
Identification of Potential Nonpotable Consumptive Uses of Reclaimed Water

WORKING DRAFT

March 2010



King County

Department of
Natural Resources and Parks
Wastewater Treatment Division

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1.0. INTRODUCTION

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

The report presents the approach and results of an effort to identify potential nonpotable consumptive reclaimed water uses in the reclaimed water planning area (Figure 1). A nonpotable consumptive reclaimed water use is a non-drinking water application where the reclaimed water is acceptable and legally allowed by Washington State statute and rule. Applications include use of reclaimed water for irrigation of agricultural crops, parks, school grounds, or landscaped areas and for commercial and industrial uses such as vehicle washing, laundry, cooling, and process water.

This report has been completed as part of Step 2 of the reclaimed water planning process. Later in the process, strategies will be developed for delivering reclaimed water to potential nonpotable consumptive uses identified in this report and to potential environmental uses identified in earlier reports.¹ Strategies will include projections of the amount of reclaimed water available for specific withdrawal locations.

Data were collected for planning purposes only and do not represent any implied preference or commitment on the part of any interested parties or end users.

¹ For information on potential environmental uses and other topics related to the Reclaimed Water Comprehensive Plan, see <http://www.kingcounty.gov/environment/wastewater/ReclaimedWater/CompPlan/Library.aspx>.

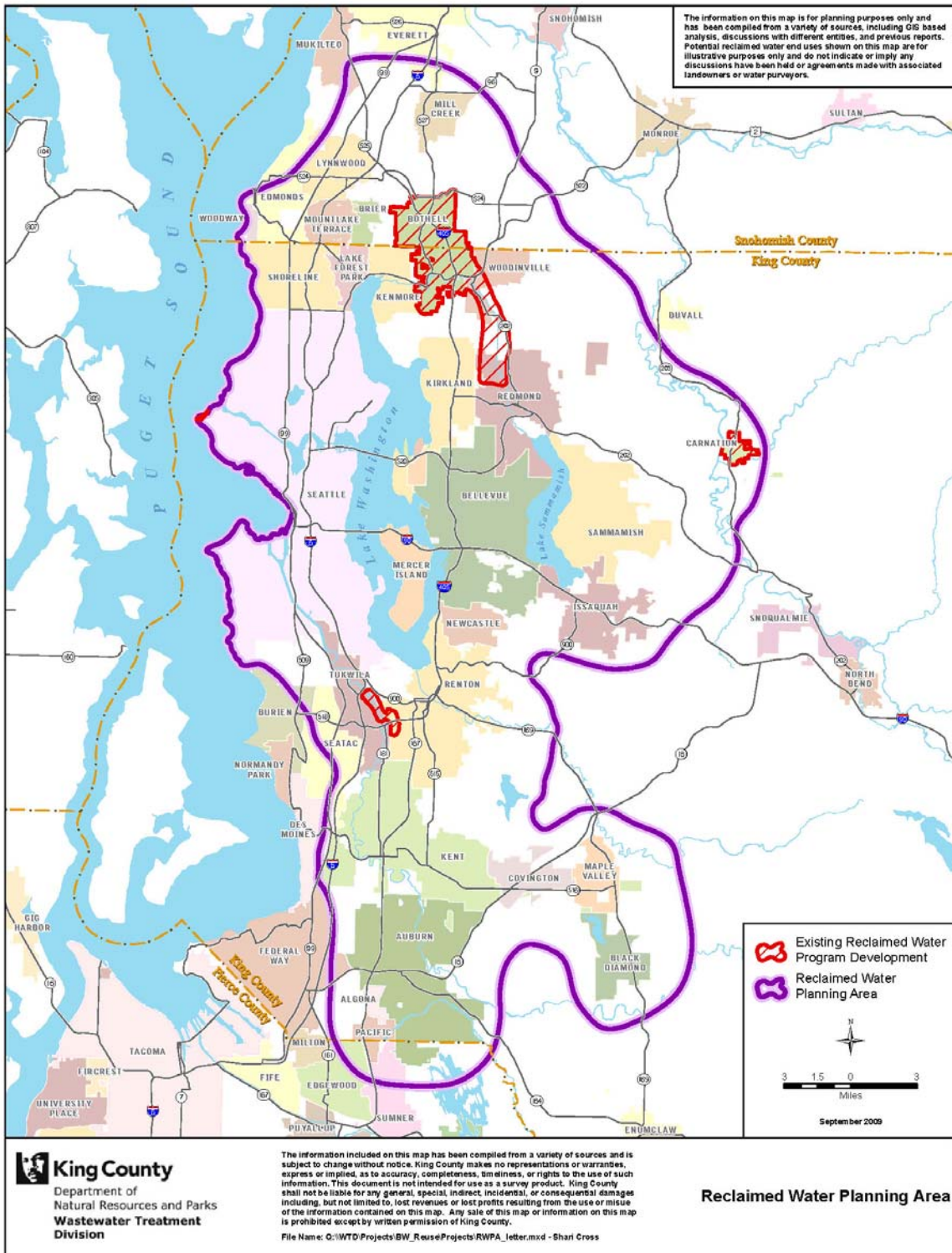


Figure 1. Reclaimed Water Planning Area

2.0. APPROACH

King County staff reviewed existing data sources to identify potential nonpotable consumptive reclaimed water uses in the reclaimed water planning area. Staff then met with water utilities and other interested parties to review these preliminary findings and to collect historical water usage information. For sites with no historical water usage records, the county estimated the daily demand (flow rate) for reclaimed water and combined these estimates with demand estimates based on historical records. All data were organized and stored in a database. The database is linked to geographic information system (GIS) data for mapping and spatial analysis of the sites.

The following sections describe this approach in more detail.

2.1 Reviewing Existing Data

King County reviewed GIS-based information—primarily land use information and aerial photographs—to identify potential irrigation and large water-use sites such as industrial complexes. Existing water and wastewater comprehensive plans and reclaimed water studies produced by water utilities also provided information on potential uses. Identified potential uses were then compiled into maps and lists.

2.2 Collecting Information from Interested Parties

In 2008 and 2009, King County met with 34 interested parties (Appendix A) to obtain feedback on the compiled maps and lists. Outcomes of the discussions included addition or deletion of some sites, identification of types of potential uses, and estimated reclaimed water demand based on historical water usage records. Water usage records were available for about half the sites.

2.3 Estimating Reclaimed Water Demand for Potential Use Types

For the potential sites with no historical water usage records, reclaimed water demand was estimated using methods that rely on standard water usage data and estimating practices. The following sections describe the methods used to estimate demand for irrigation, commercial, and industrial uses.

2.3.1 Irrigation

To estimate demand for reclaimed water at potential irrigation sites with no water usage records, King County reviewed existing literature and data to derive length of irrigation season, net and gross irrigation water requirements, and irrigable area. The pasture/turf crop was used to estimate demand because a large number of the potential irrigation sites in the reclaimed water planning area are turf sites.

- **Define irrigation season.** The pasture/turf irrigation season, or the period when there is not enough rainfall to meet the plant's watering needs, is defined as May through September (153 days) for the area covered by the Seattle-Tacoma climatic station at the Seattle-Tacoma International Airport (USDA, 1985).

- **Determine monthly net irrigation requirements.** Table 1 shows monthly net irrigation requirements for pasture/turf during the irrigation season. The net irrigation requirement is the amount of water in addition to rainfall that must be applied to meet a crop’s evapotranspiration needs.² The net irrigation requirements shown in Table 1 were taken from Appendix A of the *Washington Irrigation Guide* (USDA, 1985).
- **Calculate monthly gross irrigation requirements.** Some water is lost while being transported to the irrigation site. Losses occur from causes such as leaky pipes and evaporation as water is sprayed through the air. More water than the net irrigation requirement must be provided to account for the losses. To determine this gross irrigation requirement, the net irrigation requirement is divided by an irrigation efficiency. A range of irrigation efficiencies for each of three irrigation methods—surface flooding, sprinklers, and trickling—was given in *Irrigation Requirements for Washington – Estimates and Methodologies* (Washington State University, 1982). Sprinklers are the most common irrigation method in this part of the state. A 75 percent efficiency, representing the high end of the range for sprinklers, was selected because high-efficiency sprinklers are often used for turf irrigation. Table 1 below shows the resulting monthly gross irrigation requirements for pasture/turf during the irrigation season.
- **Estimate irrigable area.** It was assumed that the pervious portion of a potential irrigation parcel is its irrigable area. To determine the pervious or irrigable portion, GIS layers for land parcels were combined with King County impervious surface GIS data.
- **Estimate average daily irrigation flow rates.** The monthly gross irrigation requirements were summed and divided by the number of days in the irrigation season to obtain the daily gross irrigation requirement (in inches per day). This number was converted to inches-acres/day, multiplied by the number of identified irrigable acres for each site, and converted to million gallons per day (day) using a conversion factor of 0.0272.

Table 1. Estimated Monthly Irrigation Requirements for Pasture/Turf During the Irrigation Season

	May	June	July	Aug	Sep	Total
Monthly net irrigation requirement (inches)	1.81	3.91	5.51	4.04	1.99	17.2
Monthly gross irrigation requirement (net requirement divided by 75% irrigation efficiency) (inches)	2.41	5.21	7.35	5.39	2.65	23.0

Sources:

U.S. Department of Agriculture. 1985. *Washington Irrigation Guide*.

Washington State University. 1982. *Irrigation Requirement for Washington – Estimates and Methodologies*.

² Evapotranspiration measures the quantity of water evaporated (transpired) from plant tissues and the surface of surrounding soil (usually measured in inches).

2.3.2 Commercial

To estimate reclaimed water demand for potential commercial locations with no water usage records, information from published sources was used to determine the typical annual water usage volumes for broad categories of commercial users and the percentage of total water use that could be met by reclaimed water. For more information, see Brown and Caldwell (2009).

- Identify commercial user types.** King County’s database of potential nonpotable consumptive reclaimed water sites was queried to find the sites that were categorized as commercial and then for site name to determine the type of commercial users, such as offices, car washes, groceries, hospitals, and laundries. King County tax assessor data, which describe the land use of a tax parcel, were used to determine the type of user if the site name did not provide enough information.
- Find typical annual water usage for each type.** Information in *Commercial and Institutional End Uses of Water*, sponsored by the American Water Works Association Research Foundation (AWWARF), was used as the basis to estimate total annual water use for identified types of commercial users (AWWARF, 2000). Table 2 shows typical annual water use by broad commercial categories, independent of size of the site. In some cases, usage assumptions were made for particular user types that were not included in AWAARF. For example, it was assumed that the user type “retail” would consume the same amount of water as the “office” user type found in AWWARF.
- Determine percent of annual usage for potential reclaimed water end uses.** Information in *Waste Not, Want Not: The Potential for Urban Water Conservation in California*, published by the Pacific Institute (2003), was used as the basis to estimate the nonpotable reclaimed water end uses for each user type as a percentage of annual water use. Potential reclaimed water end uses were assumed to be cooling, laundry, and process water. Table 2 shows the reclaimed water end use percentages for each broad commercial category. As with total annual usage, assumptions were made when the Pacific Institute did not provide end use percentages for user types on the list.
- Estimate average daily commercial flow rates.** Total annual water usage was converted from 100 cubic feet (ccf) to gallons (Table 2). The percentage of total water use for reclaimed water end uses was applied to total water use to develop an annual reclaimed water use estimate for each site. To estimate daily flow rates (mgd), it was assumed that these uses occur for 225 days throughout the year (Pacific Institute, 2003, p. 84).

Table 2. Typical Annual Water Use for Commercial User Types

Commercial Type	Typical Annual Water Usage ^a		Reclaimed Water End Use (as % of Total Usage) ^b	Potential Reclaimed Water End Use
	(ccf/year)	(gallons/year)		
Auto shop	335	250,580	21	Cooling
Car wash	3,031	2,267,188	100	Process
Grocery ^c	729	545,292	49	Cooling

Commercial Type	Typical Annual Water Usage ^a		Reclaimed Water End Use (as % of Total Usage) ^b	Potential Reclaimed Water End Use
	(ccf/year)	(gallons/year)		
Hospital	1,236	924,528	51	Process, laundry, cooling
Hotel	3,471	2,596,308	24	Cooling, laundry
Laundry	2,961	2,214,828	90	Laundry, cooling
Office	1,204	900,592	23	Cooling
Restaurant	906	677,688	0	None
Retail ^d	1,204	900,592	21	Cooling
Warehouse ^d	1,204	900,592	23	Cooling

Source: Brown and Caldwell. 2009. *Draft Technical Memorandum, Subtask 320 – Estimate Reclaimed Water Volumes*. Prepared for King County Wastewater Treatment Division.

^a Annual usage is based on actual 1997 billing data from five water utilities, categorized into general use types independent of site size (AWWARF, 2000).

^b Percentage reclaimed water end use is based on published information on water audits of different use categories (Pacific Institute, 2003).

^c Assumed to have the same annual water usage as “food store” in AWWARF (2000).

^d Assumed to have the same annual water usage as “office” in AWWARF (2000).

2.3.3 Industrial

Data from King County industrial waste permit applications were used to estimate reclaimed water demand at the potential industrial sites with no water usage records.

- **Identify industrial user types.** The database of potential nonpotable consumptive use sites was queried to find industrial sites. Standard Industrial Classification (SIC) codes were used to sort the sites by user type.³ The preference was to identify specific user types by the full four-digit SIC code. If a site did not match a specific code, it was placed in a broader (“major”) type according to the first two digits of a SIC code.
- **Estimate average daily reclaimed water flow rates from data on industrial waste permit applications.** For each potential industrial site with a King County industrial waste permit application on file, the daily water flow rates (in gallons per day) listed on the application for end uses that could potentially be served by reclaimed water were summed. The sums for sites in each user type were then averaged.
- **Apply average daily flow rates to sites without permit applications.** The average daily flow rates developed from information in the industrial waste permit applications were applied to sites without permit applications.

The number of operating days was based on the average operating days in the industrial waste permits. The range for operating days per industrial use was 214–365 days.

³ The Standard Industrial Classification (SIC) is a U.S. government system for classifying industries by a four-digit code.

Table 3. Estimated Average Daily Water Flow Rate by Major Industrial Type

Major Industry Type	First Two Digits of SIC Code	Average Flow Rate (gallons/day)
Food and kindred products	20	49,302
Industrial and commercial machinery and computer equipment	35	21,124
Electronic and other electrical equipment (no computer equipment)	36	0
Transportation equipment	37	99,237
Miscellaneous manufacturing industries	39	6,000
Water transportation	44	250
Electric, gas, and sanitary services	49	9,951
Wholesale trade – non-durable goods	51	59,000

Table 4. Estimated Average Daily Flow Rate by Specific Industrial Type

Specific Industry Type	SIC Code	Average Flow Rate (gallons/day)
Sausages and other prepared meat products	2013	25,500
Glass containers	3221	67,300
Cement, hydraulic	3241	18,475
Ready-mix concrete	3273	26,277
Metal plating and finishing	3471	2,263
Construction machinery and equipment	3531	31,687
Printed circuit boards	3672	0
Aircraft	3721	37,372
Local and suburban transit	4111	4,013
Airports, flying fields, and airport terminal services	4581	150
Refuse systems	4953	2,551
Scrap and waste material recyclers and processors	5093	6,004

3.0. RESULTS

A total of 831 potential locations for nonpotable consumptive use of reclaimed water were identified. Of these locations, 7 percent were identified as potential sites for agricultural/nursery irrigation; 61 percent for turf irrigation; and 32 percent for commercial/industrial uses.

The locations are organized and displayed in four data collection areas—north, south, east, and west—within the reclaimed water planning area (Figure 2):

- **North Area**—encompasses the northern portion of the Central Puget Sound metropolitan area, including the cities of Lynnwood, Mountlake Terrace, Edmonds, Shoreline, Lake Forest Park, Kenmore, and Woodinville.
- **West Area**—encompasses the city of Seattle.
- **East Area**—encompasses the eastern portion of the Central Puget Sound metropolitan area, including the cities of Kirkland, Redmond, Bellevue, Newcastle, Issaquah, and Sammamish.
- **South Area**—encompasses the southern portion of the Central Puget Sound metropolitan area, including the cities of Renton, Tukwila, Kent, Auburn, Covington, Maple Valley, Black Diamond, and Pacific.

Excluded from data collection were areas within the existing reclaimed water program including cities of Bothell and Carnation, the Sammamish Valley, and parts of the City of Tukwila.

The figures in Appendix B show the potential use locations and estimated average daily demand during the irrigation and wet seasons for irrigation and commercial/industrial uses in each data collection area. Table 5 below summarizes this information. The irrigation season is defined as 153 days per year (May through September); the wet season is defined as the remainder of the year (October through April).

The locations presented in this report represent those that were identified through December 2009. Additional potential nonpotable consumptive uses for reclaimed water may be identified as King County continues its discussions with interested parties during the reclaimed water comprehensive planning process.

Table 5. Number of Potential Locations and Estimated Daily Demand for the Irrigation and Wet Seasons in the Four Data Collection Areas

	North	East	West	South	Total
Number of potential use locations	113	175	82	461	831
Estimated irrigation season (May – September) demand (mgd)	5.6	14.0	2.7	16.0	38.3
Estimated wet season (October – April) demand (mgd)	0.2	0.3	0.7	1.2	2.4

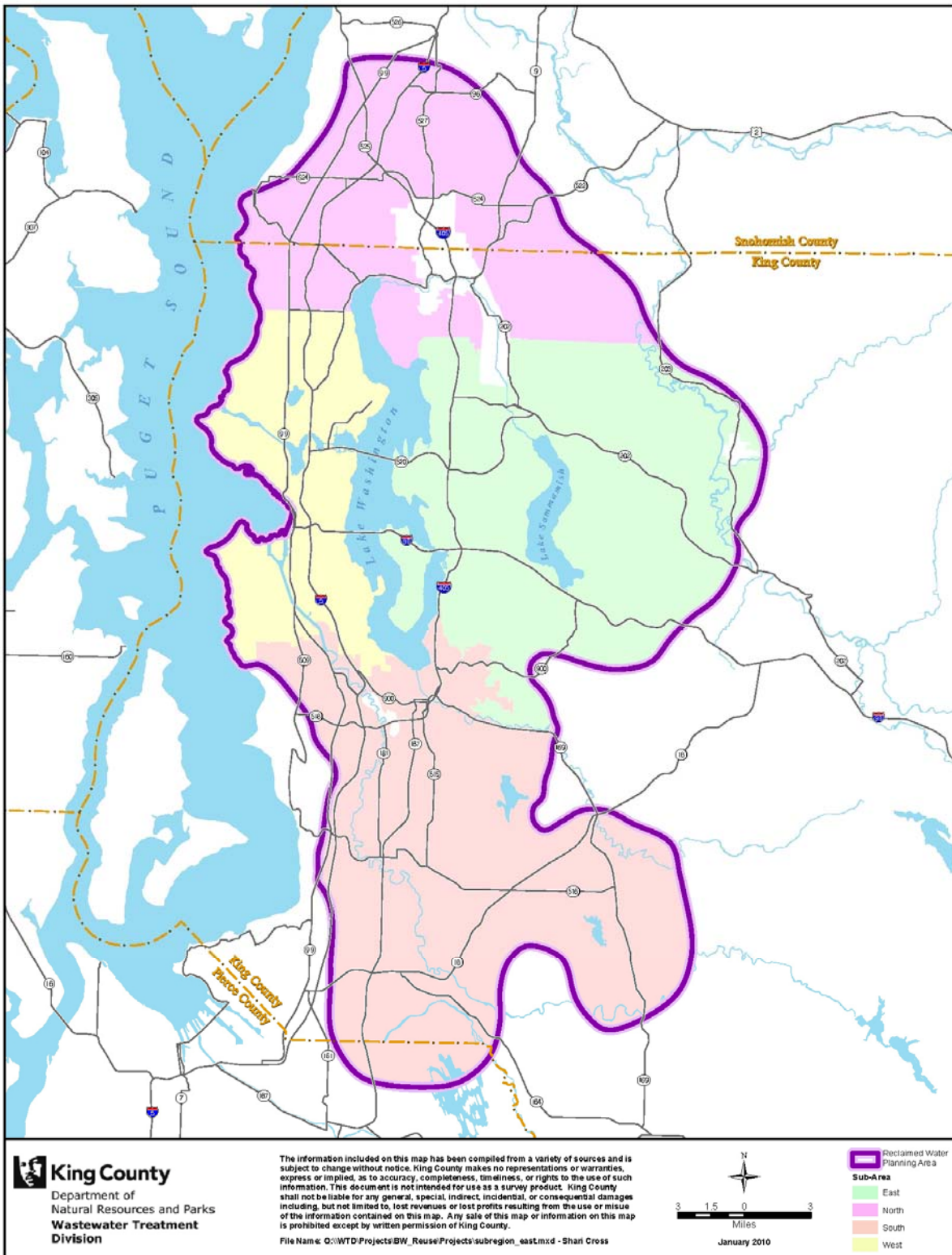


Figure 2. Four Data Collection Areas in the Reclaimed Water Planning Area

4.0. REFERENCES

- American Water Works Association Research Foundation (AWWARF). 2000. *Commercial and institutional end uses of water*. Prepared by B. Dziegielewski, J. C. Kiefer, E. M. Opitz, G. A. Porter, G.L. Lantz, W. B. DeOreo, P. W. Mayer, and J. Olaf Nelson. AWWARF and the American Water Works Association. Denver, Colorado.
- Brown and Caldwell. 2009. *Draft technical memorandum, Subtask 320 – Estimate reclaimed water volumes*. Prepared for King County Wastewater Treatment Division.
- Pacific Institute. 2003. *Waste not, want not: The potential for urban water conservation in California*. Prepared by P. Gleick, D. Haasz, C. Henges-Jeck, V. Srinivasan, G. Wolff, K. Kao Cushing, and A. Mann. Oakland, California.
http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf
- U.S. Department of Agriculture, Natural Resources Conservation Service. 1985 (supplemented in 1992 and updated in 2007). *Washington irrigation guide*. Appendix A. Supplement to the *National Engineering Handbook – Part 652, Irrigation Guide*.
- Washington State University, Cooperative Extension. 1982 (reprinted in 2001). *Irrigation requirements for Washington – Estimates and methodology*. EB1513. Prepared by L.G. James, J.M. Erpenbeck, D.L. Bassett, and J.E. Middleton.

APPENDIX A—INTERESTED PARTIES

King County met with the following interested parties to discuss potential nonpotable consumptive reclaimed water uses:

Alderwood Water & Wastewater District	Cascade Water Alliance
City of Auburn	Coal Creek Utility District
City of Bellevue	Covington Water District
City of Black Diamond	Cross Valley Water District
City of Brier	Highline Water District
City of Issaquah	King County Water District 90
City of Kent	King County Water District 111
City of Kirkland	King County Water District 125
City of Lake Forest Park	Northeast Sammamish Sewer & Water District
City of Mountlake Terrace	Northshore Utility District
City of Pacific	Olympic Water and Sewer District
City of Redmond	Port of Seattle
City of Tukwila	Sammamish Plateau Water and Sewer
City of Renton	Skyway Water and Sewer District
City of Seattle	Washington State Nursery & Landscape Association
City of Shoreline	
City of Woodinville	Woodinville Water District

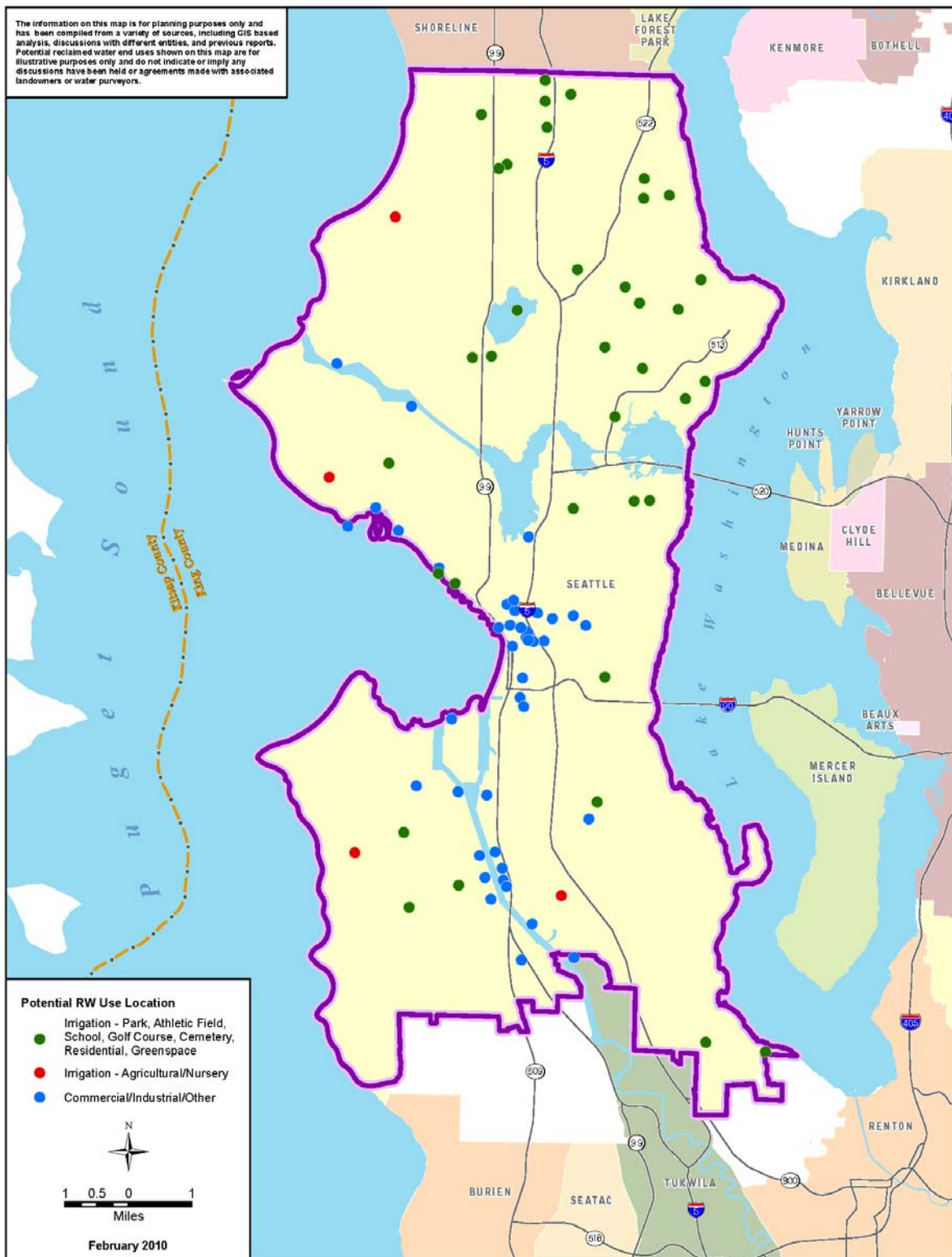


Figure B-2. Potential Nonpotable Consumptive Reclaimed Water Use Locations in West Area

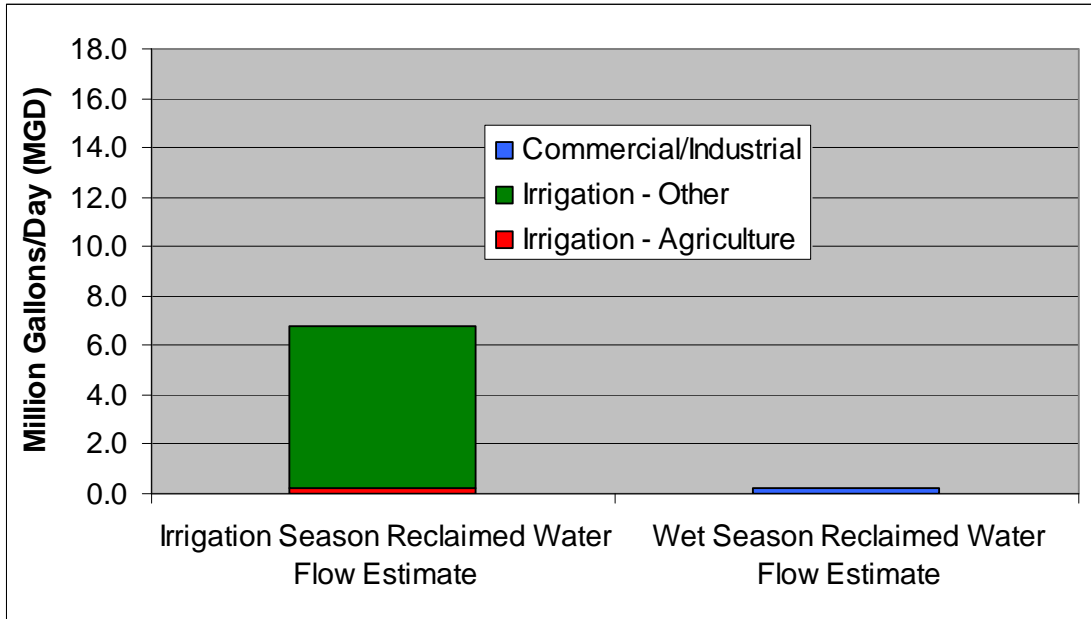


Figure B-3. Estimated Average Daily Demand for Nonpotable Consumptive Reclaimed Water Uses in North Area

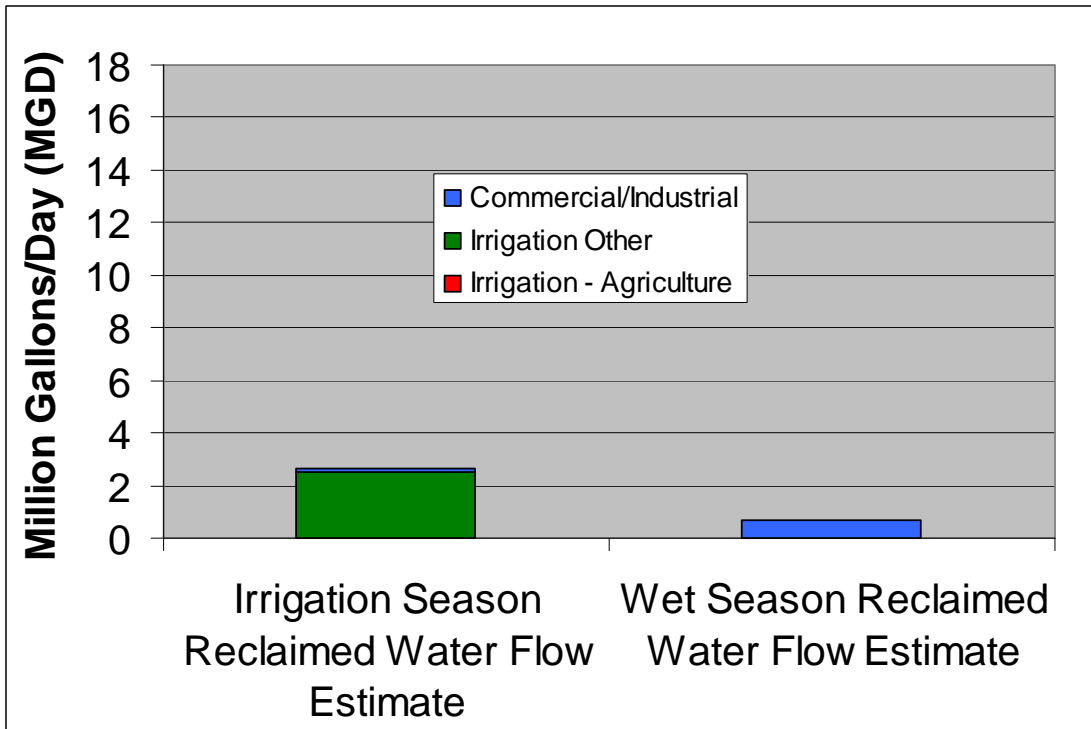


Figure B-4. Estimated Average Daily Demand for Nonpotable Consumptive Reclaimed Water Uses in West Area

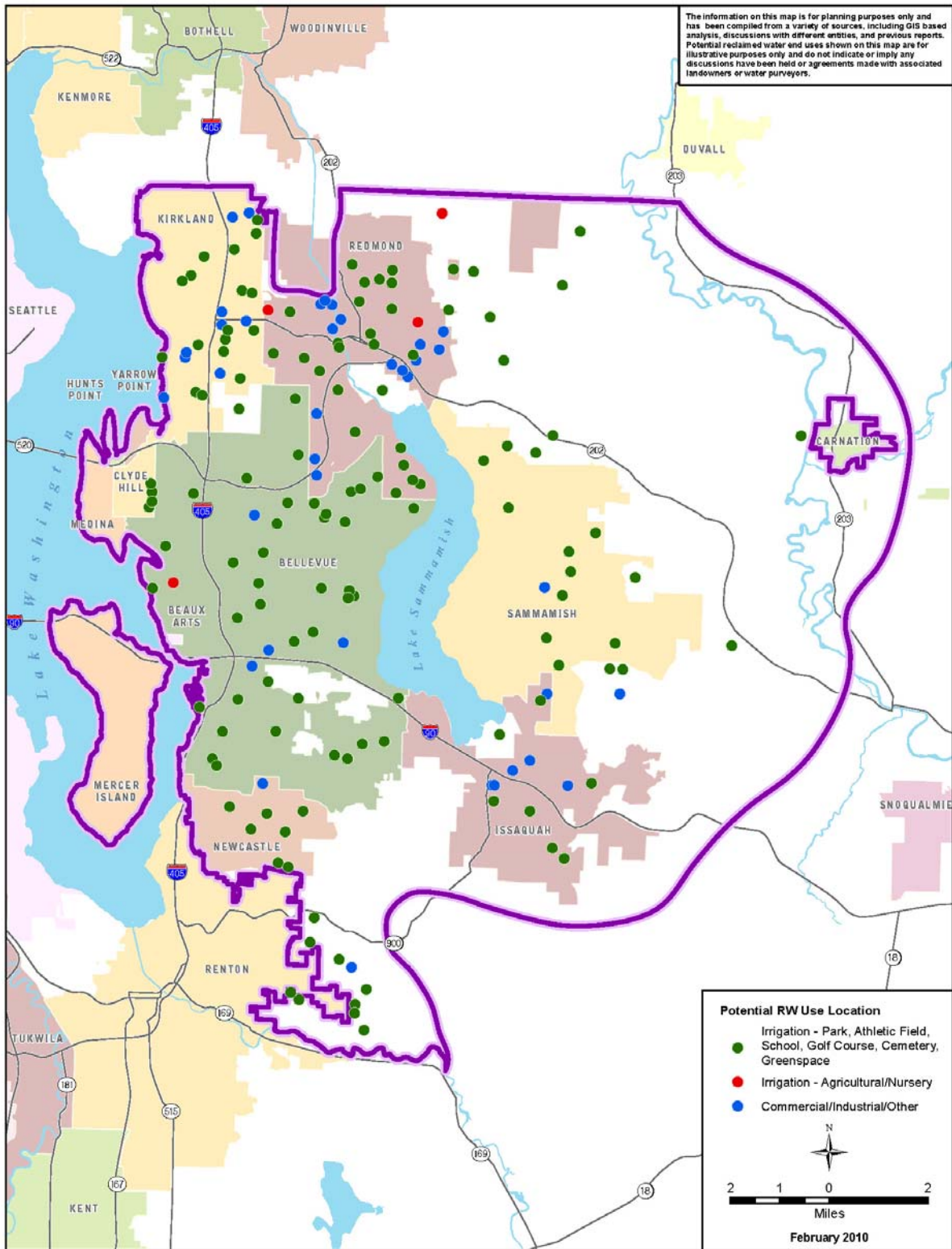


Figure B-5. Potential Nonpotable Consumptive Reclaimed Water Use Locations in East Area

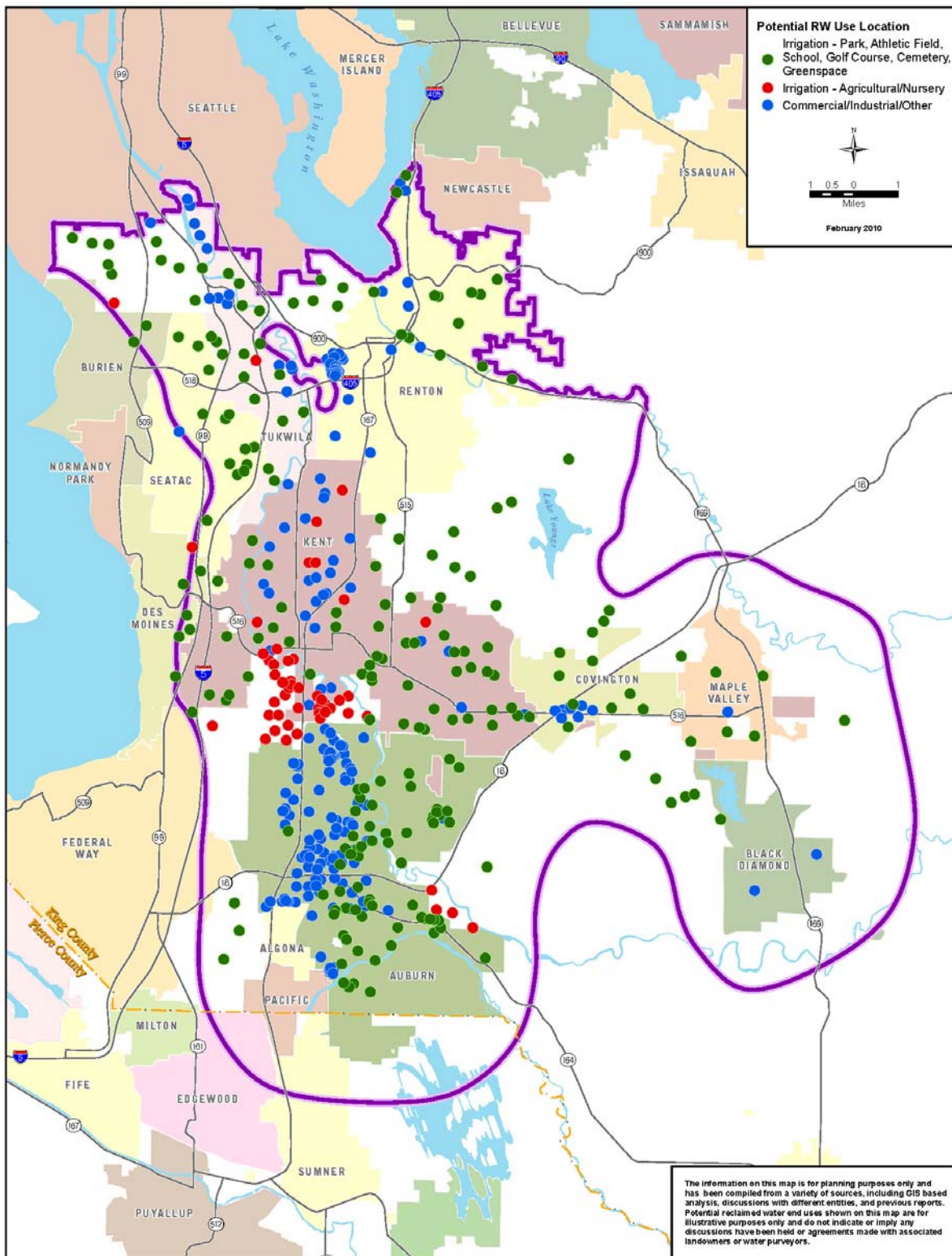


Figure B-6. Potential Nonpotable Consumptive Reclaimed Water Use Locations in South Area

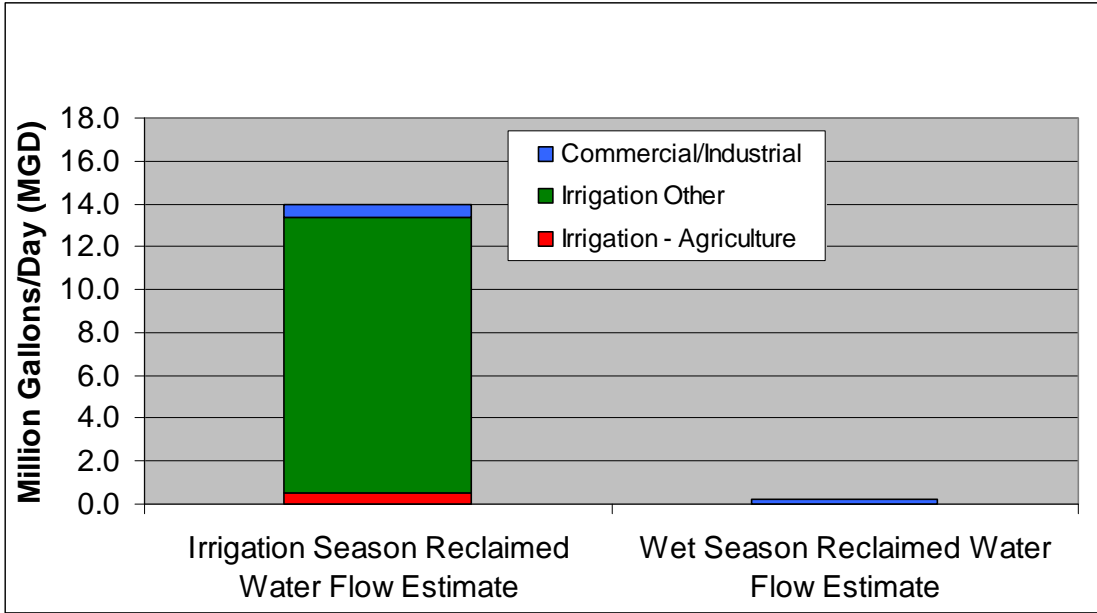


Figure B-7. Estimated Average Daily Demand for Nonpotable Consumptive Reclaimed Water Uses in East Area

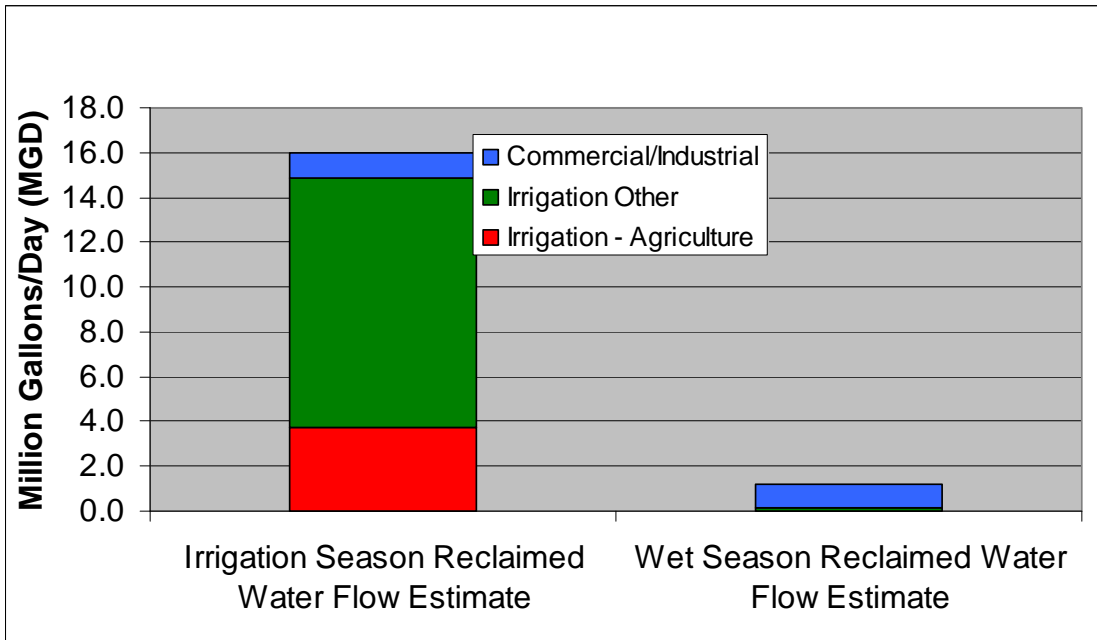


Figure B-8. Estimated Average Daily Demand for Nonpotable Consumptive Reclaimed Water Uses in South Area