
Reclaimed Water Strategy Effects on Puget Sound

WORKING DRAFT

March 2012



King County

Department of
Natural Resources and Parks
Wastewater Treatment Division

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Prepared by:

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EXECUTIVE SUMMARY

This document reports on an evaluation of the potential changes in discharge of treated wastewater from the King County regional wastewater system and on the potential effects on Puget Sound and its coastal habitats and wildlife that might result from implementing reclaimed water strategies. The evaluation determined that no discernable effects on Puget Sound or its coastal habitats and wildlife are expected as a result of the reclaimed water strategies.

The evaluation was done to support development of a Reclaimed Water Comprehensive Plan for King County's Wastewater Treatment Division (WTD). The purpose of the Reclaimed Water Comprehensive Plan is to determine if, how, when, where, and by what funding mechanisms King County's existing reclaimed water program should expand over the next 30 years, through 2040 and beyond.

This report is part of a series of reports that document efforts to further define and evaluate three reclaimed water strategies developed and approved earlier in the reclaimed water planning process.

Each reclaimed water strategy represents a concept for producing and supplying reclaimed water to serve potential uses identified during the reclaimed water planning process. The uses include both non-potable, consumptive uses (irrigation, commercial, industrial) and environmental enhancement uses (wetland enhancement or creation and associated indirect groundwater recharge and/or streamflow augmentation). The following are brief descriptions of the strategies:

- **Redmond/Bear Creek Basin Brightwater Centralized Strategy.** Reclaimed water would be produced through the membrane bioreactor (MBR) process at the Brightwater Treatment Plant for distribution to two areas—one in the immediate vicinity of the plant and one farther south above Lake Sammamish via new pipelines connected to the South Segment of the Brightwater reclaimed water pipeline.
- **Renton/Tukwila South Plant Centralized Strategy.** Reclaimed water would be produced through expansion of the South Treatment Plant's tertiary sand filtration system for distribution to an area just south of Lake Washington via extension of an existing pipeline that delivers reclaimed water to the City of Tukwila.
- **Reclaimed Water Skimming or Polishing Decentralized Strategy.** This strategy represents opportunities for small-scale reclaimed water implementation. Infrastructure was constrained to a single treatment plant of up to 0.5 million gallons per day (mgd) capacity and up to 1 mile of reclaimed water pipeline. Three potential areas and configurations—two in Seattle and one in the Green River Valley—were identified to help define the decentralized strategy.

This evaluation found that the reduction in discharge to Puget Sound resulting from the reclaimed water strategies would be less than 7 percent of the entire amount that King County currently discharges. The reclaimed water strategies combined would reduce overall nutrient and toxic pollutant loadings to Puget Sound by less than 0.3 percent. However, discharges from Brightwater into Puget Sound must also satisfy water quality standards imposed by the Washington State Department of Natural Resources ("WDNR") as a condition of the Aquatic Lands Easement for the Brightwater outfall.

1.0. INTRODUCTION

This document reports on an evaluation of the potential effects on Puget Sound and its coastal habitats and wildlife that might result from implementing reclaimed water strategies. The evaluation was done as part of a comprehensive planning effort to better understand the potential for expanding King County's reclaimed water program through implementation of three reclaimed water strategies.

This chapter provides background information on the comprehensive planning process and reasons for analyzing the strategies. It then briefly describes the reclaimed water strategies and outlines the objectives of this evaluation.

1.1 Background

This report was prepared to support the development of a Reclaimed Water Comprehensive Plan for King County's Wastewater Treatment Division (WTD). The purpose of the Reclaimed Water Comprehensive Plan is to determine if, how, when, where, and by what funding mechanisms the County's existing reclaimed water program should expand over the next 30 years, through 2040 and beyond.

The work documented in this report was conducted as part of Step 4 of the reclaimed water planning process as amended and approved by the King County Council in May 2011. It is one of a series of reports that document efforts to define and analyze three reclaimed water strategies developed and approved earlier, during Step 3.¹ The results of these analyses will provide information on the following topics:

- Potential for use of reclaimed water to reduce reliance on Puget Sound for discharge of treated effluent.
- How reclaimed water strategies could fit into regional wastewater system planning and operations, including their effect on planned improvements and future operation of the regional wastewater system.
- The ability to use small prepackaged or preassembled reclaimed water facilities to produce and distribute reclaimed water.
- The potential effects of reclaimed water strategies on the environment, including the following:
 - Potential for reclaimed water to enhance watershed basin flows
 - Effects of reclaimed water use on groundwater and surface water quality
 - Effects of reclaimed water use on the built environment, including energy demands and greenhouse gas emissions

¹ More information on the reclaimed water comprehensive planning process is available at <http://www.kingcounty.gov/environment/wastewater/RWCompPlan.aspx>. More information on reclaimed water strategy development and identification is available at http://your.kingcounty.gov/dnrp/library/wastewater/rw/CompPlan/1012_RWCPStrategyReport.pdf. Other reports in the series can be found at <http://www.kingcounty.gov/environment/wastewater/RWCompPlan/Library.aspx#4>.

- The full range of benefits and costs associated with providing additional reclaimed water to serve both nonpotable consumptive and environmental enhancement uses.

Throughout the development, definition, and analysis of the strategies, WTD applied County Council–approved evaluation criteria to assess how each strategy addresses the three drivers for the Reclaimed Water Comprehensive Plan—regional wastewater system planning, creating resources from wastewater, and protecting Puget Sound water quality.

The strategies were developed for planning and evaluation purposes only and are not intended to necessarily represent any future reclaimed water improvement projects or any implied preference or commitment on the part of any interested parties or potential end users.

1.2 Description and Location of Strategies

Each reclaimed water strategy represents a concept for producing and supplying reclaimed water to serve potential uses identified during the reclaimed water planning process. The uses include both nonpotable consumptive uses (irrigation, commercial, industrial) and environmental enhancement uses (wetland enhancement and associated indirect groundwater recharge and/or streamflow augmentation). The following are brief descriptions of the strategies:

- **Redmond/Bear Creek Basin Brightwater Centralized Strategy.** Reclaimed water would be produced through the membrane bioreactor (MBR) process at the Brightwater Treatment Plant for distribution to two areas—one in the immediate vicinity of the plant and one farther south above Lake Sammamish—via new pipelines connected to the South Segment of the Brightwater reclaimed water pipeline.
- **Renton/Tukwila South Plant Centralized Strategy.** Reclaimed water would be produced through expansion of the South Treatment Plant’s tertiary sand filtration system for distribution to an area just south of Lake Washington via extension of an existing pipeline that delivers reclaimed water to the City of Tukwila.
- **Reclaimed Water Skimming or Polishing Decentralized Strategy.**² This strategy represents opportunities for smaller scale reclaimed water implementation. Infrastructure was constrained to a single treatment plant of up to 0.5 million gallons per day (mgd) capacity and up to 1 mile of reclaimed water pipeline. Three potential areas and configurations were identified to help define the decentralized strategy:
 - An MBR skimming plant located in the Interbay area of Seattle would produce reclaimed water from untreated wastewater in adjacent conveyance pipelines for distribution near the plant via a new pipeline.
 - A sand filtration polishing plant located in Seattle on the west side of the Duwamish River would produce reclaimed water from flows in the Effluent Transfer System (ETS) pipeline that carries South plant secondary effluent for

² A skimming plant removes some of the raw wastewater from pipelines that carry the wastewater to regional plants for treatment and then treats the wastewater to reclaimed water quality for local distribution. A polishing plant removes some secondary-treated effluent from pipelines exiting regional treatment plants and treats the effluent to reclaimed water quality standards.

discharge at Alki Point in West Seattle. The reclaimed water would be distributed to nearby uses via a new pipeline.

- An MBR skimming plant located in the lower Green River Valley in south King County would produce reclaimed water from untreated wastewater in adjacent conveyance pipelines for distribution near the plant via a new pipeline.

The locations of the strategies are shown in Figure 1.

1.3 Objectives of this Evaluation

This document reports on an evaluation of the potential changes in discharge of treated wastewater from the King County regional wastewater system and of the potential positive and negative effects to Puget Sound that might result from implementing reclaimed water strategies. The evaluation addressed the following questions:

- How will the strategy alter discharge of treated wastewater to Puget Sound and what will be the results of any alteration, including pollutant loadings?
- What secondary effects to coastal habitats and wildlife such as fish and shellfish could be expected as a result of an alteration to discharge of secondary effluent?

Existing research on the impacts of wastewater treatment plant discharges to Puget Sound forms the basis for this evaluation.

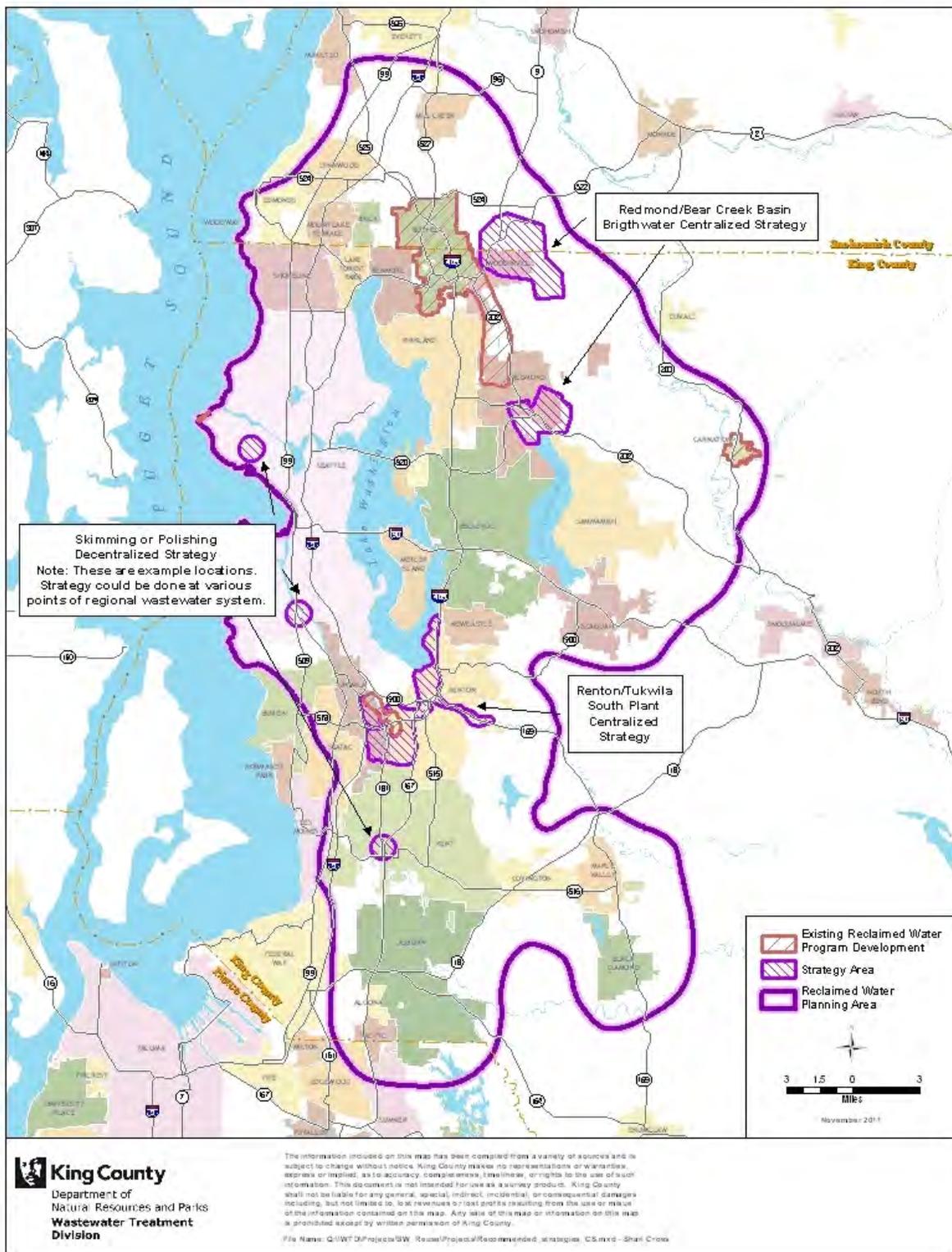


Figure 1. Reclaimed Water Strategies Recommended for Analysis

2.0. EXISTING CONDITIONS

King County's Wastewater Treatment Division operates three regional wastewater treatment facilities with discharges to Puget Sound. Puget Sound is a deep glacially carved, fjord-like estuary that connects to the Strait of Juan de Fuca through Admiralty Inlet and Deception Pass. It extends approximately 140 miles in a north-south direction, reaches a maximum depth of 930 feet off of Point Jefferson, contains approximately 1,331 miles of shoreline, and is characterized by a series of relatively deep underwater valleys and ridges (basins) and submerged hills (sills).

Studies have been conducted to evaluate the impacts of wastewater treatment plant discharges to Puget Sound. The studies, which do not account for the potential effects of the three reclaimed water strategies, include analysis of the discharge volumes, the nutrient and toxic pollutant loadings from wastewater treatment facilities, and the effects of discharges on coastal habitat and wildlife. These studies were consulted in order to determine the potential effect of the three reclaimed water strategies on Puget Sound. This section provides an overview of the results of these studies.

2.1 Discharge to Puget Sound

Municipal and industrial wastewater facilities discharge an average of 475 mgd to Puget Sound, according to data from 2006 and 2007 (EnviroVision et al. 2008). Almost half of this discharge volume, approximately 200 mgd, is from King County's regional treatment plants. The treated effluent from these plants is discharged through multiport diffusers located at significant depths (230–600 feet) in Puget Sound and at a significant distance (3,500–8,000 feet) from the shoreline. The locations of WTD outfalls to Puget Sound are shown in Figure 2.

An array of contaminants from a variety of sources and transport mechanisms add a mix of pollutants to wastewater flows. Wastewater treatment plants remove a significant amount of these pollutants. Two classes of pollutants of concern to the health of Puget Sound are nutrients and toxic pollutants. Nutrients are chemicals that are needed by plants and animals for growth but become detrimental when they exist in overabundance. Toxic pollutants include metals, petroleum products, and trace organic chemicals.

2.1.1 Nutrient Loading

In marine ecosystems, nitrogen is usually the limiting nutrient for phytoplankton growth, so dissolved inorganic nitrogen (DIN), which includes nitrate, nitrite, and ammonium, is used as an indicator of nutrient availability. A study of nutrient loading to Puget Sound showed that wastewater discharges of DIN are comparable in magnitude to riverine discharges and estimated that municipal wastewater discharges comprised 59 percent of total riverine and wastewater DIN loading to these regions (Washington State Department of Ecology 2011). Of this amount, King County's discharges comprise 60 percent of the total municipal wastewater load, or 35 percent of the total riverine and wastewater DIN load. Including the input of nitrogen from oceanic waters, King County's wastewater contributes approximately 4 percent of the total nitrogen load to Puget Sound (Mackas and Harrison 1997).



Figure 2. Puget Sound Discharge Locations

2.1.2 Toxic Pollutant Loading

For toxic pollutants for which adequate data have been collected, the total loadings from all municipal and industrial wastewater dischargers range from 1.4 to 7.0 percent of the total loading to Puget Sound (EnviroVision et al. 2008). King County's wastewater discharges comprise approximately 38 percent of the total wastewater discharge, indicating that County treatment facilities discharge 0.5 to 2.7 percent of the total loading.

2.2 Effects on Coastal Habitat and Wildlife

Nutrient loading and toxic pollutants from the discharge of treated effluent, or from other sources, can potentially impact plants and animals in coastal habitats. Habitats in the general vicinity of wastewater outfalls are commonly discussed under four subheadings: (1) the riparian zone, or the interface between land and intertidal habitat; (2) the upper intertidal zone, or the uppermost intertidal habitat in which plants and animals are exposed during low tide; (3) the intertidal and shallow subtidal zone, where plants and animals may be exposed only during very low tides; and (4) the deep subtidal zone, where plants and animals are not exposed during low tides.

King County's three outfalls from its treatment plants to Puget Sound are all located within the deep subtidal zone. The depth at which treated effluent is discharged into Puget Sound results in a high degree of dilution of the discharge with ambient Puget Sound waters. The natural stratification within Puget Sound waters often traps the discharge below the surface, particularly during the summer months when stratification is the greatest. The effluent discharge therefore has little interaction with or effect on plants and animals that inhabit the riparian, upper intertidal, or intertidal and shallow subtidal habitats. Within the water column and the deep subtidal habitat around the effluent outfalls, a wide variety of organisms inhabit Puget Sound that may use these waters at some stage in their lifecycle.

Through detailed evaluations and modeling, a King County study determined that a small area (the mixing zone) near the outfall diffuser has concentrations of some chemical constituents with the potential to negatively affect aquatic organisms (King County 2001). The study used a Water Quality Effects (WQE) process, which was designed to identify toxicity thresholds beyond those required by a Clean Water Act evaluation and which represented the best available science for the evaluation of WTD effluent discharges. Beyond the mixing zone, King County evaluations have shown that expected concentrations of effluent-derived chemicals would not represent a significant risk to human or aquatic health. The impacts of these discharges have been studied and monitored for many years, with the most recent evaluation of discharges being for the Brightwater Biological Assessment (King County 1999, Dexter et al. 1981, Jones & Stokes 2004).

Efforts are ongoing to assess water quality and coastal habitat in Puget Sound, including Washington State Department of Ecology's continued work to collect water quality monitoring data and evaluate the effects of nitrogen discharges on dissolved oxygen levels in South Puget Sound. Such efforts may lead to a more complete understanding of nutrient dynamics in Puget Sound. The results discussed in this report could be reevaluated when results of new studies are available.

3.0. METHODOLOGY

Each reclaimed water strategy would reduce the discharge of treated wastewater to Puget Sound by diverting it to other consumptive uses, and the amount diverted would provide a corresponding reduction in the nutrient and toxic pollutant loading to Puget Sound. For this evaluation, the amount of reduction in discharge of effluent and corresponding nutrient and toxic loading was calculated and compared to current loading levels. To the extent possible, the evaluation quantified the effect of reclaimed water strategies on these loadings. The secondary effects that the potential changes in loadings could have, including effects on coastal habitats and wildlife such as fish and shellfish, were assessed qualitatively.

In this analysis, the reduction in loading from each reclaimed water strategy is assumed to be proportional to the reduction in discharge volume. The volume diverted is dependent upon the mix of seasonal (irrigation) and year-round uses that are served by the reclaimed water facility. Irrigation uses are assumed to average 153 days per year versus 365 days for year-round uses. A range of reclaimed water volumes is given, corresponding to the possible range in uses.

4.0. CONCLUSIONS

No discernable effects on Puget Sound or coastal habitats and wildlife are expected as a result of the reclaimed water strategies. Impacts to Puget Sound from existing discharges are already minimal due to the high quality of the treated effluent and the fact that the effluent is discharged at significant depths in Puget Sound (230–600 feet) and at a significant distance (3,500–8,000 feet) from the shoreline.

However the Washington State Legislature has sought to reduce wastewater effluent discharges to Puget Sound by requiring the development of reclaimed water programs. The Legislature clearly expressed its intent to increase the use of reclaimed water in order to improve water quality in Puget Sound:

“ . . . (b) Puget Sound. The governor has initiated a Puget Sound partnership, with a request for an initial strategy to address high priority problems. In December [2007], the partnership delivered a strategy that includes expanded use of reclaimed water both in order to improve the Puget Sound’s water quality by reducing wastewater discharges and by replacing current sources of supply for nonpotable uses . . . ”

RCW 90.46.005 (Notes) (emphasis added).

While the reduction in discharge to Puget Sound would be sizeable in and of itself, it would be a relatively small fraction of the entire amount King County discharges—less than 7 percent—and would comprise less than 0.3 percent of the overall loadings to Puget Sound.

The reductions in nutrient and toxic pollutant loadings that would result from the reclaimed water strategies are summarized in Table 1. The sections that follow present conclusions for each strategy.

Table 1. Nutrient and Toxic Pollutant Loadings to Puget Sound

Current King County discharge to Puget Sound	Reduction of King County total by Brightwater strategy	Reduction of King County total by South plant strategy	Reduction of King County total by Decentralized strategy
Municipal wastewater flow out of the 130,000 mgd total municipal wastewater flow from all sources ^a			
77,621 mgd 38%	1,500–3,600 mgd 1–2%	300–800 mgd 0.2–0.6%	150–350 mgd 0.1–0.3%
DIN out of the 54,834 kg/day total riverine and municipal wastewater DIN ^b			
19,300 kg/day 35%	400–1,100 kg/day 1–2%	100–200 kg/day 0.2–0.4%	40–100 kg/day 0.1–0.2%
DIN out of the 463,000 kg/day total riverine, wastewater, and oceanic DIN ^b			
19,300 kg/day 4.2%	400–1,100 kg/day < 0.2%	100–200 kg/day < 0.05%	40–100 kg/day < 0.02%
Toxic pollutants out of the total loading to Puget Sound that comes from municipal and industrial wastewater, loading from these sources being 1.4–7% of the total from all sources ^c			
0.5–2.7%	< 0.2%	< 0.04%	< 0.02%
^a Assumes all reclaimed water is consumed and none is returned to the collection system.			
^b Assumes DIN reduction is proportional to the amount of reclaimed water.			
^c Assumes reduction of toxic pollutants is proportional to the amount of reclaimed water and that total discharge volume of industrial and municipal wastewater is 173,708 mgd.			

4.1 Redmond/Bear Creek Basin Brightwater Centralized Strategy

The Redmond/Bear Creek Basin Brightwater Centralized Strategy has the potential to divert the greatest amount of effluent and thus has the potential for the largest impact to Puget Sound.

The strategy would initially divert an estimated 9.8 mgd average daily flow to reclaimed water. Depending on the mix of seasonal to year-round uses, this would equate to 1,500–3,600 million gallons per year (mgy), or 1–2 percent of the total municipal wastewater flow entering Puget Sound, total flow being 130,000 mgy (EnviroVision et al. 2008). Nitrogen loading would be expected to decrease in proportion to the reduction in discharge volume, a reduction of 400–1,100 kg N/day from King County’s total DIN load of 19,300 kg N/day (Ecology 2011). This is equivalent to a reduction of 1–2 percent of the total riverine and wastewater nitrogen loading to Puget Sound, or less than 0.2 percent of the total nitrogen loading, including the nitrogen flux from the incoming oceanic water. Likewise, toxic loading would be expected to decrease in proportion to the reduction in discharge volume, representing less than 0.2 percent of the total toxic loading to Puget Sound, based on the 1.4–7 percent estimated to come from municipal and industrial wastewater.

The actual reduction in load may be lower than this estimate due to two factors. One, users of reclaimed water may return a portion of the water back to the sewer system, thus reducing the net diversion from Puget Sound. Two, additional nutrient removal would divert nutrients from reclaimed water to the Brightwater effluent or treated solids. The amount diverted to the Brightwater effluent is highly dependent on the nutrient removal technology and is difficult to quantify at this time.

The Redmond/Bear Creek Basin Brightwater Centralized Strategy would also enable the County to satisfy water quality standards imposed by WDNR as a condition of the Brightwater Aquatic Lands Outfall Easement by demonstrating progress towards reducing the reliance on the receiving waters of Washington State for the disposal of waste effluent from Brightwater.

4.2 Renton/Tukwila South Plant Centralized Strategy

The Renton/Tukwila South Plant Centralized Strategy would initially divert an estimated 2.2 mgd average daily flow to reclaimed water. This diversion would be reduced by the portion of reclaimed water returned to the sewer system by end users. Depending on the mix of seasonal to year-round uses, the estimated diversion would be 300–800 mgy, or 0.2–0.6 percent of the total municipal wastewater flow entering Puget Sound, total flow being 130,000 mgy (EnviroVision et al. 2008). Nitrogen loading would be expected to decrease in proportion to the reduction in discharge volume, a reduction of 100–200 kg N/day from King County’s total DIN load of 19,300 kg N/day (Ecology 2011). This is equivalent to a reduction of 0.2–0.4 percent of the total riverine and wastewater nitrogen loading to Puget Sound, or less than 0.05 percent of the total nitrogen loading, including the nitrogen flux from the incoming oceanic water. Likewise, toxic

loading would be expected to decrease in proportion to the reduction in discharge volume, representing less than 0.04 percent of the total toxic loading to Puget Sound, based on the 1.4–7 percent estimated to come from municipal and industrial wastewater.

4.3 Reclaimed Water Skimming or Polishing Decentralized Strategy

The Reclaimed Water Skimming or Polishing Decentralized Strategy includes three conceptual small scale reclaimed water production and supply facilities. These facilities could be implemented together or individually. This evaluation assumes that they would be implemented together and evaluates the cumulative reduction in discharge to Puget Sound from all three.

The combination of the three plants would initially divert an estimated 0.97 mgd average daily flow to reclaimed water. This diversion would be reduced by the portion of reclaimed water returned to the sewer system by end users. Depending on the mix of seasonal to year-round uses, the estimated diversion would be 150– 350 mgy, or 0.1–0.3 percent of the total municipal wastewater flow entering Puget Sound, total flow being 130,000 mgy (EnviroVision et al. 2008). Nitrogen loading would be expected to decrease in proportion to the reduction in discharge volume, a reduction of 40–100 kg N/day from King County’s total DIN load of 19,300 kg N/day (Ecology 2011). This is equivalent to a reduction of 0.1–0.2 percent of the total riverine and wastewater nitrogen loading to Puget Sound, or less than 0.02 percent of the total nitrogen loading, including the nitrogen flux from the incoming oceanic water. Likewise, toxic loading would be expected to decrease in proportion to the reduction in discharge volume, representing less than 0.02 percent of the total toxic loading to Puget Sound, based on the 1.4–7 percent estimated to come from municipal and industrial wastewater.

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