Flow Restoration and Protection Priority**	**Water Flow Recommendation**
Deschutes River (Mainstem Middle)	13037	M	L	MH	M	MH	L	L	L	Conservation (C2)	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's low importance and medium level of degradation. Focus on conserving recharge processes.
Deschutes River (Mainstem Middle)	13038	M	MH	MH	MH	MH	MH	L	H	Restoration (R3)	Less suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's medium-high level of importance and medium-high level of degradation. Focus on protecting recharge processes and restoring surface storage and discharge processes.
Deschutes River (Mainstem Middle)	13040	M	MH	H	MH	MH	M	L	MH	Protection (P2R)	Not suitable for intense development or in need of BMPs and development standards which protect water flow processes due to the area's medium-high level of importance and medium level of degradation. Focus on protecting discharge and recharge processes, and restoring surface storage processes.
Deschutes River (Mainstem Middle)	13041	M	MH	H	MH	M	M	L	M	Protection (P2)	Not suitable for intense development or in need of BMPs and development standards which protect water flow processes due to the area's medium-high importance and low level of degradation. Focus on protecting recharge, discharge, and surface storage processes.
Deschutes River (Mainstem Middle)	13042	MH	M	H	M	M	L	L	L	Protection/ Conservation (P3)	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's medium importance and low level of degradation. Focus on protecting/conserving delivery and recharge processes.
Deschutes River (Mainstem Middle)	13044	M	MH	MH	MH	L	L	L	M	Highest Protection (P1)	Not suitable for development due to the area's high importance for water flow processes and low level of degradation. Focus on protecting recharge, discharge, and surface storage processes.
Deschutes River (Mainstem Middle)	13045	M	H	H	H	M	H	L	H	Highest Restoration (R1)	Least suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's high importance and medium-high level of degradation. Focus on protecting recharge, and

Basin Name	Assessment Unit ID	Importance to Water Flow Processes: Delivery	Discharge	Recharge	Surface Storage	Degradation to Water Flow Processes: Delivery	Discharge	Recharge	Surface Storage	Overall Water Flow Restoration and Protection Priority	Water Flow Recommendation
											restoring discharge and surface storage processes.
Deschutes River (Mainstem Middle)	13050	M	H	MH	H	M	M	L	H	Highest Protection (P1R)	Not suitable for development due to the area's high importance for water flow processes and medium level of degradation. Focus on protecting discharge and recharge processes, and restoring surface storage processes.
Reichel Lake	13001	MH	H	H	H	L	MH	L	H	Highest Restoration (R1)	Least suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's high importance for water flow processes and medium-high level of degradation. Focus on protecting delivery and recharge, and restoring discharge and surface storage processes.
Lake Lawrence	13043	M	M	M	H	MH	H	L	H	Highest Restoration (R)	Least suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's high importance for water flow processes and high level of degradation. Focus on restoring surface storage processes.
Deschutes River (Mainstem Upper)	13002	H	MH	M	M	L	L	L	M	Protection (P2)	Not suitable for intense development or in need of BMPs and development standards which protect water flow processes due to the area's medium-high importance and low level of degradation. Focus on protecting delivery and discharge processes.
Deschutes River (Mainstem Upper)	13003	H	M	M	L	L	L	L	M	Conservation (C1)	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's low importance and low level of degradation. Focus on conserving delivery processes.
Deschutes River (Mainstem Upper)	13004	H	L	M	L	M	L	L	L	Protection/ Conservation (P3)	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's medium importance and low level of degradation. Focus on protecting/conserving delivery processes.
Deschutes River (Mainstem Upper)	13005	H	L	MH	L	L	L	L	L	Protection (P2)	Not suitable for intense development or in need of BMPs and development standards which protect water flow processes due to the area's

		Importance to Water Flow Processes				Degradation to Water Flow Processes					
Basin Name	Assessment Unit ID	Delivery	Discharge	Recharge	Surface Storage	Delivery	Discharge	Recharge	Surface Storage	Overall Water Flow Restoration and Protection Priority	Water Flow Recommendation
											medium-high importance and low level of degradation. Focus on protecting delivery and recharge processes.
Deschutes River (Mainstem Upper)	13006	H	L	L	L	L	L	L	L	Conservation (C1)	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's low importance and low level of degradation. Focus on conserving delivery processes.

3.2.2 Integrating Water Quality Assessment Results

In addition to looking at water flow processes, this study is also considering water quality impairments and processes. The Deschutes River and its tributaries are on the Washington State Water Quality Assessment 303(d) list of impaired waterbodies for temperature, fecal coliform bacteria, dissolved oxygen, pH, and fine sediment.

Of the water quality parameters assessed by Ecology in the Puget Sound Watershed Characterization Project, sediment, nitrogen, and pathogens are of significant concern for the study area and are included in Deschutes River water clean-up plans (see section 3.3). This study used Ecology's water quality process degradation results to identify areas that are relatively more degraded or less degraded in respect to their capacity to generate loads of sediment, nitrogen, or pathogens into aquatic areas during a storm. The water quality degradation results may be compared across Water Resource Inventory Area (WRIA) 13.

Based on the recommendation from Ecology staff, water quality degradation results for sediment, nitrogen, and pathogens were re-classified into new bins using Jenks Natural Breaks, instead of quartiles, due to skewed distributions (Hume, personal communication, March 6, 2015).

The results for sediment, nitrogen, and pathogen degradation were each evaluated and will be described generally for the study area. For display purposes, and integrating the results with the water quality assessment, assessment units are categorized based on the most degraded of the three components (Map 24). For results by basin or assessment unit, please see Table 10 where the water quality results are shown alongside the water flow results and there is an integrated management recommendation. The integrated management recommendation used the following language template for water quality (Table 9).

Table 9: Water quality result and recommendation language template

WQ Result	Water Quality Result
(dark green)	Not a likely source of water quality impairment due to current land uses.
(light green)	Likely a moderate source of water quality impairment due to current land uses. Implement appropriate BMPs. Focus restoration on improving water quality and limiting inputs to surface waters.
(yellow)	Likely a moderate/high source of water quality impairment due to current land uses. Implement appropriate BMPs. Focus restoration on improving water quality and limiting inputs to surface waters.
(orange)	Likely a high source of water quality impairment due to current land uses. Implement appropriate BMPs. Focus restoration on improving water quality and limiting inputs to surface waters.

Degradation to Sediment Processes

"The Degradation to Sediment process model (NSPECT) evaluates the current land cover type within assessment units and the relative capacity to generate and transport sediment to aquatic systems during a storm. Areas that generate relatively high quantities of sediment typically have higher gradients, more erosive soils, and an extensive change in native land cover due to the following land uses: forestry, urban and rural residential development, and agriculture" (Ecology, 2015b).

The upper and middle study area shows generally low to moderate degradation. The area just west of McIntosh Lake along Highway 507 is an exception with moderately high degradation. Much of the lower study area shows moderately high degradation with a few areas of moderate degradation.

Nitrogen Degradation

"The Degradation to Nitrogen process model (NSPECT) compares land cover within assessment units to evaluate the relative capacity to generate and load nitrogen into aquatic systems during a storm. Areas that generate relatively high quantities of nitrogen include the following land uses: agricultural, commercial and industrial, and residential" (Ecology, 2015b).

The upper and middle study area display low nitrogen degradation. The area at Silver Springs displays moderate nitrogen degradation. The lower study area shows mixed results including areas of high, moderately high, and moderate nitrogen degradation.

Pathogen Degradation

"The Degradation to Pathogen process model (NSPECT) compares land cover within assessment units to evaluate the relative capacity to generate and transport pathogens to aquatic systems during a storm. Areas that generate relatively high quantities of pathogens include the following land uses: commercial and industrial, residential, and agricultural" (Ecology, 2015b).

The upper and middle study area show entirely low pathogen degradation. The lower study area displays primarily moderate pathogen degradation with two areas of moderately high degradation in the northernmost study area.

3.2.3 Integrating Fish and Wildlife Habitat Assessments

In addition to integrating the results of the water flow and water quality assessments, this study considered results of the Puget Sound Watershed Characterization's Local Salmonid Habitat Index and Terrestrial Habitat Index (Map 25 and Map 26). Evaluating the potential benefits or losses to these habitats from the condition of water flow and water quality as well as the management recommendations will provide a more complete understanding of the study area's conditions and will help guide land use planning.

Local Salmonid Habitat Index

The local salmonid habitat index uses models that are unique to each salmonid species and yield an index that quantifies the potential habitat quality of a stream reach based on high-resolution digital elevation and climate data, as well as expert opinion. The models incorporate characteristics that are generally resistant to anthropogenic impacts, and therefore, evaluate species-specific habitat potential in the absence of such human-caused impacts. The models attempt to estimate a reach's potential to provide habitat and not the actual quality of habitat (Wilhere et al., 2013).

The Local Salmonid Habitat Index (see Figure 3) is calculated as the maximum of either the:

a. sum of habitat units for all stream reaches in the assessment unit; or
b. sum of habitat units for reaches in the assessment unit that have maximum habitat value greater than the 90th percentile for the WRIA where the assessment unit is located.

N stands for normalization which is done within WRIAs.

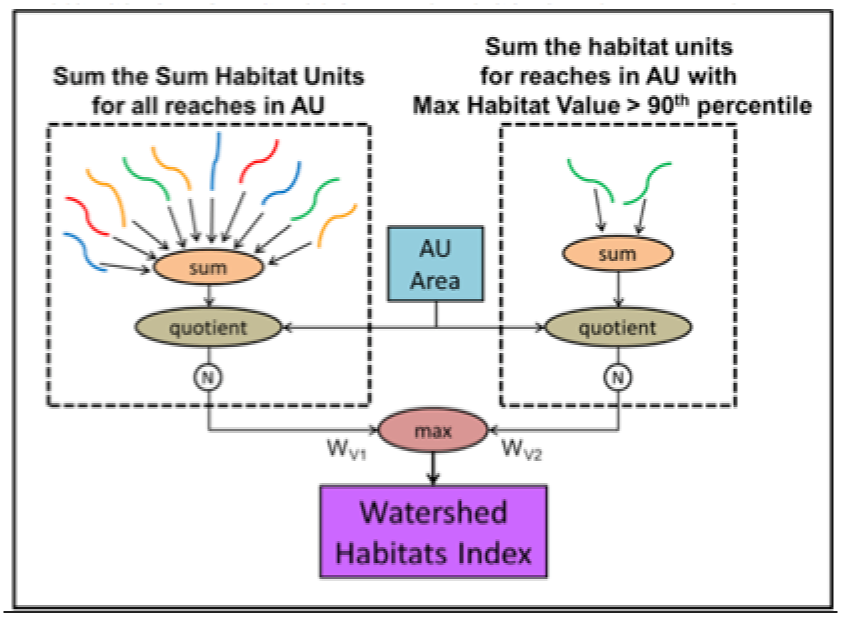

Figure 3: Local Salmonid Watershed Habitats Index

See volume 2 of the *Puget Sound Watershed Characterization Project (A Coarse-scale Assessment of the Relative Value of Small Drainage Areas and Marine Shorelines for the Conservation of Fish and Wildlife Habitats in Puget Sound Basin)* for a complete discussion of this methodology (Ecology, 2015b).

For mapping purposes, the results of the local salmonid habitat index were broken into four categories to make it easier for the viewer to distinguish differences in habitat scores (see Map 26). The local salmonid habitat index shows the highest relative habitat scores in the upper study area, with habitat scores declining in the middle and lower study area. Some portions of the study area were not included in this analysis including Spurgeon and Chambers Creeks.

3.2.4 Integrating Terrestrial Habitat Conditions

The index of Relative Conservation Value for the terrestrial habitats is comprised of two main components: landscape integrity and the locations of priority habitats and species (see Figure 4). Priority species and their habitats of primary association are identified on the Washington Department of Fish & Wildlife (WDFW) Priority Habitats and Species (PHS) List. The PHS List designates habitat and species that are considered to be priorities for conservation and require management actions for their survival. State Endangered, Threatened, Sensitive, and Candidate species; animal aggregations (e.g., heron colonies, bat colonies) considered vulnerable; and species of recreational, commercial, or tribal importance that are vulnerable are some examples of types of priority species. [5] Oak-Prairie habitats were also included in the index due to the accuracy and precision of available data and are considered one of the most imperiled terrestrial habitat types in the Puget Sound Basin (Ecology, 2015b).

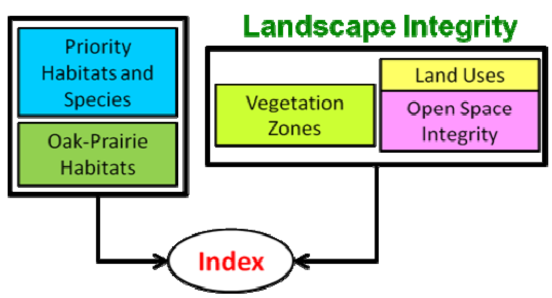

Figure 4: Terrestrial Habitats Relative Conservation Value Index

See Volume 2 of the *Puget Sound Watershed Characterization Project (A Coarse-scale Assessment of the Relative Value of Small Drainage Areas and Marine Shorelines for the Conservation of Fish and Wildlife Habitats in Puget Sound Basin)* for a complete discussion of this methodology (Ecology, 2015b).

For mapping purposes, the results of the terrestrial habitat index were broken into four categories from lowest to highest value habitat to make it easier for the viewer to distinguish differences in habitat quality (Map 26). The upper study area contains entirely highest value habitat. The middle study area shows primarily high and moderate value habitat with a few exceptions. The areas around Offut Lake, north of McIntosh Lake, and Lake Lawrence show moderately low habitat values, and the area around McIntosh Lake shows low habitat value. In the lower study area, most of the Deschutes mainstem and Spurgeon Creek show high to moderately high value habitat, while Chambers Basin and the

[5] More information and the current PHS list can be found at: http://wdfw.wa.gov/conservation/phs/list/.

northernmost portion of the Deschutes mainstem show moderately low to lowest habitat value.

3.2.5 Integrating the Puget Sound Watershed Characterization Assessments

The overall restoration/protection recommendations provided by water flow assessments identify the most appropriate management strategy for each AU and can inform the identification of management "zones." Water flow is presumed to be the driver of watershed conditions and processes, but the results of the water quality assessments can guide more specific actions. Management recommendations can also be refined with additional information and expertise, including habitat assessments that identify the most important assessment units to protect for fish and wildlife, and other regulatory information. The most appropriate places for development are assessment units that have the least importance for all processes. The highest-priority assessment units for protection are located where all assessments indicate high importance for natural resources (Stanley et al., 2012).

The integrated results from the various Puget Sound Watershed Characterization assessments (water flow protection/restoration assessment, water quality degradation assessments for sediment, nitrogen, and pathogens, local salmonid habitat and terrestrial habitat indices) provide a picture to guide management activities in different areas across the watershed (summarized in Table 10). The overall management strategy of protection, restoration, conservation, or development was defined based on the results of the water flow assessment. The water quality assessments provide additional information about the assessment unit and where there may be impacts to water quality related to land use.

The highest level of degradation among all three water quality degradation assessments was used to determine the category of water quality impairment for each AU. For example, if there is a moderate source of sediment, a high source of nitrogen, and a moderate/high source of pathogens then the AU is categorized as "likely a high source of water quality impairment due to current land uses" and appropriate BMPs are recommended to address the parameter contributing the highest source of impairment. The two habitat indices illustrate where there are potential added benefits or potential losses to salmonid habitat and terrestrial habitat based on water flow and water quality conditions. Additional information from the Deschutes TMDL and other local studies and expertise can further refine how these recommendations are applied.

Table 10: Integrated water flow, water quality, and habitat recommendations

Part of Study Area	Basin Name	Assessment Unit ID	Overall Water Flow Priority	Water Quality Degradation			Local Salmonid Habitat Index	Terrestrial Habitats Index	Integrated Water Flow, Water Quality, and Habitat Recommendation
				Sediment	Nitrogen	Pathogen			
Lower	Chambers	13026	Highest Restoration (R)	M	H	MH	1	17.3	Least suitable for intense development or in need of BMPs and development standards which protect and restore water flow processes due to the area's high importance and high level of degradation to water flow processes. Focus restoration on surface storage and recharge processes, as well as improving water quality and limiting inputs to surface waters. Likely a high source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce nitrogen and pathogen loads. Low value for local salmonid habitat and low value for terrestrial habitat so restoration for water flow and water quality may provide minimal additional benefits to species and habitats.
Lower	Chambers	13028	Restoration/ Development (RD1)	M	MH	M	0	21.7	May be suitable for more intense development intensity with BMPs and development standards which protect and restore water flow processes due to the area's medium importance and high level of degradation. Focus restoration on recharge processes, as well as improving water quality and limiting inputs to surface waters. Likely a moderate/high source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce nitrogen loads. Low value for terrestrial habitat. Additional development in this area may further degrade terrestrial habitats so improved/stringent development standards, BMPs, or restoration should be encouraged to improve degraded habitat/reduce further degradation.
Lower	Chambers	13047	Restoration (R3)	MH	MH	M	0	29.5	Less suitable for intense development or in need of BMPs and development standards which protect and restore water flow processes due to the area's medium-high importance and medium-high level of degradation. Focus restoration on surface storage processes, as well as improving water quality and limiting inputs to surface waters. Likely a moderate/high source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce sediment and nitrogen loads. Moderately low value for terrestrial habitat so restoration may also improve degraded habitats and provide some additional benefits to species.

Part of Study Area	Basin Name	Assessment Unit ID	Overall Water Flow Priority	Water Quality Degradation: Sediment	Water Quality Degradation: Nitrogen	Water Quality Degradation: Pathogen	Local Salmonid Habitat Index	Terrestrial Habitats Index	Integrated Water Flow, Water Quality, and Habitat Recommendation
Lower	Deschutes River (Mainstem Lower)	13018	Restoration (R2)	M	H	MH	11	20.4	Less suitable for intense development or in need of BMPs and development standards which protect and restore water flow processes due to the area's medium-high importance and high level of degradation. Focus restoration on discharge, recharge, and surface storage processes, as well as improving water quality and limiting inputs to surface waters. Likely a high source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce nitrogen and pathogen loads. Moderately high value for local salmonid habitat and low value for terrestrial habitat so focus restoration and protection on salmonid habitat, which may also provide benefits to terrestrial habitats and species.
Lower	Deschutes River (Mainstem Lower)	13027	Highest/ Restoration (R)	MH	MH	M	7	100	Least suitable for development or in need of BMPs and development standards which protect and restore water flow processes due to the area's high importance and high level of degradation. Focus restoration on discharge, recharge, and surface storage processes, as well as improving water quality and limiting inputs to surface waters. Likely a moderate/high source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce sediment and nitrogen loads. Moderately low value for local salmonid habitat and high value for terrestrial habitat so focus restoration on terrestrial habitat, which may also provide benefits to other species and habitats.
Lower	Deschutes River (Mainstem Lower)	13029	Restoration (R3)	MH	M	M	4	100	Less suitable for intense development or in need of BMPs and development standards which protect and restore water flow processes due to the area's medium-high importance and medium-high level of degradation. Focus restoration on recharge, surface storage, and discharge processes, as well as improving water quality and limiting inputs to surface waters. Likely a moderate/high source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce sediment loads. Low value for local salmonid habitat and high value for terrestrial habitat so focus restoration and protection on terrestrial habitat, which may also benefit other species and habitats.
Lower	Deschutes River (Mainstem Lower)	13032	Highest Protection (P1R)	M	L	L	8	62.6	Not suitable for development due to the area’s high importance for water flow processes and medium level of degradation. Focus restoration on surface storage and discharge processes, as well as improving water quality and limiting inputs to surface waters. Likely a moderate source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce sediment loads. Moderately low value for local salmonid habitat and moderately high value

Part of Study Area	Basin Name	Assessment Unit ID	Overall Water Flow Priority	Water Quality Degradation			Local Salmonid Habitat Index	Terrestrial Habitats Index	Integrated Water Flow, Water Quality, and Habitat Recommendation
				Sediment	Nitrogen	Pathogen			
									for terrestrial habitat so focus on protection of terrestrial habitat, which may also benefit other species and habitats.
Lower	Spurgeon Creek	13030	Highest Restoration (R1)	MH	L	L	0	64	Least suitable for intense development or in need of BMPs and development standards which protect and restore water flow processes due to the area's high importance and medium-high level of degradation. Focus restoration on surface storage and discharge processes, as well as improving water quality and limiting inputs to surface waters. Likely a moderate/high source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce sediment loads. Moderately high value for terrestrial habitat so focus on protection and restoration of terrestrial habitat to also benefit species and habitats.
Lower	Spurgeon Creek	13031	Protection/ Conservation (P3)	L	L	L	0	86.7	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's medium importance and low level of degradation. Focus on protecting/conserving surface storage processes. Not a likely source of water quality impairment due to current land uses. High value for terrestrial habitat so focus on conservation of terrestrial habitat to also benefit species and habitats.
Middle	Offutt Lake	13033	Highest Protection (P1R)	L	L	L	11	29.2	Not suitable for development due to the area's high importance for water flow processes and medium level of degradation. Focus on restoring discharge and surface storage processes. Not a likely source of water quality impairment due to current land uses. Moderately high value for local salmonid habitat and moderately low value for terrestrial habitat so focus protection on salmonid habitat, which may also benefit other species and habitats.
Middle	McIntosh Lake	13039	Protection (P2)	L	L	L	2	21.1	Not suitable for intense development or in need of BMPs and development standards which protect water flow processes due to the area's medium-high importance and low level of degradation. Focus on protecting surface storage processes. Not a likely source of water quality impairment due to current land uses. Low value for local salmonid habitat and low value for terrestrial habitat so protection may also provide minimal benefits to species and habitats.

Part of Study Area	Basin Name	Assessment Unit ID	Overall Water Flow Priority	Water Quality Degradation			Local Salmonid Habitat Index	Terrestrial Habitats Index	Integrated Water Flow, Water Quality, and Habitat Recommendation
				Sediment	Nitrogen	Pathogen			
Middle	Deschutes River (Mainstem Middle)	13034	Conservation (C1)	L	L	L	2	87.7	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's low importance and low level of degradation. Focus on conserving recharge processes. Not a likely source of water quality impairment due to current land uses. Low value for local salmonid habitat and high value for terrestrial habitat so focus conservation on terrestrial habitat, which may also benefit other species and habitats.
Middle	Deschutes River (Mainstem Middle)	13035	Highest Protection (P1)	L	L	L	7	52.1	Not suitable for development due to the area's high importance for water flow processes and medium level of degradation. Focus on protecting discharge and surface storage processes. Not a likely source of water quality impairment due to current land uses. Moderately low value for local salmonid habitat and moderately high value for terrestrial habitat so focus protection on terrestrial habitat, which may also benefit other species and habitats.
Middle	Deschutes River (Mainstem Middle)	13036	Highest Protection (P1)	L	L	L	14	41.1	Not suitable for development due to the area's high importance for water flow processes and low level of degradation. Focus on protecting discharge and restoring surface storage processes. Not a likely source of water quality impairment due to current land uses. Moderately high value for local salmonid habitat and moderately low value for terrestrial habitat so focus protection on salmonid habitat, which may also benefit other species and habitats.
Middle	Deschutes River (Mainstem Middle)	13037	Conservation (C2)	L	L	L	3	59.5	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the areas low importance and medium level of degradation. Focus on conserving recharge processes. Not a likely source of water quality impairment due to current land uses. Low value for local salmonid habitat and moderately high value for terrestrial habitat so focus conservation on terrestrial habitat, which may also benefit other species and habitats.
Middle	Deschutes River (Mainstem Middle)	13038	Restoration (R3)	M	M	L	10	100	Less suitable for intense development or in need of BMPs and development standards which protect and restore water flow processes due to the area's medium-high level of importance and medium-high level of degradation. Focus on protecting recharge processes and restoring surface storage and discharge processes, as well as improving water quality and limiting inputs to surface waters. Likely a moderate source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce sediment and nitrogen loads. Moderately low value for local salmonid habitat and high value for terrestrial habitat so focus restoration on terrestrial habitat, which may also benefit other species and habitats.

Part of Study Area	Basin Name	Assessment Unit ID	Overall Water Flow Priority	Water Quality Degradation			Local Salmonid Habitat Index	Terrestrial Habitats Index	Integrated Water Flow, Water Quality, and Habitat Recommendation
				Sediment	Nitrogen	Pathogen			
Middle	Deschutes River (Mainstem Middle)	13040	Protection (P2R)	MH	L	L	5	68.2	Not suitable for intense development or in need of BMPs and development standards which protect water flow processes due to the area's medium-high level of importance and medium level of degradation. Focus on protecting discharge and recharge processes, and restoring surface storage processes, as well as improving water quality and limiting inputs to surface waters. Likely a moderate/high source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce sediment loads. Low value for local salmonid habitat and moderately high value for terrestrial habitat so focus protection on terrestrial habitat, which may also benefit other species and habitats.
Middle	Deschutes River (Mainstem Middle)	13041	Protection (P2)	L	L	L	0	100	Not suitable for intense development or in need of BMPs and development standards which protect water flow processes due to the area's medium-high importance and low level of degradation. Focus on protecting recharge, discharge, and surface storage processes. Not a likely source of water quality impairment due to current land uses. High value for terrestrial habitat so focus protection on terrestrial habitat to also benefit species and habitats.
Middle	Deschutes River (Mainstem Middle)	13042	Protection/ Conservation (P3)	L	L	L	15	80.6	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's medium importance and low level of degradation. Focus on protecting/conserving delivery and recharge processes. Not a likely source of water quality impairment due to current land uses. Moderately high value for local salmonid habitat and high value for terrestrial habitat so protection/conservation will also provide significant benefits to multiple species and habitats.
Middle	Deschutes River (Mainstem Middle)	13044	Highest Protection (P1)	L	L	L	7	73.7	Not suitable for intense development due to the area's high importance for water flow processes and low level of degradation. Focus on protecting recharge, discharge, and surface storage processes. Not a likely source of water quality impairment due to current land uses. Moderately low value for local salmonid habitat and moderately high value for terrestrial habitat so focus protection on terrestrial habitat, which may also benefit other species and habitats.

Part of Study Area	Basin Name	Assessment Unit ID	Overall Water Flow Priority	Water Quality Degradation			Local Salmonid Habitat Index	Terrestrial Habitats Index	Integrated Water Flow, Water Quality, and Habitat Recommendation
				Sediment	Nitrogen	Pathogen			
Middle	Deschutes River (Mainstem Middle)	13045	Highest Restoration (R1)	M	L	L	16	76	Least suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's high importance and medium-high level of degradation. Focus on protecting recharge, and restoring discharge and surface storage processes, as well as improving water quality and limiting inputs to surface waters. Likely a moderate source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce sediment loads. Moderately high value for local salmonid habitat and high value for terrestrial habitat so restoration and protection will also provide significant benefits to multiple species and habitats.
Middle	Deschutes River (Mainstem Middle)	13050	Highest Protection (P1R)	L	L	L	1	79.3	Not suitable for development due to the area's high importance for water flow processes and medium level of degradation. Focus on protecting discharge and recharge processes, and restoring surface storage processes, as well as delivery and discharge processes. Not a likely source of water quality impairment due to current land uses. Low value for local salmonid habitat and high value for terrestrial habitat so focus protection on terrestrial habitat, which may also benefit other species and habitats.
Middle	Reichel Lake	13001	Highest Restoration (R1)	M	L	L	13	96	Least suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's high importance for water flow processes and medium-high level of degradation. Focus on protecting delivery and recharge, and restoring discharge and surface storage processes, as well as improving water quality and limiting inputs to surface waters. Likely a moderate source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce sediment loads. Moderately high value for local salmonid habitat and high value for terrestrial habitat so restoration and protection will also provide significant benefits to multiple species and habitats.
Middle	Lake Lawrence	13043	Highest Restoration (R)	L	L	L	7	45.1	Least suitable for intense development or in need of BMPs and development standards which restore water flow processes due to the area's high importance for water flow processes and high level of degradation. Focus on restoring surface storage processes. Not a likely source of water quality impairment due to current land uses**.** Moderately low value for both local salmonid habitats and terrestrial habitats so restoration may also provide minimal benefits to species and habitats.
Upper	Deschutes River (Mainstem Upper)	13002	Protection (P2)	L	L	L	19	90	Not suitable for intense development or in need of BMPs and development standards which protect water flow processes due to the area's medium-high importance and low level of degradation. Focus on protecting delivery

Part of Study Area	Basin Name	Assessment Unit ID	Overall Water Flow Priority	Water Quality Degradation			Local Salmonid Habitat Index	Terrestrial Habitats Index	Integrated Water Flow, Water Quality, and Habitat Recommendation
				Sediment	Nitrogen	Pathogen			
									and discharge processes. Not a likely source of water quality impairment due to current land uses. High value for both local salmonid habitats and terrestrial habitats so protection will also provide significant benefits to multiple species and habitats.
Upper	Deschutes River (Mainstem Upper)	13003	Conservation (C1)	L	L	L	17	96.1	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's low importance and low level of degradation. Focus on conserving delivery processes. Not a likely source of water quality impairment due to current land uses. High value for both local salmonid habitats and terrestrial habitats so conservation will also provide significant benefits to multiple species and habitats.
Upper	Deschutes River (Mainstem Upper)	13004	Protection/ Conservation (P3)	M	L	L	12	96.1	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's medium importance and low level of degradation. Focus on protecting/conserving delivery processes. Likely a moderate source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce sediment loads. Moderately high value for local salmonid habitat and high value for terrestrial habitat so conservation will also provide significant benefits to multiple species and habitats.
Upper	Deschutes River (Mainstem Upper)	13005	Protection (P2)	M	L	L	19	97.1	Not suitable for intense development or in need of BMPs and development standards which protect water flow processes due to the area's medium-high importance and low level of degradation. Focus on protecting delivery and recharge processes. Likely a moderate source of water quality impairment due to current land uses. Implement appropriate BMPs, particularly to reduce sediment loads. High value for both local salmonid habitats and terrestrial habitats so protection will also provide significant benefits to multiple species and habitats.
Upper	Deschutes River (Mainstem Upper)	13006	Conservation (C1)	L	L	L	20	96.2	Less suitable for intense development or in need of BMPs and development standards which conserve water flow processes due to the area's low importance and low level of degradation. Focus on conserving delivery processes. Not a likely source of water quality impairment due to current land uses. High value for both local salmonid habitats and terrestrial habitats so conservation will also provide significant benefits to multiple species and habitats.

3.2.6 Management Zones and Recommended Actions

Based on the integration of the assessment results, staff identified five main management zones and a preliminary list of management actions for each, based on the “solution templates” in the Puget Sound Watershed Characterization (Stanley et al., 2012, p. 35). See Map 23. The PSWC and the solution templates provide a useful tool for identifying priority areas and types of management actions for improving watershed health. However, because the GIS data on which the PSWC is developed are aggregated into assessment units of several square miles, it cannot address specific locations and types of actions at the site level. Rather it provides a systematic tool to better understand the regional context and identify general management zones and recommended actions.

UPPER STUDY AREA:

Zone 1 = Protection/Conservation

Basins and assessment units include: the Deschutes River (Mainstem Upper)

- This area should be protected and conserved due to primarily low degradation and varying importance to water flow processes, as well as primarily low water quality degradation, and primarily high value for local salmonid habitats and terrestrial habitats. Focus on protecting/conserving specific water flow processes for each Assessment Unit (AU). Low intensity development may be appropriate in some areas recommended for protection/conservation, given appropriate BMPs and development standards are put into place. The primary land use in zone 1 is forestry.
- For forest land use, future management should:
    - Reduce number of stream crossings by road. This is both a protection and restoration action that addresses surface storage water flow processes.
    - Reduce interception of shallow groundwater in channels and road ditches. This is both a protection and restoration action that addresses recharge and discharge water flow processes.
    - Replant deforested areas: This is both a protection and restoration action that addresses delivery water flow processes.
    - Ensure zoning is consistent with long-term protection of resources. This is both a protection and restoration action that addresses delivery, surface storage, recharge, and discharge water flow processes.
    - Decommission and remove unneeded forest roads: This is both a protection and restoration action that addresses surface storage, recharge, and discharge water flow processes.
    - Ensure a large area around streams/wetlands is protected (Stanley et al., 2012). This is both a protection and restoration action that addresses delivery, surface storage, recharge, and discharge water flow processes.

MIDDLE STUDY AREA:

Zone 2 = Restoration. Lower intensity uses are appropriate.

Basins and assessment units include: Lake Lawrence, Reichel Lake, and AUs 13045 and 13038 within the Deschutes River (Mainstem Middle).

- These areas are less suitable for intense development or in need of appropriate BMPs and development standards, as well as restoration efforts which improve water quality and restore water flow processes due to the medium-high to high levels of degradation in these areas. This zone has low to moderate levels of water quality degradation due to current land uses. Local salmonid habitat value ranges from moderately low to moderate, and terrestrial habitat ranges from moderately low to high value. The primary land uses in this zone are forestry, agriculture, and residential.
- For forest land use, future management should:
    - Reduce number of stream crossings by roads. This is both a protection and restoration action that addresses surface storage water flow processes.
    - Reduce interception of shallow groundwater in channels and road ditches. This is both a protection and restoration action that addresses recharge and discharge water flow processes.
    - Replant deforested areas: This is both a protection and restoration action that addresses delivery water flow processes.
    - Ensure zoning is consistent with long-term protection of resources. This is both a protection and restoration action that addresses delivery, surface storage, recharge, and discharge water flow processes.
    - Decommission and remove unneeded forest roads: This is both a protection and restoration action that addresses surface storage, recharge, and discharge water flow processes.
    - Ensure a large area around streams/wetlands is protected (Stanley et al., 2012). This is both a protection and restoration action that addresses delivery, surface storage, recharge, and discharge water flow processes.
- For agricultural land use, future management should:
    - Apply source controls for nitrogen and pathogens. This action applies to all management categories (protection, restoration, conservation, and development) and addresses surface storage water flow processes.
    - Allow greater residence time of water on fields and ditches outside of growing season. This action applies to all management categories (protection, restoration, conservation, and development) and addresses surface storage, recharge, and discharge water flow processes.
    - Require and encourage (with outreach and education or incentives and assistance programs) properly functioning septic systems. This action applies to all management categories (protection, restoration, conservation, and development) and addresses recharge and discharge water flow processes.
    - Ensure zoning is consistent with long-term protection of agriculture and resources. This is both a protection and

restoration action that addresses delivery, surface storage, recharge, and discharge water flow processes.

- Reduce groundwater withdrawals. This is both a protection and restoration action that addresses recharge and discharge water flow processes.
- Reduce drainage density of artificial channels. This is both a restoration and protection action that addresses surface storage, recharge, and discharge water flow processes.
- Establish buffers for water quality improvement in strategic areas. This is both a protection and restoration action that addresses delivery, recharge, and discharge water flow processes.
- Reduce interception of shallow groundwater in channels and road ditches. This is both a protection and restoration action that addresses recharge and discharge water flow processes.
- Revegetate upland areas. This is both a protection and restoration action that addresses delivery, and surface storage water flow processes.
- Restore overbank flooding. This is a restoration action that addresses surface storage water flow processes.
- Restore degraded stream reaches, floodplains, or wetlands to recover lost processes and functions. This is a restoration action that addresses surface storage, recharge, and discharge water flow processes.
- Restore highly infiltrative soils. This is a restoration action that addresses recharge and discharge water flow processes.

- For rural land use, future management should:
  - Require and encourage (with outreach and education or incentives and assistance programs) properly functioning septic systems. This action applies to all management categories (protection, restoration, conservation, and development) and addresses recharge and discharge water flow processes.
  - Emphasize dispersive/infiltrative stormwater management. This action applies to all management categories (protection, restoration, conservation, and development) and addresses delivery water flow processes.
  - Ensure zoning is consistent with long-term protection of resources (e.g., clustered development). This is both a restoration and protection action that addresses delivery, surface storage, recharge, and discharge water flow processes.
  - Ensure large size of protected areas around streams/wetlands. This is both a restoration and protection action that addresses delivery, surface storage, recharge, and discharge water flow processes.
  - Reduce drainage density of artificial channels. This is both a restoration and protection action that addresses surface storage, recharge, and discharge water flow processes.
  - Revegetate upland areas. This is both a restoration and protection action that addresses delivery and surface storage water flow processes.

  - Reduce groundwater withdrawals. This is both a restoration and protection action that addresses recharge and discharge water flow processes.
  - Reduce interception of shallow groundwater in channels and road ditches. This is both a protection and restoration action that addresses recharge and discharge water flow processes.
  - Replant deforested areas. This is both a restoration and protection action that addresses delivery water flow processes.
  - Restore overbank flooding. This is a restoration action that addresses surface storage water flow processes.
  - Restore stream reaches, floodplains, or wetlands to recover lost processes and functions. This is a restoration action that addresses surface storage, recharge, and discharge water flow processes.

Zone 3 = Protection/Conservation

Basins and assessment units include: the majority of the Deschutes River Mainstem Middle (with the exceptions of the assessment units listed in Zone 2), including McIntosh Lake and Offut Lake, as well as one AU (13031) within the Spurgeon Creek Basin (Lower Sub-basin), and one AU (13032) within the Deschutes River Mainstem Lower Sub-basin.

- This area should be protected and conserved due to low to medium degradation and varying importance to water flow processes, as well as primarily low water quality degradation. The area’s local salmonid habitat ranges from low to moderately high value, and terrestrial habitat ranges from low to high value, although it is primarily high value. Focus on protecting/conserving, and in some cases restoring, specific water flow processes for each Assessment Unit (AU). Low-intensity development may be appropriate in some conservation areas, given appropriate BMPs and development standards are put into place. The primary land uses in this zone are forestry, agriculture, and residential.
- For forest land use, future management should:
  - Reduce number of stream crossings by roads. This is both a protection and restoration action that addresses surface storage water flow processes.
  - Reduce interception of shallow groundwater in channels and road ditches. This is both a protection and restoration action that addresses recharge and discharge water flow processes.
  - Replant deforested areas: This is both a protection and restoration action that addresses delivery water flow processes.
  - Ensure zoning is consistent with long-term protection of resources. This is both a protection and restoration action that addresses delivery, surface storage, recharge, and discharge water flow processes.
  - Decommission and remove unneeded forest roads: This is both a protection and restoration action that addresses surface storage, recharge, and discharge water flow processes.
  - Ensure a large area around streams/wetlands is protected (Stanley et al., 2012). This is both a protection and restoration action that addresses delivery, surface storage, recharge, and discharge water flow processes.

- For agricultural land use, future management should:
    - Apply source controls for nitrogen and pathogens. This action applies to all management categories (protection, restoration, conservation, and development) and addresses surface storage water flow processes.
    - Allow greater residence time of water on fields and ditches outside of growing season. This action applies to all management categories (protection, restoration, conservation, and development) and addresses surface storage, recharge, and discharge water flow processes.
    - Require and encourage (with outreach and education or incentives and assistance programs) properly functioning septic systems with outreach and incentives or assistance programs. This action applies to all management categories (protection, restoration, conservation, and development) and addresses recharge and discharge water flow processes.
    - Ensure zoning is consistent with long-term protection of agriculture and resources. This is both a protection and restoration action that addresses delivery, surface storage, recharge, and discharge water flow processes.
    - Reduce groundwater withdrawals. This is both a protection and restoration action that addresses recharge and discharge water flow processes.
    - Reduce drainage density of artificial channels. This is both a restoration and protection action that addresses surface storage, recharge, and discharge water flow processes.
    - Establish buffers for water quality improvement in strategic areas. This is both a protection and restoration action that addresses delivery, recharge, and discharge water flow processes.
    - Reduce interception of shallow groundwater in channels and road ditches. This is both a protection and restoration action that addresses recharge and discharge water flow processes.
    - Revegetate upland areas. This is both a protection and restoration action that addresses delivery, and surface storage water flow processes.
    - Restore overbank flooding. This is a restoration action that addresses surface storage water flow processes.
    - Restore degraded stream reaches, floodplains, or wetlands to recover lost processes and functions. This is a restoration action that addresses surface storage, recharge, and discharge water flow processes.
    - Restore highly infiltrative soils. This is a restoration action that addresses recharge and discharge water flow processes.
- For rural land use, future management should:
    - Require and encourage (with outreach and education or incentives and assistance programs) properly functioning septic systems. This action applies to all management categories (protection, restoration, conservation, and development) and addresses recharge and discharge water flow processes.
    - Emphasize dispersive/infiltrative stormwater management. This action applies to all management categories (protection,

restoration, conservation, and development) and addresses delivery water flow processes.
    - Ensure zoning is consistent with long-term protection of resources (e.g., clustered development). This is both a restoration and protection action that addresses delivery, surface storage, recharge, and discharge water flow processes.
    - Ensure large size of protected areas around streams/wetlands. This is both a restoration and protection action that addresses delivery, surface storage, recharge, and discharge water flow processes.
    - Reduce drainage density of artificial channels. This is both a restoration and protection action that addresses surface storage, recharge, and discharge water flow processes.
    - Revegetate upland areas. This is both a restoration and protection action that addresses delivery and surface storage water flow processes.
    - Reduce groundwater withdrawals. This is both a restoration and protection action that addresses recharge and discharge water flow processes.
    - Reduce interception of shallow groundwater in channels and road ditches. This is both a protection and restoration action that addresses recharge and discharge water flow processes.
    - Replant deforested areas. This is both a restoration and protection action that addresses delivery water flow processes.
    - Restore overbank flooding. This is a restoration action that addresses surface storage water flow processes.
    Restore stream reaches, floodplains, or wetlands to recover lost processes and functions. This is a restoration action that addresses surface storage, recharge, and discharge water flow processes.

LOWER STUDY AREA:

Zone 4 = Restoration. Lower intensity uses are appropriate.

Basins and assessment units include: the majority of the Deschutes River Mainstem Lower (with the exception of the AUs listed in Zone 3), including the northern assessment unit (13030) within the Spurgeon Creek Basin, and two assessment units (13047 and 13026) within Chambers Creek.

- These areas are less suitable for intense development or in need of BMPs and development standards that protect and restore water flow processes due to the area's medium-high to high importance for water flow processes and medium-high to high level of degradation. Focus on restoring various water flow processes and improving water quality specific to each AU. The area has variable water quality degradation trending toward moderately high. Local salmonid habitats range from low value to moderately high. Terrestrial habitats range from low value to moderately high. The primary land use in this zone is residential (in parts urban/suburban, and rural) since this area covers both incorporated cities and their urban growth areas as well as rural areas.
- For urban/suburban land use, future management should:
    - Emphasize dispersive/infiltrative stormwater management. This action applies to all management categories (protection,

restoration, conservation, and development) and addresses delivery, surface storage, recharge, and discharge water flow processes.
    - Reduce groundwater withdrawals. This is both a protection and restoration action that addresses recharge and discharge water flow processes.
    - Reduce interception of shallow groundwater in channels and road ditches. This is both a protection and restoration action that addresses recharge and discharge processes.
    - Revegetate upland areas. This is both a protection and restoration action that addresses delivery and surface storage water flow processes.
    - Retrofit structures and roads for greater infiltration. This is a restoration action that addresses delivery, recharge, and discharge water flow processes.
    - Construct stream reaches or artificial wetlands to recover lost processes and functions if/as feasible. This is a restoration action that addresses surface storage, recharge, and discharge water flow processes.
- For rural land use, future management should:
    - Require and encourage (with outreach and education or incentives and assistance programs) properly functioning septic systems. This action applies to all management categories (protection, restoration, conservation, and development) and addresses recharge and discharge water flow processes.
    - Emphasize dispersive/infiltrative stormwater management. This action applies to all management categories (protection, restoration, conservation, and development) and addresses delivery water flow processes.
    - Ensure zoning is consistent with long-term protection of resources (e.g., clustered development). This is both a restoration and protection action that addresses delivery, surface storage, recharge, and discharge water flow processes.
    - Ensure large size of protected areas around streams/wetlands. This is both a restoration and protection action that addresses delivery, surface storage, recharge, and discharge water flow processes.
    - Reduce drainage density of artificial channels. This is both a restoration and protection action that addresses surface storage, recharge, and discharge water flow processes.
    - Revegetate upland areas. This is both a restoration and protection action that addresses delivery and surface storage water flow processes.
    - Reduce groundwater withdrawals. This is both a restoration and protection action that addresses recharge and discharge water flow processes.
    - Reduce interception of shallow groundwater in channels and road ditches. This is both a protection and restoration action that addresses recharge and discharge water flow processes.
    - Replant deforested areas. This is both a restoration and protection action that addresses delivery water flow processes.

- o Restore overbank flooding. This is a restoration action that addresses surface storage water flow processes.
- o Restore stream reaches, floodplains, or wetlands to recover lost processes and functions. This is a restoration action that addresses surface storage, recharge, and discharge water flow processes.

Zone 5 = Development/restoration.

Basins and assessment units include: one assessment unit (13028) within the Chambers Creek Basin.

- This area may be suitable for low to moderate development intensity with appropriate BMPs and development standards due to the area's medium importance and high level of degradation to water flow processes. Focus on restoring recharge processes and improving water quality. This area has moderate to moderately high water quality degradation, and low value for terrestrial habitats. The primary land use in this zone is urban/suburban as well as some rural residential. However, areas with rural land use are not recommended for development (only protection and restoration) and the same future management recommendations as zone 4 can be applied in these areas.
- For urban/suburban land use, future management should:
  - o Emphasize dispersive/infiltrative stormwater management. This action applies to all management categories (protection, restoration, conservation, and development) and addresses delivery, surface storage, recharge, and discharge water flow processes.
  - o Retrofit structures and roads for greater infiltration. This is a restoration action that addresses delivery, recharge, and discharge water flow processes.
  - o Construct stream reaches or artificial wetlands to recover lost processes and functions if/as feasible. This is a restoration action that addresses surface storage, recharge, and discharge processes.
  - o Emphasize mixed use and transit oriented development.
  - o Promote higher density use of land, such as with infill and encouraging accessory dwelling units where feasible.
  - o Retrofit older infrastructure for better stormwater management.
  - o Promote increased canopy cover by encouraging tree retention and planting.

3.3 Deschutes River TMDL Management Recommendations

3.3.1 TMDL Implementation Overview

In 2003, the Washington Department of Ecology began a Total Maximum Daily Load (TMDL) project to address the impairments to water quality in the Deschutes River, Capitol Lake, and Budd Inlet Tributaries. In 2012, a technical report describing pollutant loading and pollutant reduction scenarios for all rivers and streams within the Budd Inlet watershed, Capitol Lake, as well as for marine water within Budd Inlet was published in Roberts et al. (2012).

Ecology implemented a phased approach to the Deschutes TMDL because the nature of dissolved oxygen impairments in Budd Inlet is complex and affected by nutrient sources from other areas of Puget Sound. The first phase uses the results from the 2012 technical study to determine load allocations to meet water quality standards to address freshwater impairments in the Deschutes River, Percival Creek, their tributaries, and other tributaries to Budd Inlet. Load allocations are "the portion of a receiving water's loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources."

The draft Water Quality Improvement Report / Implementation Plan (WQIR/IP), contains numeric load allocations for temperature, bacteria, dissolved oxygen, pH, and fine sediment as well as specific implementation actions (Wagner and Bilhimer, 2015). Based on the technical study findings, the WQIR/IP states what needs to happen to bring freshwater bodies within the TMDL boundary into compliance with the state water quality standards. This freshwater WQIR/IP also includes load allocations for nitrogen for stretches of the river above Offut Lake. Additional implementation actions will be identified in a second phase of the Deschutes TMDL (Wagner and Bilhimer, 2015).

Nonpoint pollution source load allocations apply to all land uses within the TMDL boundary including residential (including non-commercial farms), commercial uses, agriculture, and forestry. Each land use category has potential effects on water quality, and the report identifies best management practices (BMPs) to reduce or eliminate pollution from these land uses. The TMDL established "Load Allocation (LA) Compliance Areas," which are the drainage areas that contribute non-point pollution to the location at which water quality is measured to see if it meets the load allocations. When the appropriate BMPs are implemented and maintained correctly for the different land uses within a LA area, those activities will be considered compliant with the TMDL (Wagner and Bilhimer, 2015).

The most important implementation actions identified in the freshwater TMDL are to establish forested riparian buffers and conserve existing buffers on the Deschutes River and other streams. In order to make significant progress on problems related to temperature, fecal coliform bacteria, dissolved oxygen, pH, and fine sediment, it is essential to establish these forested riparian buffers. Achieving this crucial goal will require a concerted effort by all of the watershed land owners, non-profit organizations, and governments (Wagner and Bilhimer, 2014).

Essential Management Actions Identified in the Freshwater TMDL for the study area include:

- Reduce fecal coliform bacteria concentrations during the summer growing season
- Establish mature riparian shade throughout the entire Deschutes Watershed. Although the restoration of mature riparian vegetation and channel conditions would not create conditions where temperature meets the numeric criteria throughout the system, the actions would have significant results including cooling water temperatures, reducing the number of reaches above lethal temperatures, increasing minimum DO, and decreasing maximum pH (Roberts et al., 2012, Wagner and Bilhimer, 2015)

- The combination of restoration and improvement of riparian areas through the establishment of mature riparian shade, reduction of wetted stream widths and the near stream disturbance zone, and microclimate cooling would produce the biggest impact to raise minimum DO and lower maximum pH in the Deschutes mainstem (Wagner and Bilhimer, 2015)

Management recommendations from the Deschutes freshwater TMDL are summarized below for each parameter by basin within the study area (see Table 18). They focus on restoration of degraded areas as well as activities that will improve water quality from its current impaired condition. The TMDL did not consider in depth the potential impact of projected new development on water quality, and does not set aside a "reserve capacity" for future growth as a part of the load allocations. Instead, the WQIR/IP report acknowledges that new development within the Deschutes River watershed will need to occur in such a way that it does not contribute additional pollution sources.

3.3.2 Temperature

Temperature Load Allocation

The temperature load allocation for the Deschutes River and all its tributaries represents the improvement that would result from full mature riparian vegetation, microclimate, channel improvements, and decreased headwater and tributary temperatures. The stream temperature load allocation compliance area is the riparian area surrounding the Deschutes River, and effective shade allocations define the percent improvement needed. It is necessary to establish forested riparian buffers and conserve existing riparian shade on the Deschutes and its tributaries to reduce the water temperature. June through September is the critical period for temperature (Wagner and Bilhimer, 2015).

Map 27 illustrates the locations of effective shade improvement allocations for potential vegetation. Areas with the greatest difference between system potential shade and current shade will require the greatest increases in effective shade.

The Deschutes WQIP/IR recommends load allocations (LA) to meet numeric threshold criteria, although some areas are naturally warmer than those criteria. In such cases, load allocations are set to reduce the amount of warming caused by human activities. Although the maximum temperatures predicted under mature riparian shade would not meet the 16 or 17.5°C numeric water quality criteria during critical conditions in the Deschutes River, mature riparian shade would substantially reduce peak temperatures below the limit lethal for fish. Therefore, maximum protection from direct solar radiation throughout the system is necessary. Map 6 shows the existing shade conditions in reaches mapped by the Thurston Conservation District Riparian Assessment study (Kutel, 2007).

Deschutes River (Mainstem Lower)

Most of the lower mainstem river needs between 30-75% improvement in effective shade from current conditions. Focus should be given to improving riparian areas in the many locations which were identified as having moderate to poor existing shade conditions (Kutel, 2007) (Map 6).

Tempo Lake outflow did not meet the water quality standards based on 2003 peak temperatures, analyzed as the 7-day average of the daily maximum stream temperature (7DADMax). Full mature riparian vegetation is needed in order to reduce temperatures in this tributary. The Tempo Lake outflow has hot conditions, due in part to solar heating of the lake surface. The lake outlet should be evaluated for hydraulic modifications that enhance cooler water or subsurface connection (Roberts et al., 2012).

Ayer Creek did not meet the water quality standards based on 2003 peak temperatures (7DADMax). Full mature riparian vegetation is needed in order to reduce temperatures in this tributary (Roberts et al., 2012; Wagner and Bilhimer, 2015).

Chambers Basin

Focus on improving riparian areas in the long stretches of poor existing riparian shade cover along Chambers Creek and Chambers Ditch (Kutel, 2007) (Map 6).

Spurgeon Creek Basin

Focus on improving riparian areas in the long stretch of poor existing riparian shade cover along Spurgeon Creek (Kutel, 2007) (Map 6).

Spurgeon Creek did not meet the water quality standards based on 2003 peak temperatures (7DADMax). Full mature riparian vegetation is needed in order to reduce temperatures in this tributary (Roberts et al., 2012; Wagner and Bilhimer, 2015).

Offut Lake Basin

There are no recommendations for this basin.

McIntosh Lake Basin

There are no recommendations for this basin.

Deschutes River (Mainstem Middle)

The mainstem Deschutes in this sub-basin needs a range of improvements. There are many locations that only need a 15-30% improvement in effective shade, notably the area upstream of the Reichel Lake Creek confluence. Other areas fall primarily within a needed 30-60% improvement in effective shade. There is one area upstream of the Hull Creek confluence that requires a 60-75% improvement in effective shade (Map 27). Focus on improving riparian areas in areas where existing riparian shade cover varies from low to moderate. Many areas on the Deschutes mainstem near Lake Lawrence have low to moderate shade cover. The area around Highway 507 has low to moderate shade cover. Silver Creek has low shade cover (Kutel, 2007) (Map 6).

Reichel Lake Basin

Reichel Creek did not meet the water quality standards based on 2003 peak stream temperature data (7DADMax). Full mature riparian vegetation is needed in order to reduce temperatures in this tributary (Roberts et al., 2012; Wagner and Bilhimer, 2015).

Lake Lawrence Basin

Focus on improving riparian areas in the area of low riparian shade cover where the Lake Lawrence outlet meets the Deschutes River (Kutel, 2007) (Map 6).

Deschutes River (Mainstem Upper)

The mainstem Deschutes in this sub-basin needs a range of improvements from 2-75%. There are several locations that only need a 2-30% improvement in effective shade. More of the river will require a 30-60% improvement. There is one area downstream of the Fall Creek confluence that requires a 60-75% improvement (Map 27). Focus restoration on improving riparian areas in the small area of low percent shade cover at the mouth of Johnson Creek (Kutel, 2007) (Map 6).

Thurston Creek, Johnson Creek, and Mitchell Creek did not meet the water quality standards based on 2003 peak stream temperature data (7DADMax). Full mature riparian vegetation is needed in order to reduce temperatures in these tributaries (Roberts et al., 2012; Wagner and Bilhimer, 2015).

Huckleberry Creek did not violate water quality standards in 2003 (7DADMax was 15.6°C); however, it was on the 303(d) list in 2004, and during critical conditions it could violate water quality standards. Full mature riparian shade is also recommended for Huckleberry Creek (Roberts et al., 2012; Wagner and Bilhimer, 2015).

Additional recommended management activities for temperature (in addition to the numeric load targets for effective shade in the Deschutes Watershed) (Roberts et al., 2012):

- Achieve full mature riparian vegetation on tributaries
- Develop voluntary programs to increase riparian vegetation for areas that are not managed by the USFS or in accordance with the Forests and Fish Agreement, such as private non-forest areas. For example, riparian buffers or conservation easements may be sponsored by the Natural Resources and Conservation Service, U.S. Department of Agriculture, or Conservation Reserve Enhancement Program. In particular, the area between RK 12 and RK 20 should be targeted for riparian and channel restoration.
- Encourage future projects that have the potential to increase groundwater or surface-water inflows to streams in the watershed because they have the potential to decrease peak water temperatures. Instream flows and water withdrawals are not established in TMDLs and are instead managed through alternative regulatory structures. However, instream flow affects stream temperature. Continued drops in summer baseflows will have a negative effect on Deschutes River water temperatures, and increasing baseflow would decrease peak water temperatures in the river.
    - Opportunities exist to diminish the effects of current and potential future withdrawals. Reclaimed water use with appropriate management practices would lessen the need for potable water or groundwater but should not produce increased nutrient loads to surface water. Improving and maximizing stormwater infiltration would reduce erosion during high flows and would increase summer baseflows. Strengthen water conservation programs to reach urban, suburban, and rural water users (Roberts et al., 2012).
    - Quantify water withdrawals for all watershed users. Agencies should identify illegal withdrawals and work with landowners. Enforcement actions should be taken to eliminate illegal withdrawals if needed (Roberts et al., 2012).
- Management activities that would decrease the load of sediment to the Deschutes River would benefit water temperature as a result of the subsequent improvement in channel characteristics.
- Use short-term restoration strategies to increase LWD abundance as one means to increase channel complexity. Increased channel complexity, which, in combination with greater water depth, would improve peak temperatures. Mature riparian vegetation eventually would provide large woody debris (LWD) to the channel; however, in the interim, it would be valuable to do short-term restoration of LWD. Key locations include the areas around Henderson Boulevard, Waldrick Road, State Route 507, and Old Camp Lane.
- The effect of solar radiation on water temperature is substantially buffered by existing hyporheic exchange flows and groundwater inflows. Activities such as accumulation of fine sediment that reduce the

hydraulic conductivity, could increase stream temperatures. Management activities should reduce channel and upland erosion and avoid sedimentation of fine materials in the stream substrate (Roberts et al., 2012).

This temperature TMDL does not include a specific reserve capacity for future growth in the Deschutes Watershed. Future development may not increase heat loads to the Deschutes River, particularly the sensitive area between Fall Creek and the Lake Lawrence outlet [1000 Road (13-DES-37.4) and Vail Cutoff Road SE (13-DES-28.6)]. Future management and development should be planned to prevent degradation from loss of riparian vegetation, decreased groundwater recharge, or groundwater withdrawals (Roberts et al., 2012).

3.3.3 Fecal Coliform Bacteria

Reductions are necessary in much of the study area. There are a variety of potential sources including permitted wastewater discharges, cross-connected infrastructure, onsite-septic systems, domestic animals, recreational users, and homeless populations; agricultural non-point sources include poor manure management that does not prevent runoff to streams and livestock defecating in streams (Wagner and Bilhimer, 2015).

Load Allocation

Water quality standards for fecal coliform bacteria within the study area are not met during the summer in numerous areas, and reductions are necessary (see Table 12 and Map 28). Fecal coliform load allocations (LA) are a percent reduction from current conditions from either Part 1 or Part 2 of the water quality standards, whichever part required greater reductions. The Load Allocation is prescribed for two different seasonal periods, Summer (May-September) and Winter (October-April), as well as during storm events. The Load Allocation Compliance Areas are shown in Table 11 and Map 29 (Oct-April).

Summer season fecal coliform concentrations along the Deschutes River were highest in the upstream segments and decrease downstream (Roberts et al., 2012). The Deschutes River Mainstem Middle Sub-basin needs the highest reduction of summer fecal coliform at 82%. Reichel Lake Basin needs the next highest summer fecal coliform reduction of 68%. The Deschutes River Mainstem Upper Sub-basin and Spurgeon Creek Basin need reduction of fecal coliform in the summer of 53% and 44%, respectively. Chambers Creek requires a summer reduction of fecal coliform of 35%. During the winter and during storm events, load allocations within the study area are met and no further reductions are necessary (see Table 12 and Map 289).

Table 11: Load allocation compliance areas for bacteria LAs within the study area

Basin Name	LA Station	Load Allocation Compliance Area Description	Map Label
Deschutes River (Mainstem Lower)	13-DES-00.5	Deschutes River at E St. Bridge	I
Deschutes River (Mainstem Lower)	13-DES-02.7	Deschutes River at Henderson Blvd	J
Deschutes River (Mainstem Lower)	13-AYE-00.0	Ayer Creek	D
Deschutes River (Mainstem Lower)	13-DES-05.5	Deschutes River below Ayer Creek	K
Chambers Basin	13-CHA-00.1	Chambers Creek	H
Spurgeon Creek Basin	13-SPU-00.0	Spurgeon Creek	Y
Deschutes River (Mainstem Middle)	13-DES-09.2	Deschutes River near Rich Road	L
Deschutes River (Mainstem Middle)	13-DES-20.5	Deschutes River at Route 507	M
Reichel Lake	13-REI-00.9	Reichel Creek	W
Deschutes River (Mainstem Upper) primarily, except area around Lake Lawrence which is Deschutes River (Mainstem Middle)	13-DES-28.6	Vail Loop Road SE crossing	N
Deschutes River (Mainstem Upper)	13-HUC-00.3	Huckleberry Creek	O

**This table is also the key for maps that include these LA compliance areas*

Management recommendations for reducing summer fecal coliform levels include eliminating human and domestic animal sources of fecal coliform bacteria. Location-specific management activities could include waste management and fencing for areas such as the Deschutes River between Rainier and Old Camp Lane where fecal material and cows were observed on the gravel bars (Roberts et al., 2012). Incentive-based programs, such as the VSP, could be utilized as a method to address domestic animal sources of fecal coliform bacteria through the implementation of conservation and restoration practices in site-specific management plans. Residences and businesses located outside of the urban growth area all use on-site sewage systems (OSS). OSS have a high potential to be a source of bacteria if they are failing, sited in low permeable soils, and/or within close proximity to streams (Wagner and Bilhimer, 2015).

Thurston County is the permitting authority for On-site Sewage Systems within the TMDL boundary. Thurston County is also the agency that will be working within this area to find failing systems near surface water bodies. Ecology recommends several priority areas to focus OSS efforts:

- Chambers Creek sub-watershed
- Residential development around Lake Lawrence
- Town of Rainier (Wagner and Bilhimer, 2015)

Table 12: Load Allocations for Fecal Coliform Bacteria

Basin that contains majority of LA Compliance Area	LA Compliance Area ID (and map key)	90th Percentile* Load Allocation	Summer LA (May-Sept) (Percent Reduction)**	Winter LA (Oct-Apr) (Percent Reduction)**	Additional load reduction targets during storms	Load Allocation Compliance Area Description
Deschutes River (Mainstem Lower)	I	200 cfu/ 100 mL	0%	0%	None	E St. Bridge
Deschutes River (Mainstem Lower)	J	200 cfu/ 100 mL	0%	0%	None	Henderson Blvd crossing
Deschutes River (Mainstem Lower)	D	200 cfu/ 100 mL	0%	0%	None	Ayer Creek
Chambers	H	200 cfu/ 100 mL	35%	0%	None	Chambers Creek
Spurgeon Creek	Y	200 cfu/ 100 mL	44%	0%	None	Spurgeon Creek
Deschutes River (Mainstem Middle)	L	200 cfu/ 100 mL	0%	0%	None	Rich Road crossing
Deschutes River (Mainstem Middle)	M	100 cfu/ 100 mL	82%	0%	None	At Route 507 crossing
Reichel Creek	W	200 cfu/ 100 mL	68%	0%	None	Reichel Creek
Majority: Deschutes River (Mainstem Upper); small amount in Deschutes River (Mainstem Middle) (around Lake Lawrence)	N	100 cfu/ 100 mL	53%	0%	None	Vail Loop Road SE crossing
Deschutes River (Mainstem Upper)	O	200 cfu/ 100 mL	0%	0%	None	Huckleberry Creek

Source: Modified from Table 10 in Wagner and Bilhimer, 2015.

Notes:

**The 90th percentile concentration target is the part of the criteria most often violated and is assumed the Geometric Mean is met if the 90th percentile target is also.*

*** The percent reduction of the 90th percentile reduction scores at each station that is needed to be in compliance with the surface water quality standard for fecal coliform bacteria. Ecology recognizes that significant nonpoint sources of bacteria may exist in some areas that were meeting standards during the TMDL study. Load allocation compliance areas with a zero percent reduction target must continue to meet standards and future violations will require a reevaluation of the specific load allocation" (Wagner and Bilhimer, 2014).*

3.3.4 Dissolved Oxygen and pH

Load Allocation for Dissolved Oxygen and pH

The TMDL recommends load allocations to meet numeric threshold criteria, although in some areas DO and pH naturally do not meet the state criteria for water quality. In such cases, an allowance for the impact of human activities was built into the load allocation. Upstream of Offut Lake under system potential conditions, minimum DO would not meet the numeric DO criteria of >9.5mg/L. However, minimum DO during critical conditions would be substantially improved with greater effective shade on the Deschutes mainstem in combination with channel improvements that stabilize and reduce the near stream disturbance zone, and reduction of headwater and tributary temperatures (Wagner and Bilhimer, 2015). Improvements in headwater, tributary, and groundwater quality to reduce nutrient loading will also be needed in the Deschutes River upstream of Offut Lake where the 9.5 mg/L criteria applies. Map 30 identifies where the most improvements for DO are needed on the Deschutes mainstem, and shows the difference between the DO criterion and expected DO improvement based on one of the scenarios developed by Ecology through the TMDL process (Scenario DO8: system potential effective shade and nutrient reductions). Map 31 shows the percent reduction in the near stream disturbance zone needed to improve DO.

Table 13: Specific DO improvement activities by basin and river location

Basin Name	Dissolved Oxygen Improvement Needed	Most significant DO improvement activity by location
Deschutes River (Mainstem Lower)	Meets the standard; Ayer Creek may not meet DO criteria	Downstream of RK 58 (Ayer Creek): partially restoring riparian shade would further improve DO. Ayer Creek: restore mature riparian vegetation to limit primary productivity
Deschutes River (Mainstem Middle)	Ranges from needing the most to moderate improvement	RK 5 (Michelle Creek) and 46 (Offut Lake): restore full mature riparian shade RK 10 (Fall Creek) - 20 (south of Lake Lawrence): second highest benefit - decrease the near-stream disturbance zone and wetted width. RK 10 (Fall Creek) and 46 (Offut Lake): 3rd highest benefit - achieving microclimate benefits.
Deschutes River (Mainstem Upper)	Ranges from needing the most to moderate improvement	RK 0-5: restore headwater DO to meet numeric standard RK 5 (Michelle Creek) and 46 (Offut Lake): restore full mature riparian shade RK 10-20: 2nd highest benefit - decrease the near-stream disturbance zone and wetted width by 40-50% RK 10 and 46: 3rd highest benefit - achieving microclimate benefits.
Tributaries to Deschutes		
Reichel Creek	May not meet DO criteria	Reichel Creek: restore mature riparian vegetation to limit primary productivity
Lake Lawrence	May not meet DO criteria	Lake Lawrence tributary: restore mature riparian vegetation to limit primary productivity

Table 14: Specific pH improvement activities by basin and river location

Basin Name	Most significant pH improvement activity by location
Deschutes River (Mainstem Lower)	RK 55 – 59 and RK 60-68: restore full mature riparian shade to lower maximum pH RK 62-68: increase shade to reduce the pH range
Deschutes River (Mainstem Middle)	RK 40 – 46: restore full mature riparian shade to lower maximum pH RK 21.5 – 27: reduce tributary nutrients and increase shade to reduce the pH range RK 37.5 – 46: increase shade to reduce the pH range
Deschutes River (Mainstem Upper)	RK 5.5 – 8.5: reduce tributary nutrients to reduce the pH range

Reducing nutrient levels is helpful to lower primary productivity and improve DO. There are numerous tributaries with nitrogen and phosphorus nutrient loads that contribute to violations of the DO and pH standards in the mainstem Deschutes River (Table 15).

Nutrient sources include on-site sewage systems (OSS), stormwater runoff from fields and lawns where fertilizers and manure are applied in excess of agronomic rates, some types of residential landscaping and fertilizers applied adjacent to lakes and rivers, livestock directly accessing and defecating in streams, as well as erosion of stream banks that mobilizes phosphorus adsorbed to soil particles. Minimum DO will be increased and nutrient loading at the mouth of the Deschutes will be reduced by applying BMPs that reduce nutrient inputs to the Deschutes mainstem, tributaries, and groundwater (Wagner and Bilhimer, 2015).

Load allocations for inorganic nitrogen (DIN), and orthophosphate (OP) are the natural condition for these two parameters, which applies to the Deschutes watershed above Offutt Lake. These load allocations may be changed during Phase II of the TMDL that will set nutrient allocations for Capitol lake and Budd Inlet (Wagner and Bilhimer, 2015). Groundwater concentrations for organic phosphorous were capped at 0.054 mg/L, 0.052 mg/L for inorganic phosphorous, 0.616 mg/L for nitrate, 0.034 mg/L for ammonia, and 0.007 mg/L for organic nitrogen (Roberts et al., 2012). The reduction of nutrient inputs from tributaries and groundwater to estimated natural conditions will improve the average daily minimum DO in the Deschutes River by only 0.03 mg/L and 0.02 mg/L respectively, which is within the 0.02 mg/L allowance in the water quality standards for anthropogenic influences on minimum DO (Roberts et al., 2012). Upstream of Offutt Lake the loading capacity for the daily minimum DO is the potential minimum DO minus 0.2 mg.L. Downstream of Offutt Lake, the current condition is the loading capacity between river kilometer (RK) 46 (Waldrick Road) and 58 (near south end of the Olympia Airport), as well as downstream of RK 68 (near E St. Bridge). The current condition is the loading capacity in this area because DO conditions are already better than the water quality standards. Between RK 58 and 68, the loading capacity is 8.0 mg/L. The loading capacity for DO in the Percival Creek watershed is expressed as the solar radiation heat loads based on system potential vegetation. Mature riparian vegetation would decrease stream temperatures and improve the DO due to saturation effects and decreased primary productivity from riparian shade.

Table 15: Tributaries that should be evaluated for future nitrogen or phosphorus reduction strategies

Basin Name	Tributaries with elevated nitrogen	Tributaries with elevated phosphorus
Deschutes River (Mainstem Lower)	Ayer/Elwanger; Tempo Lake; and unnamed creek at RK 64.	Ayer/Elwanger; Spurgeon
Chambers Creek	Chambers Creek	N/A
Deschutes River (Mainstem Middle)	N/A	Lake Lawrence outlet
Reichel Lake	N/A	Reichel Creek
Deschutes River (Mainstem Upper)	N/A	N/A

Source: Roberts et al., 2012

Septic systems, particularly those near a water body, could be contributing excess nutrients. Thurston County is the permitting authority for OSS within the TMDL boundary and is the entity that will be working to find failing systems in areas where the geology contributes to nitrate contamination in groundwater. Priority areas are identified in Table 16.

Table 16: Areas with high surface or groundwater nutrient concentrations where future efforts should reduce nutrient loading from OSS

Basin Name	Location
Deschutes River (Mainstem Lower)	Tempo Lake and its outlet creek; Ayer Creek
Chambers Creek	Chambers Lake and its outlet creek
Deschutes River (Mainstem Middle)	Upstream of Offut Lake City of Rainier
Lake Lawrence	Residential development around Lake Lawrence

Sources: Roberts et al., 2012; Wagner and Bilhimer, 2015

Management recommendations to mitigate the low DO and high pH in the Deschutes Watershed include:

- Low-impact development (LID) should be instituted for future development in appropriate areas in the watershed, with particular attention to decreasing nutrient contributions below current levels. Future development should not worsen DO or pH.
- Future groundwater infiltration facilities should quantify the potential increases in nutrient loads to the Deschutes River and tributaries and offset any inputs by reducing other local sources such that DO and pH do not worsen.
- Agricultural operations, including dairies, should eliminate offsite transport of sediments and nutrients. The two dairy operations in the Deschutes Watershed should be evaluated further for facility management and manure applications; water quality monitoring should be considered (Roberts et al., 2012).

- Thurston County's existing septic system management programs should continue and intensify. Additionally, future efforts should assess and implement options to reduce nutrient loading from onsite sewage systems in areas with high surface or groundwater nutrient concentrations (Roberts et al., 2012).

3.3.5 Fine Sediment

Load Allocation

Fine sediment must be reduced to achieve healthy levels in the salmonid spawning gravels of the Deschutes River. Load allocations for fine sediment are identified as a percent reduction from current conditions. The load allocation for the Deschutes River Mainstem is to reduce fine sediments to no more than 12% of the substrate. Compliance with these allocations in the future will be based on comparing measured data with the healthy habitat levels established in the Timber Fish and Wildlife Watershed Analysis Manual (Washington Forest Practices Board, 1997) (Wagner and Bilhimer, 2015). Table 17 and Map 32 portray the fine sediment load allocations for the Deschutes Watershed based on the river reaches assessed by Konovsky and Puhn (2005).

Table 17: Fine sediment load allocations by basin and by reach for the Deschutes River

Basin Name	Reach Name	Approximate Model segment River Kilometer	1995	2004	Target	% Reduction
Deschutes River (Mainstem Lower)	Pioneer	RK 64 – RK 68	22.0%	22.1%	12%	46%
Deschutes River (Mainstem Middle)	Waldrick	RK 41 – RK 45	19.9%	20.1%	12%	40%
Deschutes River (Mainstem Middle)	State Route 507	RK 33 – RK 35	19.4%	20.5%	12%	41%
Deschutes River (Mainstem Middle)	Lake Lawrence	RK 22-RK 23	22.5%	17.1%	12%	30%
Deschutes River (Mainstem Upper)	Weyerhaeuser	RK 11 – RK 16	15.5%	17.7%	12%	32%

Anchor Environmental (2008) found that improved fine sediment levels would produce the greatest increase in Coho production out of the various restoration elements evaluated in the Deschutes River, particularly in the mainstem and tributaries between RM 31 and RM 41. Human-related activities contribute up to 32% of known sediment sources and 23% of the total sediment inputs to the Deschutes River. Unpaved roads and landslides associated with roads are anthropogenic sources (Roberts et al., 2012).

Within the area covered by the Forests and Fish Agreement, extensive road rehabilitation and other sediment control strategies have been implemented, and long-term turbidity has declined (Reiter et al., 2009). Despite source control measures, the upstream reaches have poor fine sediment levels. Intensive sediment management should continue, since it often takes many years after a management program begins to see instream responses (Roberts et al., 2012).

To mitigate fine sediment, as well as improve temperature, DO, and pH, channel and riparian restoration should be a focus throughout the river, in particular between River Kilometer 12 - 20 near Lake Lawrence. Create channel complexity using large woody debris, to boost pool formation and lower the transport of fine sediment and phosphorus. River restoration would also benefit Coho and other fisheries resources (Anchor Environmental, 2008; Roberts et al., 2012).

In the future, land cover changes in the Deschutes Watershed must not increase fine sediment inputs to tributaries or to the Deschutes River beyond natural conditions. Methods to protect areas with waters of a higher quality than the criteria in the Deschutes Watershed must be considered to ensure that continued development in the Deschutes Watershed does not result in a loss of current water quality in these high-quality areas (Roberts et al., 2012).

3.3.6 Land Use

To achieve nonpoint compliance with the Deschutes Freshwater TMDL's load allocations, Ecology has prescribed a suite of best management practices (BMPs) required to minimize the impact on water quality of each type of land use activity (Map 16). The general BMPs that apply to each land use category are identified in the implementation portion of the Deschutes Freshwater WQIP/IR (Wagner and Bilhimer, 2014). When appropriate BMPs have been implemented by landowners to reduce or eliminate the impacts of their land use activity on water quality, they will be considered in compliance with the TMDL.

Reserve Capacity for Future Growth

The Deschutes TMDL did not build in reserve capacity for future growth to contribute additional inputs to nonpoint sources of pollution within the Deschutes Freshwater TMDL area. Within the urban growth areas (UGAs) of the cities of Olympia, Tumwater, and Lacey, and in adjacent areas within Thurston County, all new development must implement LID practices as a requirement of their Western Washington Phase II Municipal Stormwater Permit. Outside of the UGAs, in unincorporated rural areas of Thurston County, new development should implement best management practices (BMPs) and LID principles and ensure that nonpoint sources of pollution are reduced to a negligible amount (Wagner and Bilhimer, 2015).

Forest Practices

Ecology will rely on Washington State's forest practices regulations to bring waters on private and state forest lands into compliance with the load allocations established in the Deschutes Freshwater TMDL. Ecology will not require more stringent measures except through adaptive management-based changes established under the Forests and Fish Adaptive Management Program and subject to reopening in the event benchmarks are not achieved in accordance with Clean Water Act (CWA) Assurances established under Schedule M-2 of the Forests and Fish Report (USFWS et al., 1999; Hicks, 2006)(Wagner and Bilhimer, 2015).

3.3.7 Summary of TMDL Management Recommendations

Table 18: TMDL Management Recommendations

	TMDL Load Allocations					
Basin Name	**Temperature: Effective shade improvement needed and focus areas**	**Fecal Coliform: % reduction needed (summer)**	**Fecal Coliform: % reduction needed (winter)**	**DO: improvement needed and management recommendations**	**pH: improvement needed and management recommendations**	**Fine Sediment % reduction needed and management**
Deschutes River (Mainstem Lower)	Increase effective shade 30-75% on mainstem; restore full mature riparian vegetation along Tempo Lake outfall and Ayer Creek	0%	0%	Meets the standard; Ayer Creek may not meet DO criteria. Downstream of RK 58 (Ayer Creek): partially restoring riparian shade would further improve DO. Ayer Creek: restore mature riparian vegetation to limit primary productivity. Evaluate the following tributaries for nitrogen reduction strategies: Ayer/Elwanger; Tempo Lake; and unnamed creek at RK 64. Evaluate the following tributaries for phosphorus reduction strategies: Ayer/Elwanger; Spurgeon. Reduce nutrient loading from OSS in Tempo Lake and its outlet creek and Ayer Creek.	RK 55 – 59 and RK 60-68: restore full mature riparian shade to lower maximum pH. RK 62-68: increase shade to reduce the pH range. Evaluate the following tributaries for nitrogen reduction strategies: Ayer/Elwanger; Tempo Lake; and unnamed creek at RK 64. Evaluate the following tributaries for phosphorus reduction strategies: Ayer/Elwanger; Spurgeon. Reduce nutrient loading from OSS in Tempo Lake and its outlet creek and Ayer Creek.	RK 64 – RK 68: 46%
Chambers	Improve riparian shade in areas of poor existing riparian shade cover along Chambers Creek and Chambers Ditch	35%	0%	Evaluate Chambers Creek for nitrogen reduction strategies including OSS.	Evaluate Chambers Creek for nitrogen reduction strategies including OSS.	—
Spurgeon Creek	Improve full mature riparian vegetation in areas of poor existing riparian shade cover along Spurgeon Creek	44%	0%	—	—	—
Offut Lake	—	0%	0%	—	—	—
McIntosh Lake	—	0%	0%	—	—	—

	TMDL Load Allocations					
Basin Name	**Temperature: Effective shade improvement needed and focus areas**	**Fecal Coliform: % reduction needed (summer)**	**Fecal Coliform: % reduction needed (winter)**	**DO: improvement needed and management recommendations**	**pH: improvement needed and management recommendations**	**Fine Sediment % reduction needed and management**
Deschutes River (Mainstem Middle)	Increase effective shade 15-30% on mainstem upstream of Reichel Lake confluence and 30-60% in most other areas; restore riparian shade in areas where existing riparian shade varies from low to moderate such as near Lake Lawrence, around Highway 507, and Silver Creek	82%	0%	Ranges from needing the most to moderate improvement. RK 5 (Michelle Creek) and 46 (Offut Lake): restore full mature riparian shade RK 10 (Fall Creek) - 20 (south of Lake Lawrence): second highest benefit - decrease the near-stream disturbance zone and wetted width. RK 10 (Fall Creek) and 46 (Offut Lake): 3rd highest benefit - achieving microclimate benefits. Reduce nitrogen loading from OSS upstream from Offut Lake and near the City of Rainier.	RK 40 – 46: restore full mature riparian shade to lower maximum pH. RK 21.5 – 27: reduce tributary nutrients and increase shade to reduce the pH range. RK 37.5 – 46: increase shade to reduce the pH range. Evaluate the following tributaries for phosphorus reduction strategies: Lake Lawrence outlet; Reichel Creek. Reduce nitrogen loading from OSS upstream from Offut Lake and near the City of Rainier.	RK 41 – RK 45: 40%; RK 33 – RK 35: 41%; RK 22-RK 23: 30%. RK 12- RK - 20: channel and riparian restoration to mitigate fine sediment as well as improve temperature, DO, and pH.
Lake Lawrence	Focus on improving riparian areas in the area of low riparian shade cover where the Lake Lawrence outlet meets the Deschutes River	53%	0%	May not meet DO criteria. Lake Lawrence tributary: restore mature riparian vegetation to limit primary productivity. Reduce nitrogen loading from OSS in residential development around Lake Lawrence.	Reduce nitrogen loading from OSS in residential development around Lake Lawrence.	—
Reichel Lake	Full mature riparian vegetation is needed in order to reduce temperatures in Reichel Creek	68%	0%	May not meet DO criteria. Reichel Creek: restore mature riparian vegetation to limit primary productivity.	—	—
Deschutes River (Mainstem Upper)	Increase effective shade from 2-75% on the mainstem Deschutes. Several locations need a 2-30% improvement, more of the river will require a 30-60% improvement. Focus on improving riparian areas at the mouth of Johnson Creek. Full mature riparian vegetation is needed in order to reduce temperatures in Thurston Creek, Johnson Creek, Mitchell Creek, and Huckleberry Creek.	53%	0%	Ranges from needing the most to moderate improvement. RK 0-5: restore headwater DO to meet numeric standard RK 5 (Michelle Creek) and 46 (Offut Lake): restore full mature riparian shade RK 10-20: 2nd highest benefit - decrease the near-stream disturbance zone and wetted width. RK 10 and 46: 3rd highest benefit - achieving microclimate benefits.	RK 5.5 – 8.5: reduce tributary nutrients to reduce the pH range	RK 11 – RK 16: 32%

3.4 Management Recommendations by Basin

In addition to the management recommendations listed in the Puget Sound Watershed Characterization and Deschutes TMDL sections, Table 20 lists management recommendations taken from the following sources:

- Haring and Konovsky. 1999. *Salmonid Habitat Limiting Factors Final Report, Water Resource Inventory Area 13.*
- Thurston Conservation District Lead Entity. 2004. *Salmon Habitat Protection and Restoration Plan for Water Resource Inventory Area 13, Deschutes.*
- Anchor Environmental. 2008. *Final Deschutes River Watershed Recovery Plan: Effects of Watershed Habitat Conditions on Coho Salmon Production*
- Roberts et al. 2012. *The Deschutes River, Capitol Lake, and Budd Inlet Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment Total Maximum Daily Load Water Quality Study Findings*

Table 19 provides general management recommendations that should be implemented across all basins in the study area. Table 20 lists basin-specific recommendations that should be considered in addition to applying the general management recommendations.

Table 19: Overall management recommendations for the Deschutes study area – all basins

Haring and Konovsky (1999)	Thurston Conservation District Lead Entity (2004)	Anchor Environmental (2008)	Roberts et al., 2012.
• Further characterize and solve fine sediment and water quality problems in the lower river; • Restore mature coniferous riparian zones (site potential tree height) throughout the watershed, maintaining full protection of the channel meander zone; • Support bank protection efforts that restore channel and riparian function, and avoid use of funds to try to stop natural channel erosion of glacial terraces; • Develop and implement a strategy to place LWD, particularly key-piece sized pieces and/or log jams, through the interim period until restored riparian zones are capable of natural contribution of LWD; • Field verify off-channel habitat maps and protect/enhance high priority areas, and, • Search for solutions to instream flow concerns.	• Complete and implement Deschutes TMDL action plan to correct the impaired temperature and sediment parameters; • Address issues of water use to protect and improve instream flow conditions • Restore riparian corridor to provide shade, recruit LWD, and stabilize streambanks. Use Thurston County Conservation District riparian assessment (Kutel, 2007) to locate riparian restoration sites. Plant appropriate species. • Increase LWD key piece abundance to encourage sediment sorting and pool formation. Develop a strategy to place instream LWD until riparian conditions improve enough to allow natural recruitment. Educate landowners on the value of natural floodplain and stream functions (Riparian vegetation, channel migration, LWD, etc.). • Protect channel migration zones from incompatible land uses through Thurston County Critical Areas Ordinances regulations; • Protect and restore off-channel habitat priority sites identified in previous studies; • Educate landowners located in the Deschutes River Basin to increase compliance with land use regulations and voluntary implementation of best management practices. • Open up blocked intact habitat for Coho usage • Create large woody debris jams • Plant riparian corridors • Protect existing habitat	• Restoration that combines reduction of fine sediment loads, reduction of high water temperatures, decreased duration of low flows, decreased peak annual flow, and increases in LWD should be considered to reduce the likelihood of extirpation of the Deschutes River coho population. Restoration of multiple habitat parameters in the mainstem Deschutes and tributaries will likely be necessary for coho populations to survive during periods of low marine survival. Restoring the river's riparian corridor is a requirement for restoring fine sediments, water temperature, and LWD. A wide, vegetated riparian corridor will hold sediments in place, provide shade to the water, and provide fallen trees to increase LWD availability over the long-term. • Efforts to reduce fine sediment loads should be focused on reaches used for spawning. The Assessment Reach Tributaries RM 31 to 41 in the model contained the primary spawning areas. Additional restoration activities to reduce fine sediment should focus on the Assessment Reaches Mainstem RM 10 to 17 and Mainstem RM 17 to 25, where juvenile coho are thought to rear extensively. Restoration efforts in these two locations should focus on protecting river banks from erosion. • The riparian corridor should be restored to reduce summer water temperatures and increase LWD quantities. In order to restore habitat processes to keep water temperatures low and provide fallen trees to the river, a wide riparian corridor vegetated with a mix of native conifers and deciduous trees, including trees overhanging the river, will be necessary. Organic material to support prey production, provide habitat structure for fish, and contribute to habitat diversity through the creation of pools will	• Preserve existing riparian vegetation, and restore areas with young or no vegetation along the Deschutes mainstem and tributaries. Restoration plantings should include deciduous trees and shrubs, as well as conifer trees. Riparian vegetation will reduce stream temperature, DO, and pH. • Enhance channel complexity by including LWD within the active river bed and riparian zones. • Investigate and encourage opportunities to enhance groundwater recharge or surface water inflows through low-impact development (LID) practices for new development and redevelopment. This should include infiltration of existing stormwater in all possible locations, and possibly include reclaimed water. This would potentially decrease peak water temperatures. • Think about a water management strategy that recognizes the benefits of maintaining summer baseflows while meeting the community's need for water that considers projected future growth and increases in water demand. • Quantify and mitigate the effect of exempt wells • Encourage water conservation throughout the watershed and particularly residents served by exempt wells. • Restore and protect natural wetlands. • Management of future development should (1) prevent further degradation of those areas already below standards (prevent riparian vegetation removal, reduce groundwater withdrawal, or enhance groundwater recharge) and (2) protect those areas currently meeting standards, as required by the antidegradation portions of the water quality standards. • Avoid fine sediment input by controlling and reducing upland

Haring and Konovsky (1999)	Thurston Conservation District Lead Entity (2004)	Anchor Environmental (2008)	Roberts et al., 2012.
		be provided by long-term LWD recruitment. • Restoring low flows is encouraged to increase coho production. It is expected that water temperatures would be improved through restoration of low flows. • Protection and restoration of off-channel habitats is recommended. Off-channel habitats are particularly important for coho throughout the winter months. Watershed development in middle and lower areas commonly impacts off-channel habitats. Taylor (1999) conducted an inventory of off-channel habitats in the watershed which could be used to prioritize protection and restoration efforts.	and channel erosion • Develop voluntary programs to increase riparian vegetation for areas that are not managed in accordance with the Forests and Fish Agreement, such as private non-forest lands. • Evaluate tributaries with high nutrient concentrations for nutrient reduction opportunities. Consider activities that reduce nutrient loads to natural levels. • Institute low-impact development (LID) for future development in appropriate areas in the watershed, with a focus on decreasing nutrient contributions below current levels and not worsening DO or pH. • Maintain septic systems. Implement options to reduce nutrient loading and bacterial contamination from onsite sewage systems such as state-of-the-art onsite sewage systems. • Future groundwater infiltration facilities should ensure that any inputs are offset by reducing other local sources such that DO and pH do not worsen. • Eliminate offsite transport of sediments and nutrients from agricultural operations, including dairies. • Continue adaptive management of anthropogenic sources of fine sediment including: unpaved roads and landslides associated with roads. In addition, other anthropogenic sources, such as off-road vehicle use, domestic animals, and facilities covered under general permits, should be identified and reduced to the maximum extent. Fencing to remove access should be considered. • Evaluate river restoration strategies that include control of instream fine sediment. Riparian and channel restoration, will have multiple benefits including mitigating fine sediment levels and temperature improvements from increased channel complexity. Channel restoration should include large woody debris (LWD) to enhance pool formation and decrease the transport of

Haring and Konovsky (1999)	Thurston Conservation District Lead Entity (2004)	Anchor Environmental (2008)	Roberts et al., 2012.
			fines in the system. River restoration will benefit coho and other fisheries resources (Anchor Environmental, 2008). • Control anthropogenic sources of fine sediment so that sediment inputs do not exceed natural conditions. Projects should be designed so that they do not produce any offsite transport of fine sediment or any visible accumulation of fine sediment downstream of the sites.

*Table 20: Basin-specific management recommendations *Use in addition to the general management recommendations above*

Basin	Haring and Konovsky (1999)	Thurston Conservation District Lead Entity (2004)	Anchor Environmental (2008)	Roberts et al. (2012)
Deschutes River (Mainstem Lower)	General recommendations as well as: • Further characterize and solve fine sediment and water quality problems in the lower river; **Ayer (Elwanger) Creek:** • Restore functional riparian habitat; • Identify and correct sources of fecal coliform; • Address remaining agricultural activities that are causing adverse physical habitat and water quality impacts to salmonids.	General recommendations as well as: • **Ayer/Elwanger Creek** – restore its riparian corridor	• Efforts to reduce fine sediment loads should be focused on reaches used for spawning. Additional restoration activities to reduce fine sediment should focus on the Assessment Reaches Mainstem RM 10 to 17 and Mainstem RM 17 to 25, where juvenile coho are thought to rear extensively. Restoration efforts in these two locations should focus on protecting river banks from erosion.	General recommendations as well as: • Enhance channel complexity by including LWD within the active river bed and riparian zones. Key locations in this basin are located around Henderson Blvd. • Restore and protect natural wetlands in areas such as Ayer/Elwanger Creek. This tributary has elevated temperatures, and restoration of riparian zones with appropriate plantings would reduce solar heating of this system. • Tempo Lake stream tributary has one of the hottest stream conditions, partially due to solar heating of the lake surface. Evaluate the lake outlet for existing hydraulic modifications that could be altered to decrease downstream temperatures. • Evaluate tributaries with high nutrient concentrations such as Ayer (Elwanger) Creek for nutrient reduction opportunities. Consider activities that reduce nutrient loads to natural levels. • Maintain septic systems. Implement options to reduce nutrient loading and bacterial contamination from onsite sewage systems such as state-of-the-art onsite sewage systems. These systems should particularly be considered in sensitive areas such as Tempo Lake and its outlet creek, and the Ayer Creek watershed.
Chambers	• Restore functional riparian buffers, • Look for solutions to low flow concerns • Identify and correct fecal coliform sources			• Maintain septic systems. Implement options to reduce nutrient loading and bacterial contamination from onsite sewage systems such as state-of-the-art onsite sewage systems. These systems should particularly be considered in sensitive areas such as Chambers Lake and its outlet creek.
Spurgeon Creek	• Restore functional riparian habitat; • Identify benefits and potential of associated wetlands restoration; • Identify sites with unrestricted livestock access to the channel, report to Thurston County Health Department for correction; and, • Address remaining agricultural activities that are causing adverse physical habitat and water quality impacts to salmonids	• Prioritize and correct barriers identified in the WRIA 13 Fish Passage Inventory (South Puget Sound Salmon Enhancement Group (SPSSEG)).		• Restore and protect natural wetlands in areas such as Spurgeon Creek. This tributary has elevated temperatures, and restoration of riparian zones with appropriate plantings would reduce solar heating of this system.

Basin	Haring and Konovsky (1999)	Thurston Conservation District Lead Entity (2004)	Anchor Environmental (2008)	Roberts et al. (2012)
Offut Lake	• Prioritize and correct identified fish passage barriers, and • Evaluate the merits of providing fish passage at the outlet of Offut Lake			
McIntosh Lake				

Basin	Haring and Konovsky (1999)	Thurston Conservation District Lead Entity (2004)	Anchor Environmental (2008)	Roberts et al. (2012)
Deschutes River (Mainstem Middle)	General recommendations as well as: **Silver Springs Creek:** • Identify the extent of high-quality spring-fed off-channel habitat and available options to ensure long term protection.		• Efforts to reduce fine sediment loads should be focused on reaches used for spawning. The Assessment Reach Tributaries RM 31 to 41 in the model contained the primary spawning areas. Additional restoration activities to reduce fine sediment should focus on the Assessment Reaches Mainstem RM 10 to 17 and Mainstem RM 17 to 25, where juvenile coho are thought to rear extensively. Restoration efforts in these two locations should focus on protecting river banks from erosion.	• Enhance channel complexity by including LWD within the active river bed and riparian zones. Key locations in the middle basin are located around Waldrick Road, State Route 507, and Old Camp Lane. • The Lake Lawrence outflows has one of the hottest tributary stream conditions, partially due to solar heating of the lake surface. Evaluate the lake outlet for existing hydraulic modifications that could be altered to decrease downstream temperatures. • Management should be focused on the warmest, and therefore most sensitive, river section of the Deschutes mainstem, between 1000 Road (near the Lake Lawrence outlet) and Vail Cutoff Road SE. Management of future development should (1) prevent further degradation of those areas already below standards (prevent riparian vegetation removal, reduce groundwater withdrawal, or enhance groundwater recharge) and (2) protect those areas currently meeting standards, as required by the antidegradation portions of the water quality standards. • Maintain septic systems. Implement options to reduce nutrient loading and bacterial contamination from onsite sewage systems such as state-of-the-art onsite sewage systems. These systems particularly be considered in sensitive areas such as upstream of Offut Lake. • Manage nutrients along the Deschutes between Old Camp Lane and the Lake Lawrence Tributary (RK 18 - 20) where ecology staff noted cows on the banks and fecal material in the river and on gravel bars. Management could include fencing and waste management. • Evaluate river restoration strategies that include control of instream fine sediment. Riparian and channel restoration, particularly between RK 12 and RK 20, will have multiple benefits including mitigating fine sediment levels and temperature improvements from increased channel complexity. Channel restoration should include large woody debris (LWD) to enhance pool formation and decrease the transport of fines in the system. River restoration will benefit coho and other fisheries resources (Anchor Environmental, 2008).

Basin	Haring and Konovsky (1999)	Thurston Conservation District Lead Entity (2004)	Anchor Environmental (2008)	Roberts et al. (2012)
Lake Lawrence				• The Lake Lawrence tributary has high water temperatures, partially due to the solar radiation received by the lake surface. Evaluate the lake outlet for existing hydraulic modifications that could be altered and result in decreased downstream temperatures. • The Lake Lawrence outlet has elevated phosphorus and upstream nutrient sources should be quantified. Lake Lawrence is on the 303(d) list for total phosphorus. A TMDL should be conducted and implemented soon so that management activities may be coordinated.
Reichel Lake	• Prioritize and correct identified fish passage barriers; • Identify sites with unrestricted livestock access to the channel, report to Thurston County Health Department for correction; • Address remaining agricultural activities that are causing adverse physical habitat and water quality impacts to salmonids, identify and address continuing runoff problems associated with the former log sort yard; implement appropriate in-channel mitigation and restoration; and, • Restore functional riparian buffers throughout drainage			• Restore and protect natural wetlands in areas such as Reichel Creek. This tributary has elevated temperatures, and restoration of riparian zones with appropriate plantings would reduce solar heating of this system. • Evaluate tributaries with high nutrient concentrations such as Reichel Creek for nutrient reduction opportunities. Consider activities that reduce nutrient loads to natural levels.
Deschutes River (Mainstem Upper)	General recommendations as well as: **Fall Creek:** • Restore and maintain functional mature native woody vegetation in riparian buffers and on unstable slopes to minimize the rate of landslides and active bank erosion. **Mitchell Creek:** • Restore and maintain functional mature native woody vegetation in riparian buffers and on		• Efforts to reduce fine sediment loads should be focused on reaches used for spawning. The Assessment Reach Tributaries RM 31 to 41 in the model contained the primary spawning areas.	

Basin	Haring and Konovsky (1999)	Thurston Conservation District Lead Entity (2004)	Anchor Environmental (2008)	Roberts et al. (2012)
	unstable slopes to minimize the rate of landslides and active bank erosion; and • Develop and implement an interim strategy to supplement key piece LWD in the creek until restored riparian habitat is capable of contributing functional LWD. **Johnson Creek:** • Restore and maintain functional mature native woody vegetation in riparian buffers and on unstable slopes to minimize the rate of landslides and active bank erosion; and, • Develop and implement an interim strategy to supplement key piece LWD in the creek until restored riparian habitat is capable of contributing functional LWD (Haring and Konovsky, 1999).			

3.5 *Sustainable Thurston* Regional Targets

Thurston Regional Planning Council's long-range sustainability plan, *Creating Places—Preserving Spaces: A Sustainable Development Plan for the Thurston Region*, was adopted by TRPC in December 2013. The plan adapts the Puget Sound Partnership's freshwater quality target for the Thurston County region and sets a target for 2035:

- Protect small stream basins that are currently ranked as "intact" or "sensitive," and improve and restore as many as possible "impacted" stream basins.

The *Sustainable Thurston* plan also sets two land-use priority targets, which will help the region protect water quality, as well as reduce vehicle miles traveled and related greenhouse gas emissions:

- By 2035, 72 percent of all (new and existing) households in our cities, towns, and unincorporated growth areas will be within a half-mile (comparable to a 20-minute walk) of an urban center, corridor, or neighborhood center with access to goods and services to meet some of their daily needs.

- Between 2010 and 2035, no more than 5 percent of new housing will locate in the rural areas, and 95 percent will be within cities, towns, unincorporated growth areas, and tribal reservations. Rural areas include land outside of the cities, towns, unincorporated urban growth areas and tribal reservations.
  - Supporting target: No net loss of farmlands, forest lands, prairie habitats (in addition to environmentally critical areas that are currently protected) while providing for a range of densities within rural Thurston County.

The following *Sustainable Thurston* foundational policies pertain to the natural environment:

- Protect the soil, air, surface water, and groundwater quality through reducing dependence on chemicals and products that pollute and, when their use is necessary, minimizing releases to the environment.
- Ensure adequate clean water is available to support household and commercial needs while sustaining ecological systems through conservation, balancing of uses, and reuse.
- Protect our natural resources and habitat while providing for public access and sustainable uses and economic activity (forests, prairies, wetlands, surface and groundwater resources, and aquatic and terrestrial plants and animals).
- Reduce the effects of the built environment on the natural environment through land-use and transportation plans and actions that encourage compact development, retrofit existing infrastructure to reduce impacts, and reduce energy consumption and reliance on nonrenewable energy sources.
- Acknowledge that changing weather and climate patterns will impact the human, natural, and built environments and plan for impacts such as increased flooding and sea-level rise.

Below is a list of actions that will help the Thurston Region achieve *Sustainable Thurston*'s water quality goal.

Goal E-4:

Protect, preserve and restore streams, wetlands, and shorelines to protect water quality.

Actions:

E-4.1 Enforce existing environmental-protection regulations.

E-4.2 Adopt new development regulations to require the use of low-impact development (LID) practices where feasible.

E-4.3 Continue to support local efforts to identify and restore degraded streams and shorelines of Puget Sound.

- Target properties identified in local and regional restoration plans, and fund these actions through a combination of local, state, and federal resources. Establish a target date for removal or remediation of all problem culverts.

E-4.4 Conduct stormwater retrofit studies for all Thurston County basins and establish funding to retrofit existing development to improve stream flows and water quality.

E-4.5 Continue to support the property acquisitions by the Capitol Land Trust and the Nisqually Land Trust of high-quality habitat lands.

- This could entail purchasing the habitat lands or acquiring an easement on part of the property; fund these actions through a combination of local, state, and federal resources.

E-4.6 Update the wetlands inventory for the Thurston Region.

- Focus the mapping effort on parts of the county where local government has land-use control (about 615 square miles); make steady progress on an annual basis, and establishing a target date for project completion.

E-4.7 Continue to support a comprehensive stream-mapping effort throughout Thurston County.

- Use the mapping protocol established by the Wild Fish Conservancy to create detailed stream maps countywide; focus the mapping effort on parts of the county where local government has land-use control (about 615 square miles); allow local jurisdictions to use best available science for site-by-site review, including LIDAR (Light Detection and Ranging) –technology based topography, as an alternative to the inaccurate WDNR stream layer until the stream remapping is complete; and, make steady progress on an annual basis, and establishing a target date for project completion.

E-4.8 Purchase development rights for high-quality stream basins.

- Do this by: identifying stream basins in the rural area where development rights would be purchased to preserve a healthy stream. Sources to finance actions could include using local conservation futures funds or a local funding source for restoration.

E-4.9 Identify high-quality stream basins and adopt special development regulations to protect water quality.

- Regulations could include mandatory clustering for new subdivisions with a mandatory tree tract, minimum canopy cover standards, or limit for impervious areas.

E-4.10 Establish a goal of restoring a certain percentage of the riparian zone for each stream.

- Consider and evaluate a habitat restoration surcharge to stormwater utility rates to rehabilitate impacted stream and shoreline habitats. Expand incentives and requirements to restore riparian and shoreline areas as part of obtaining additional permits or building on properties.

E-4.11 Identify interjurisdictional restoration projects based upon watershed restoration plans, project identification strategies, stormwater capital facilities plans, and other mitigation efforts.

- A local example is Olympia, Lacey, and Yelm's joint water rights mitigation project on the Deschutes River near State Route 507, which is being funded by their water utility rates.

E-4.12 Identify and secure a consistent funding source to support long-term monitoring of ground and surface water quality in the region's basins.

4. Analysis of Priority Areas at Risk from Future Development

4.1 Risks Associated with Future Growth

Understanding the type and extent of future growth in Thurston County's basins is key to developing management strategies. Such growth in Thurston County is regulated under local comprehensive plans, zoning, and development codes. This means that urban growth can only occur within designated areas, called Urban Growth Areas (UGAs); rural growth is allowable in rural zoning districts; and other areas are set aside for forestry, agriculture, or open space protection. By reviewing existing plans and regulations it is possible to predict future growth patterns that can be used to forecast growth and impervious area conditions. Thurston Regional Planning Council's Population and Employment Forecast model generates estimates of future impervious surfaces, dwelling units, and loss of forest cover for watershed planning purposes.

Development regulations put in place to protect basins from the impacts of planned growth will only be effective where growth occurs. The table below shows projected new dwelling units per basin if all the units allowed under current zoning were built (buildout). These projections were used to develop estimates of future impervious area. The assumption in this table is that some of the new development within urban areas will occur on sewer systems, and some on septic systems, while all rural development will occur on septic systems. The capacity for the City of Rainier and Rainier's UGA is calculated at sewered densities.

Table 21: Potential new dwelling units at buildout

Basin	Current Conditions	2010 Dwelling Units	Potential New Dwelling Units Buildout	Potential New Dwelling Units per Sq Mi
Chambers	Impacted	12,830	5,700	430
Deschutes River (Lower)	Impacted	6,160	4,010	229
Deschutes River (Middle)	Sensitive	1,990	2,330	64
Deschutes River (Upper)	Sensitive	80	340	10
Lake Lawrence	Impacted	760	190	52
McIntosh Lake	Sensitive	140	70	28
Offut Lake	Sensitive	320	190	68
Reichel Lake	Impacted	20	110	16
Spurgeon Creek	Sensitive	540	390	41

Source: TRPC data program, 2015. See also Map 33

4.1.1 Projected Total Impervious Surfaces

Current basin conditions were compared to Total Impervious Area (TIA) at buildout to determine the "risk" of further degradation due to planned growth (Map 21).

Basins were evaluated for the expected increase in total impervious area based on anticipated new development, when compared to current conditions and 2010 TIA. A percent increase was used, as research shows that there is no particular impervious area threshold where degradation in stream integrity begins to occur; rather, the relationship is a continuum. As degradation can occur at even low levels of total impervious area, increase in impervious area was used as an evaluation criterion to ensure that the risk of even low levels of growth was considered during the basin selection process. Evaluation criteria are shown in the following table.

Table 22: Criteria used to evaluate basins for the impacts of planned growth

Current Condition	Change Criteria	Evaluation of Impacts of Planned Growth
Sensitive or Intact	Increase in TIA of <1.0%	Likely to remain in current condition
	Increase in TIA of ≥1% but <3%	Possibly at risk for further impacts
	Increase in TIA of ≥3.0%	At risk for further impacts
Impacted	Increase in TIA of <1.0% Existing TIA <15%	Likely to remain in current condition
	Increase in TIA of ≥1% but <3% Existing TIA <15%	Possibly at risk for further impacts
	Increase in TIA of ≥3.0% Existing TIA <15%	At risk for further impacts
	Increase in TIA of ≥3.0% Existing TIA >15%	Possibly at risk for further impacts
Degraded	Any increase in TIA	Likely to remain in current condition

Note: Refer to Table 6 for a description of the terms: “Intact” “Sensitive,” “Impacted,” and “Degraded.”

Table 23: Basin evaluation of impacts of planned growth under current plans

Basin	Current Condition	TIA 2010	TIA Buildout	Increase TIA, 2010-Buildout		Evaluation of Impacts of Planned Growth
Chambers	Impacted	19.4%	23.5%	High	4.1%	Possibly at risk of further impacts
Deschutes River (Lower)	Impacted	15.4%	20.3%	High	5.0%	Possibly at risk of further impacts
Deschutes River (Middle)	Sensitive	2.0%	4.5%	Moderate	2.5%	Possibly at risk of further impacts
Deschutes River (Upper)	Sensitive	0.9%	2.9%	Moderate	2.0%	Possibly at risk of further impacts
Lake Lawrence	Impacted	4.9%	6.7%	Moderate	1.8%	Possibly at risk of further impacts
McIntosh Lake	Sensitive	2.2%	4.4%	Moderate	2.2%	Possibly at risk of further impacts
Offut Lake	Sensitive	2.9%	6.0%	High	3.1%	At risk of further impacts
Reichel Lake	Impacted	1.5%	3.6%	Moderate	2.1%	Possibly at risk of further impacts
Spurgeon Creek	Sensitive	1.6%	2.8%	Moderate	1.2%	Possibly at risk of further impacts

Sources: NOAA C-Cap 2006 Impervious area estimates; Department of Fish and Wildlife High Resolution Change Detection (2006-2009) and TRPC (buildout estimates.)

Note: Increase in impervious rankings: Low (0-1%); Moderate (1-3%); High (>3%)

4.2 Development Capacity by Soil Hydrologic Group

In the Deschutes Watershed, risks to water quality include dissolved oxygen and pH, both of which can be risks associated with nitrates released by septic systems. Future septic systems on pervious soils (classified as types A & B in Thurston County's stormwater manual and GIS data layers) have a higher risk of contaminating water bodies such as aquifers and aquifer-fed streams due to high infiltration rates. Table 25 shows residential development capacity for units likely to require a septic system. It assumes development is on septic systems in Rainier and Rainier's UGA.

Table 24: Criteria used to evaluate basins for the impacts of future residential units on porous soils

Current Condition	Change Criteria	Future Risk
Sensitive or Intact	>=500	High
Sensitive or Intact	>=100 and <500	Moderate
Sensitive or Intact	<100	Low
Impacted	>=500	Moderate
Impacted	<500	Low
Degraded	All	Low

Table 25: Risk posed by potential new dwelling units on septic systems on porous soils

Basin	Current Conditions	Potential New Dwelling Units	Future Risk
Chambers	Impacted	123	Low
Deschutes River (Lower)	Impacted	227	Low
Deschutes River (Middle)	Sensitive	1,025	High
Deschutes River (Upper)	Sensitive	8	Low
Lake Lawrence	Impacted	75	Low
McIntosh Lake	Sensitive	7	Low
Offut Lake	Sensitive	58	Low
Reichel Lake	Impacted	2	Low
Spurgeon Creek	Sensitive	225	Moderate

Source: TRPC data program, 2015

Conversely, future development on septic systems on non-porous soils nearby surface water bodies could put the water bodies at risk of contamination from fecal coliform, another contaminant identified in the Deschutes TMDL. The following tables assess risk associated with this factor. Properties were included if any portion of the property was within 100 feet of a stream, river, or lake.

Table 26: Criteria used to evaluate new residential units on non-porous soils near surface water bodies

Current Condition	Change Criteria	Future Risk
Sensitive or Intact	>=500	High
Sensitive or Intact	>=100 and <500	Moderate
Sensitive or Intact	<100	Low
Impacted	>=500	Moderate
Impacted	<500	Low
Degraded	All	Low

Table 27: Risk posed by new dwelling units on septic systems on non-porous soils near surface water bodies

Basin	Current Conditions	Potential New Dwelling Units	Future Risk
Chambers	Impacted	22	Low
Deschutes River (Lower)	Impacted	80	Low
Deschutes River (Middle)	Sensitive	301	Moderate
Deschutes River (Upper)	Sensitive	295	Moderate
Lake Lawrence	Impacted	52	Low
McIntosh Lake	Sensitive	9	Low
Offut Lake	Sensitive	121	Moderate
Reichel Lake	Impacted	46	Low
Spurgeon Creek	Sensitive	36	Low

Source: TRPC data program, 2015

4.3 Forest Lands Vulnerable to Urbanization

The following table is an estimate of forest lands that are vulnerable to urbanization and loss of forest cover. Forest lands were identified as those lands enrolled in Thurston County's open space forestry tax program or in the Long Term Forestry Zoning District. The forest lands are not necessarily forested – working forest lands are often in the various stages of the forest harvest cycle.

Basins were considered for their vulnerability to loss of forest lands, as one measure of potential loss of forest canopy cover. Sensitive areas that are expected to experience only limited increases in impervious area may still be impacted by a loss of canopy cover, as land that is currently forested is cleared for residential, agricultural, or other use. Basins were evaluated by identifying forest lands within each basin that are vulnerable to urban conversion based on current zoning (residential zoning districts that allow for subdivision at a density greater than or equal to one unit per 10 acres), ownership, and land use patterns. Basins with a fairly high level of existing forest cover that are at risk of losing a substantial portion (>5%) of their total area to other, non-forested uses may be at risk of degradation.

Table 28: Criteria used to evaluate basins for the impacts of forest conversion

Percent Canopy	Change Criteria	Potential Impacts of Forest Land Conversion
> 65%	Forest Lands vulnerable to conversion >5% of basin area	High
> 65%	Forest Lands vulnerable to conversion <5% of basin area	Low
45-65%	Forest Lands vulnerable to conversion >5% of basin area	Moderate
45-65%	Forest Lands vulnerable to conversion <5% of basin area	Low
30-44%	Any conversion of Forest Lands	Low

Table 29: Basin evaluation of potential impacts of forest conversion

Basin	Current Conditions	Percent Canopy 2006	Acres Vulnerable to Conversion	Percent Forest Lands Vulnerable to Conversion	Potential Impacts of Forest Conversion
Chambers	Impacted	32.3%	173	2.0%	Low
Deschutes River (Lower)	Impacted	41.8%	1,388	12.4%	Low
Deschutes River (Middle)	Sensitive	52.9%	3,123	13.5%	Moderate
Deschutes River (Upper)	Sensitive	71.2%	57	0.3%	Low
Lake Lawrence	Impacted	44.6%	130	5.6%	Moderate
McIntosh Lake	Sensitive	80.6%	73	4.5%	Low
Offut Lake	Sensitive	61.2%	773	43.1%	Moderate
Reichel Lake	Impacted	62.3%	136	3.0%	Low
Spurgeon Creek	Sensitive	69.4%	108	1.8%	Low

Source: NOAA-CAP - 2006 Forest Canopy; TRPC – Forest land vulnerability. See also Map 36.

4.4 Forested Lands on Steep Slopes with Development Potential

One of the risks identified to the Deschutes River is fine sediment. This risk factor looks at areas of potential erosion using the criteria of forested lands on steep slopes that are vulnerable to urban conversion. Eighty percent of the properties in the table that follows are within 1,500 feet of a waterbody (lake, pond, wetland) or stream. Properties were included if greater than 10 percent of the tax parcel was both forested and steep. Basins were evaluated by identifying forested lands on steep slopes within each basin that are vulnerable to urban conversion based on current zoning (residential zoning districts that allow for subdivision at a density greater than or equal to one unit per 10 acres), ownership, and land use patterns.

Table 30: Criteria used to evaluate basins for the impacts of forested and steep slope property conversion

Current Condition	Change Criteria	Potential Impacts of Forest Conversion
Sensitive or Intact	Vulnerable forest lands with steep slopes >=5% of basin area	High
Sensitive or Intact	Vulnerable forest lands with steep slopes >=2 and <5% of basin area	Moderate
Sensitive or Intact	Vulnerable forest lands with steep slopes <2% of basin area	Low
Impacted	Vulnerable forest lands with steep slopes >=5% of basin area	Moderate
Impacted	Vulnerable forest lands with steep slopes <5% of basin area	Low
Degraded	Any vulnerable forest lands with steep slopes	Low

Table 31: Forested lands on steep slopes with development potential

Basin	Current Conditions	Total Acres	Vulnerable Properties with Forested and Steep Acres (acres)			Potential Impacts
			City or Urban Growth Area	Rural	Percent of Basin	
Chambers	Impacted	8,478	-	0	0%	Low
Deschutes River (Lower)	Impacted	11,213	98	233	3%	Low
Deschutes River (Middle)	Sensitive	23,181	17	1,515	7%	High
Deschutes River (Upper)	Sensitive	22,436	n/a	160	1%	Low
Lake Lawrence	Impacted	2,331	n/a	6	0%	Low
McIntosh Lake	Sensitive	1,619	n/a	32	2%	Moderate
Offut Lake	Sensitive	1,793	n/a	317	18%	High
Reichel Lake	Impacted	4,472	n/a	83	2%	Low
Spurgeon Creek	Sensitive	6,051	n/a	126	2%	Moderate

Sources: "Forested" - 2011 NOAA C-CAP Deciduous (9), Evergreen (10) and Mixed (11) Forest land covers; steep slope layer provide by Thurston County (40% rise or greater over a 3.5 ft grid); TRPC data program, 2015.

4.5 Summary of Future Risk Analysis

The table below summarizes future risks analyzed during this study.

Table 32: Summary of future risks due to development potential

Basin	Current Conditions	New Impervious Surfaces	New Septic Systems on Non-Porous Soils	New Septic Systems on Porous Soils	Forest Land Vulnerable to Conversion	Forested Lands on Steep Slopes Vulnerable to Conversion
Why is this a risk?		**Increased stormwater runoff**	**Increased risk of fecal coliform**	**Increased nitrates – dissolved oxygen and pH**	**Loss of forest cover**	**Increased sediment input to water bodies**
Chambers	Impacted	Possibly	Low	Low	Low	Low
Deschutes River (Lower)	Impacted	Possibly	Low	Low	Low	Low
Deschutes River (Middle)	Sensitive	Possibly	Moderate	High	Moderate	High
Deschutes River (Upper)	Sensitive	Possibly	Moderate	Low	Low	Low
Lake Lawrence	Impacted	Possibly	Low	Low	Moderate	Low
McIntosh Lake	Sensitive	Possibly	Low	Low	Low	Moderate
Offut Lake	Sensitive	At risk	Moderate	Low	Moderate	High
Reichel Lake	Impacted	Possibly	Low	Low	Low	Low
Spurgeon Creek	Sensitive	Possibly	Low	Moderate	Low	Moderate

5. Analysis of Restoration Opportunities Based on Existing Risk Factors

As noted above, water quality issues in the Deschutes watershed are influenced by the legacy of existing development, much of which was built prior to the rules for stormwater runoff, critical habitat protections, and land use practices that regulate development constructed today. Improving water quality in the Deschutes will require addressing these existing risk factors and restoring ecological functions that have been degraded. This section provides an analysis of areas where opportunities for restoration may be concentrated, and where conducting that restoration or providing additional outreach and tools to landowners could be most effective at improving current conditions. The areas identified may not necessarily be those locations that are the most impacted by existing development or current use within the study areas; instead, the goal of this analysis is to focus on areas where restoration efforts can provide the greatest ecological lift at a landscape scale. For this analysis, the risk posed by a certain factor is greatest in basins categorized as “intact” or “sensitive” in the 2013 Basin Evaluation report (TRPC 2013), and least in basins characterized as “degraded.” This is not to say that restoration can’t be beneficial in a more degraded area – particularly if such work restores some of the functions that lead to a lower categorization in the first place. Instead, this analysis can provide an initial screening of restoration opportunities across the watershed.

5.1 Agricultural Lands Near Rivers and Lakes

Agricultural activity in close proximity to surface waters is one of the risk factors associated with fecal coliform, a pollutant identified in the Deschutes TMDL. Agricultural practices can also contribute excess nutrients to surface waters through use of fertilizers, and clearing of land and compaction of soil can lead to increased scouring of channels and changes to hydrology.

Table 34 looks at the acres of agricultural land within 100 feet of a surface water body. Agricultural lands were derived from TRPC’s land use layer, and include lands within the Long Term Agriculture Zoning district (Map 34) or enrolled in the Open Space Agriculture tax program (Map 35).

Table 33: Criteria used to evaluate basins for risk from agricultural activities near surface water bodies

Current Condition	Criteria: Percent of Basin with Agricultural Lands within 100-feet of waterbodies	Risk Factor
Sensitive or Intact	>=0.5	High
Sensitive or Intact	>=0.25 and <0.5	Moderate
Sensitive or Intact	<0.25	Low
Impacted	>=0.5	Moderate
Impacted	<0.5	Low
Degraded	All	Low

Table 34: Agricultural lands within 100 feet of streams, rivers, and lakes

Basin	Current Conditions	Total Acres	Agricultural Lands within 100-ft of Streams, Rivers, or Lakes (acres)	Percent of Basin	Risk Evaluation
Chambers	Impacted	8,478	29	0.3%	Low
Deschutes River (Lower)	Impacted	11,213	61	0.5%	Moderate
Deschutes River (Middle)	Sensitive	23,181	132	0.6%	High
Deschutes River (Upper)	Sensitive	22,436	2	0.0%	Low
Lake Lawrence	Impacted	2,331	18	0.8%	Moderate
McIntosh Lake	Sensitive	1,619	-	0.0%	Low
Offut Lake	Sensitive	1,793	4	0.2%	Low
Reichel Lake	Impacted	4,472	75	1.7%	Moderate
Spurgeon Creek	Sensitive	6,051	25	0.4%	Moderate

Sources: TRPC's land use data layer; water bodies from Thurston County's hydro layer

Opportunities for restoration on agricultural lands include instituting best management practices such as planting riparian buffers to protect water bodies from runoff, installing vegetated filter trips, planting cover crops, managing nutrients onsite, and using integrated pest management.

5.2 Subdivisions With Limited Stormwater Infrastructure

Older residential subdivisions that received preliminary approval prior to current stormwater management regulations are potential sites of unmanaged stormwater runoff. The following table provides a planning-level estimate of the number of subdivision residential lots that were likely built without significant stormwater infrastructure, such as would have been required under the NPDES permit. The analysis includes all subdivisions that received preliminary approval prior to 1995 that contain more than 8 residential lots.

Table 35: Criteria used to evaluate basins for stormwater retrofit opportunities and benefit

Current Condition	Criteria: Subdivision Lots Approved Prior to 1995	Risk Factor
Sensitive or Intact	>=500	High
Sensitive or Intact	>=200 and <500	Moderate
Sensitive or Intact	<200	Low
Impacted	>=500	Moderate
Impacted	<500	Low
Degraded	All	Low

Table 36: Subdivision lots that likely were built with limited stormwater infrastructure

Basin	Current Conditions	City	Unincorp. Growth Area	Rural	Retrofit Opportunities and Benefit
Chambers	Impacted	3,220	1,440	670	Moderate
Deschutes River (Lower)	Impacted	1,960	1,030	460	Moderate
Deschutes River (Middle)	Sensitive	330	0	370	High
Deschutes River (Upper)	Sensitive	0	0	100	Low
Lake Lawrence	Impacted	0	0	620	Moderate
McIntosh Lake	Sensitive	0	0	60	Low
Offut Lake	Sensitive	0	0	240	Moderate
Reichel Lake	Impacted	0	0	0	Low
Spurgeon Creek	Sensitive	0	0	90	Low

Source: TRPC's subdivision database and Thurston County Assessor data

Opportunities for restoration related to stormwater infrastructure include designing and constructing stormwater retrofit projects that provide additional treatment and flow control.

5.3 Residential Development by Soil Type

In the Deschutes Watershed, threats to water quality include low dissolved oxygen and high pH, both of which can be associated with nitrates released by septic systems. Septic systems on pervious soils (classified as types A & B in Thurston County's stormwater manual and GIS data layers) have a higher risk of contaminating water bodies such as aquifers and aquifer-fed streams due to high infiltration rates. The table below shows current residential development on septic systems on porous soils within the Deschutes watershed study area.

Table 37: Criteria used to evaluate basins for the impacts of residential units on porous soils

Current Condition	Criteria: Dwelling Units with Septic Systems on Porous Soils	Current Risk
Sensitive or Intact	>=300	High
Sensitive or Intact	>=100 and <300	Moderate
Sensitive or Intact	<100	Low
Impacted	>=500	High
Impacted	>=300 and <500	Moderate
Impacted	<300	Low
Degraded	All	Low

Table 38: Current dwelling units on septic systems on porous soils, by basin

Basin	Current Conditions	2010 Dwelling Units on Porous Soils	Current Risk
Chambers	Impacted	339	Moderate
Deschutes River (Lower)	Impacted	413	Moderate
Deschutes River (Middle)	Sensitive	1,328	High
Deschutes River (Upper)	Sensitive	9	Low
Lake Lawrence	Impacted	374	Moderate
McIntosh Lake	Sensitive	-	Low
Offut Lake	Sensitive	279	Moderate
Reichel Lake	Impacted	1	Low
Spurgeon Creek	Sensitive	179	Moderate

Source: TRPC data program, 2015

Conversely, existing development on septic systems on non-porous soils that are near surface water bodies could put those water bodies at risk of contamination from fecal coliform, another contaminant identified in the Deschutes TMDL. The following tables assess risk associated with this factor. Properties were included if any portion of the property was within 100 feet of a stream, river, or lake.

Table 39: Criteria used to evaluate basins for the impacts of existing residential units on non-porous soils near surface water bodies

Current Condition	Criteria: Dwelling Units with Septic Systems on Non-Porous Soils and Near a Waterbody	Current Risk
Sensitive or Intact	>=100	High
Sensitive or Intact	>=50 and <100	Moderate
Sensitive or Intact	<50	Low
Impacted	>=300	High
Impacted	>=100 and <300	Moderate
Impacted	<100	Low
Degraded	All	Low

Table 40: 2010 dwelling units on septic systems on non-porous soils near surface water bodies

Basin	Current Conditions	2010 Dwelling Units	Current Risk
Chambers	Impacted	103	Moderate
Deschutes River (Lower)	Impacted	46	Low
Deschutes River (Middle)	Sensitive	183	High
Deschutes River (Upper)	Sensitive	48	Low
Lake Lawrence	Impacted	103	Moderate
McIntosh Lake	Sensitive	65	Moderate
Offut Lake	Sensitive	22	Low
Reichel Lake	Impacted	7	Low
Spurgeon Creek	Sensitive	47	Low

Source: TRPC data program, 2015

This information supplements the analysis that was conducted as part of the Urban Area Septic System Analysis (see Maps 12 and 13), which focuses on septic systems within the north county urban areas, including the cities of Olympia, Lacey, and Tumwater, as well as their urban growth areas. That earlier analysis does not consider septic systems in the rest of Thurston County, including within the city of Rainier. Within urban areas, regions identified as posing a higher risk to ground or surface water could potentially be serviced by sewer lines at a future date. In rural areas, higher risk basins could be addressed by a focused operation and maintenance program that identifies and repairs failing septic systems and helps to prevent new failures. Additional measures, such as advanced onsite treatment systems with denitrification, may need to be considered to mitigate for the contribution of nitrates in rural areas.

5.4 Summary of Restoration / Retrofit Potential

The table below summarizes restoration or retrofit opportunities, based on the existing condition of the study area basins.

Table 41: Summary of restoration and retrofit opportunities

Basin	Current Conditions	Agricultural Lands near Water Bodies	Stormwater Retrofit Opportunity and Benefit	Existing Septic Systems on Porous Soils	Existing Septic Systems on Non-Porous Soils
Why?		**Increased risk of fecal coliform**	**Increased stormwater runoff**	**Increased nitrates – dissolved oxygen and pH**	**Increased risk of fecal coliform**
Chambers	Impacted	Low	Moderate	Moderate	Moderate
Deschutes River (Lower)	Impacted	Moderate	Moderate	Moderate	Low
Deschutes River (Middle)	Sensitive	High	High	High	High
Deschutes River (Upper)	Sensitive	Low	Low	Low	Low
Lake Lawrence	Impacted	Moderate	Moderate	Moderate	Moderate
McIntosh Lake	Sensitive	Low	Low	Low	Moderate
Offut Lake	Sensitive	Low	Moderate	Moderate	Low
Reichel Lake	Impacted	Moderate	Low	Low	Low
Spurgeon Creek	Sensitive	Moderate	Low	Moderate	Low

6. Recommended Study Focus Areas

The goal of this watershed planning project is to reduce impacts to water quality and quantity from current and future residential development in the Deschutes Watershed by developing land use policy that directs growth away from areas with properly functioning ecological processes and lessens the impact on areas that do develop. Management strategies associated with new land use regulations can be most effective at reducing the impacts associated with new development, while incentive, compliance, and outreach strategies can be more effective at dealing with existing impacts and restoring ecological processes that have been degraded by past development.

As a first stage of this project, within this report we analyzed the entire study area to assess current conditions throughout the watershed, identify risks posed by future growth, and determine locations for further focused study. In Section 3.2.6 we identified Management Zones, based on the landscape scale Puget Sound Watershed Characterization (see Map 23). We recommend focusing on areas identified for protection/conservation as well as areas identified for restoration that are upstream of an area identified for protection (this corresponds to Zones 1, 2, and 3), excluding areas that are designated as Long-Term Forestry under Thurston County's zoning code. Recommended study focus areas are shown in Map 38. These are the areas where actions that protect and restore ecological functions will be the most efficient and are likely to provide the greatest ecological benefit to the watershed as a whole.

Zone 3 includes most of the Deschutes River (mainstem middle) sub-basin, which was identified as at high or moderate risk for increased stormwater runoff, increased bacterial pollution (fecal coliform), increased nitrates, loss of forest cover, and increased sediment under current regulations and future growth estimates. This was the greatest number of risk factors out of all the basins within the study area. Offut Lake basin has the second-highest number of risk factors, and is considered at moderate risk from bacterial pollution and loss of forest cover, and at high risk from increased stormwater pollution and increased sediment runoff.

Both the Deschutes (mainstem middle) sub-basin and Offut Lake are considered "sensitive" basins, and have assessment units that were identified as priority areas for "protection" or "conservation" in the Puget Sound Watershed Characterization Analysis. This area largely corresponds with Management Zone 3 (Map 38)[6]. Expanding the focus area to include all of Zone 3 would add a small section of the Deschutes (mainstem lower) sub-basin, upstream of Spurgeon Creek, as well as McIntosh Lake basin, which was identified as at moderate risk from increased stormwater runoff and sediment input from new development.

We recommend that further study also consider areas that are mapped as Zone 2 (Restoration) and are upstream of assessment units categorized for Protection or Conservation. Though these areas are more impacted currently, land use strategies that minimize additional impacts from new development or restore degraded ecological functions will benefit and help protect sensitive areas downstream and will ensure work in those areas is not undermined. Restoration in these areas could potentially help some areas improve from a current "impacted" characterization to a "sensitive" ranking. Areas in Zone 2 include:

- Lake Lawrence Basin, which is at moderate risk from increased stormwater runoff and forest loss

[6] The lower half of Spurgeon Creek Basin is included in Zone 3 and recommended for conservation; however, this area is almost entirely within federal jurisdiction on Joint Base Lewis McChord and Thurston County would have no jurisdiction over land use changes. In addition, Joint Base Lewis McChord leaves this area in undeveloped status. Therefore, this area is not recommended for inclusion in additional study.

- The remainder of Deschutes River (Mainstem Middle) Sub-basin, including the area along Silver Creek
- Reichel Lake Basin, which is at relatively low risk from new development, but which could benefit from restoration along the stream bank

Zone 1 largely corresponds with the Deschutes (mainstem upper) sub-basin and also was recommended for protection/conservation by the Puget Sound Watershed Characterization analysis, but is already almost entirely zoned within the Long Term Forestry Zoning District, which limits density to one unit per 40 acres and has additional resource-related restrictions.

Although it is not within our primary recommended area, Spurgeon Creek also could be considered for future study, as it was identified as being at moderate risk from increased stormwater runoff, increased nitrate, and increased sediment input. As noted above, much of this basin is within federal jurisdiction on Joint Base Lewis McChord and will see little future growth. The remainder of the basin is identified as a priority restoration area by the Puget Sound Watershed Characterization analysis; however, this area is upstream of more developed areas rather than priority Protection areas, and thus an investment in protective land use regulations and restoration would have a more limited impact on the watershed.

We did not select areas within zones 4 or 5 for future study. Zones 4 and 5 are already heavily impacted by development, would be more difficult and costly to restore, and are a low priority for protection, conservation, or restoration.

7. Next Steps

This report compiles background information, data, and analyses that will inform subsequent phases of the Deschutes Watershed Land Use Analysis. During the next step of this project, the project team will meet with stakeholders, scientists, and policymakers to develop up to four alternative land use management scenarios that could minimize the adverse effects of growth on water quality within the focus areas and potentially improve water quality by addressing existing risk factors. Possible actions that could be included in the scenarios include zoning and urban growth area boundary changes, development code changes, tree-retention requirements, low-impact development (LID) requirements, restoration of vegetated riparian corridors, and stormwater retrofits. These scenarios will be evaluated using the Thurston Regional Planning Council's population and employment forecast model. The model outputs will be used to predict the impact of different land use management approaches on water quality in the watershed by forecasting total impervious area, land cover, number of units on septic systems, and potential loss in forest cover at a watershed and basin scale. Opportunities for restoration may also be identified.

Based on the results of the modeling and input of stakeholders, the project team will recommend specific changes to zoning and development codes. These changes could include adjustments to zoning and UGA boundaries, development of guidance and standards targeting septic location and maintenance, low-impact development (LID) standards, and expansion of the County's Transfer and Purchase of Development Rights programs. The project team will work with local jurisdictions and other interested groups to implement any recommended changes.

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Landuse	TRPC Data Program
Septic Systems	Thurston Geodata; Thurston County Assessor
Sewer Infrastructure	Lacey, Olympia and Tumwater Public Works Departments
Zoning	Thurston Geodata
Well Logs	Dept. of Ecology
Impervious Area (1991)	Dept. of Ecology; NOAA Coastal Change Analysis Program (C-CAP)
Impervious Area (2010)	Dept. of Ecology; NOAA Coastal Change Analysis Program (C-CAP); WA Dept. of Fish and Wildlife (WDFW) High-resolution Aerial Imagery Change Detection
Impervious Area (Buildout)	TRPC Data Program
Forest Canopy	Dept. of Ecology; NOAA Coastal Change Analysis Program (C-CAP)
Open Space Tax Program Parcels	Thurston Geodata; Thurston County Assessor
Forest Land Vulnerability	TRPC Data Program
Wetlands	Thurston Geodata
Channel Migration Zone	Thurston Geodata
Flood Plain	Thurston Geodata
Current Basin Conditions	Deschutes Watershed Project
High Ground Water	Thurston Geodata
Steep Slopes	Thurston Geodata
Puget Sound Watershed Characterization	Dept. of Ecology
Soils	Thurston Geodata; USDA Natural Resource Conservation Service (USDA NRCS) Soil Survey
Deschutes TMDL	Dept. of Ecology
Riparian Shade Cover	Thurston Conservation District
Development	TRPC Data program
Urban Septic Systems Analysis	Thurston County Public Health, Environmental Health Division
Near-stream Disturbance Zone	TMDL/Ecology
Seepage	TMDL/Ecology

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10. Map Folio

11. Appendices