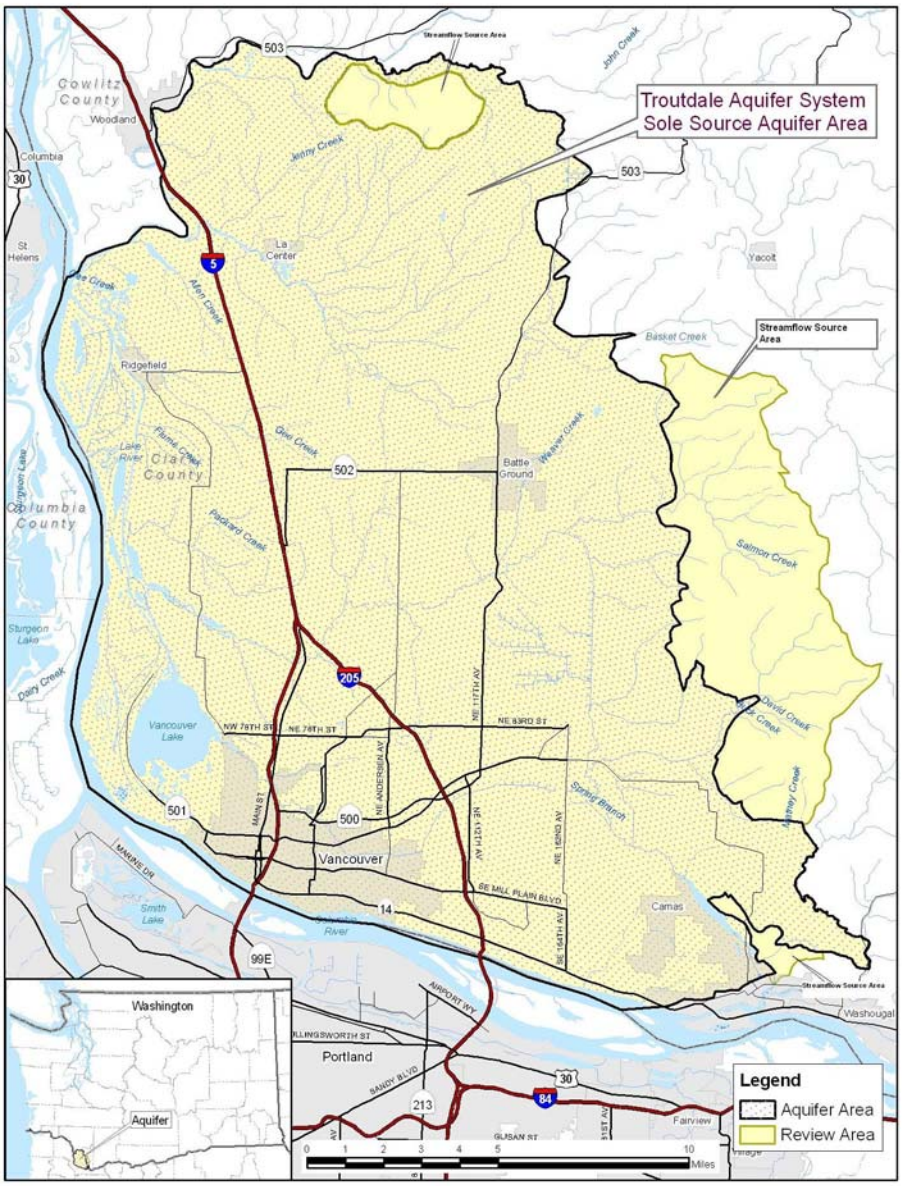
United States Environmental Protection Agency	Region 10 1200 Sixth Avenue Seattle WA 98101	Alaska Idaho, Oregon Washington

February 2006

DRAFT SUPPORT DOCUMENT FOR SOLE SOURCE AQUIFER DESIGNATION OF THE TROUTDALE AQUIFER SYSTEM



SUPPORT DOCUMENT
FOR SOLE SOURCE AQUIFER DESIGNATION
OF THE TROUTDALE AQUIFER SYSTEM

Prepared by

U.S. Environmental Protection Agency, Region 10
Office of Environmental Assessment for:
Drinking Water Section,
Seattle, Washington 98101

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TABLE OF CONTENTS

TABLES

SUPPORT DOCUMENT FOR SOLE SOURCE AQUIFER DESIGNATION OF THE TROUTDALE AQUIFER SYSTEM

INTRODUCTION

Purpose

This document is a summary of selected available information about the ground water resources of the petitioned area in western Clark County, Washington, and provides the technical basis for the U.S. Environmental Protection Agency (EPA) designation of the Troutdale aquifer system as a sole source aquifer.

Sole Source Aquifer Program

The Sole Source Aquifer Program is authorized by the Safe Drinking Water Act of 1974 (Safe Drinking Water Act, Public Law 93-523 42 U.S.C. 300 et.seq). Section 1424(e) of the Safe Drinking Water Act states:

"If the Administrator determines, on his own initiative or upon petition that an area has an aquifer which is the sole or principal drinking water source for the area and which, if contaminated, would create a significant hazard to public health, he shall publish notice of that determination in the Federal Register. After the publication of any such notice, no commitment for Federal financial assistance (through a grant, contract, loan guarantee, or otherwise) may be entered into for any project which the Administrator determines may contaminate such aquifer through a recharge zone so as to create a significant hazard to public health, but a commitment for Federal assistance may, if authorized under another provision of law, be entered into to plan or design the project to assure that it will not so contaminate the aquifer."

EPA defines a sole or principal source aquifer as an aquifer or aquifer system which supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer, and for which there is no alternative source or combination of alternative drinking water sources which could physically, legally and economically supply those dependent upon the aquifer (U. S. EPA, 1987). For convenience, all EPA designated sole or principal source aquifers or aquifer systems are often referred to simply as “sole source aquifers”.

Although EPA has authority to initiate sole source aquifer designations, the agency has a longstanding history of only responding to petitions. Until 1987, EPA accepted sole or principal source aquifer petitions which contained a minimum amount of information. This practice changed when EPA released the Sole Source Aquifer Petitioner Guidance document in February of 1987. The guidance clarifies the definition and acceptable delineation of a sole or principal source aquifer, and describes how to petition EPA.

Petition

The EPA Region 10 Drinking Water Section received a draft sole source aquifer petition in early November 2005 from a group of Clark County residents, who represent both individuals and private public interest groups. The petitioners were:

The Columbia Riverkeeper
The Rosemere Neighborhood Association
Dvija Michael Bertish
Dennis Dykes
Thom McConathy
Nathan Reynolds
Karen Kingston
Coleen Broad
Richard Dyrland

A final petition was presented to EPA on November 29, 2005. On December 28, 2005, EPA sent a letter to the petitioners acknowledging that the agency considered the petition complete, and that the technical review process would begin.

In January 2006 EPA met with the petitioners to discuss expanding the aquifer system boundary to include more of the geologic formations. There was agreement to extend the boundary, and the petitioners agreed to provide updated values for population and drinking water use data. On January 17, 2006 the petitioners provided the adjusted water use and population data to EPA.

GEOGRAPHY

The petitioned area is within Clark County, Washington, which is a part of the southernmost boundary of the state, along the Columbia River. The geography is characterized by flat-lying alluvial lands along the Columbia River and its tributaries (Columbia, 2005). These alluvial lands are interrupted by low, rolling hills and/or buttes with benches and hilly areas that rise to meet the foothills of the Cascade Range to the east and the northeast. The altitude of the land surface ranges from approximately 10 feet along the Columbia River to about 3,000 feet in the foothill of the Cascade Range. The Columbia River flows westward out of the Columbia River Gorge, past the City of Vancouver, Washington, where it flows northward. The tributaries to the Columbia River that drain Clark County include the North and East Forks of the Lewis, Little Washougal, Washougal, and Lake Rivers. Major creeks are Cedar, Salmon, Burnt Bridge, and Lacamas Creeks.

Climate

The fall, winter, and spring are generally cool and wet, and summers are warm and dry (Columbia, 2005). Average temperatures for the area range from about 39° F (degrees Fahrenheit) in January to about 68° F for July. Annual precipitation averages about 37 inches per year at the Portland Airport, which is within 10 miles of the petitioned area. About 90 percent of this amount falls between October 1st and May 31st. Average annual rainfall in the hills near the east boundary of the area is up to 80 inches per year.

HYDROGEOLOGY

Geology

The petitioned area is comprised of all lacustrine and fluvial sediments of the upper and lower members of the Troutdale Formation, other consolidated sand and gravel aquifer units, and overlying unconsolidated alluvium and flood deposits (Fig. 1). These aquifer system units overlie volcanic and marine sedimentary rocks that are commonly known as the "older rocks" unit. The older rocks unit is minimally productive as an aquifer and is therefore not included in the aquifer system being considered for sole source designation. Information presented in this section was obtained from McFarland, 1996.

Sedimentary units include eight hydrogeologic units comprising the Portland Basin aquifer system McFarland, 1996. From youngest to oldest, these hydrogeologic units are (1) the unconsolidated sedimentary aquifer, (2) the Troutdale gravel aquifer in the Troutdale Formation, (3) confining unit 1, (4) the Troutdale sandstone aquifer in the Troutdale Formation, (5) confining unit 2, (6) the sand and gravel aquifer, and (7) older rocks. The eighth unit is an undifferentiated fine-grained sediment deposit that occurs in the basin where the Troutdale sandstone and the sand and gravel aquifer are absent or where there is insufficient information to characterize the aquifer units within the lower Troutdale member of Mundorff, 1964. Swanson further grouped these units into two hydrogeologic subunits, the Upper Sedimentary and Lower Sedimentary Subsystems.

Water-bearing Aquifer Characteristics

The following information is from Columbia et.al, 2005:

"The upper sedimentary subsystem consists of the unconsolidated sedimentary aquifer and the Troutdale Gravel aquifer. This subsystem is the primary source of drinking water in the proposed aquifer service area and is expected to supply most of the projected increases in demand. The unconsolidated sedimentary aquifer consists primarily of flood deposits of late Pleistocene age varying from bouldery gravel to silt. It includes flood plain and terrace deposits along major tributaries and glacial outwash in some areas. The top of the unit is land surface, and its thickness is mostly between 50 and 100 feet although deposits range up to 300 feet thick in some areas. Wells completed in these deposits have maximum yields between 1,000 and 6,000 gallons per minute near Washougal, Camas, and Vancouver, Washington, and up to 10,000 gallons per minute north of Blue Lake in Oregon.

The Troutdale Gravel consists of principally of sandy gravel, silty sand, sand, and clay. The altitude of the top of the unit ranges from about 700 feet in the Prune Hill area in Camas to minus 600 feet northwest of Gresham in Oregon. The maximum thickness of this unit is about 800 feet and well yields are as large as 3,000 gallons per minute in some areas.

The lower sedimentary subsystem consists of two confining units, the Troutdale Sandstone, and sand and gravel beds within the Sandy River Mudstone geologic unit. Swanson et al (1993) identify portions of this subsystem as the Undifferentiated Fine-Grained Unit where data were not available to differentiate the units. In the aquifer service area the confining units and the Troutdale Sandstone unit are mapped as overlying each other. They extend from Camas up to Meadow glade and west to the Orchards area.

The upper confining unit (identified as Confining Unit 1) is a grayish olive-green clay and silt with lenses of silt and fine-to-medium-grained sand. The altitude of the unit ranges from about 900 feet in the area south of the City of Sandy to about minus 300 feet near the center of the basin. The thickness is generally less than about 200 feet.

The lower confining unit (identified as Confining Unit 2) is lithologically similar to Confining Unit 1. The altitude of the top of the unit ranges from about 900 feet in the Tickle Creek area to about minus 500 feet toward the center of the basin. The thickness of the unit ranges from about 200 feet in the southeastern part of the basin to about 800 feet toward the center of the basin.

The Troutdale sandstone aquifer consists of coarse sandstone and conglomerate with lenses and beds of fine-to-medium sand and silt. The altitude of the top of the aquifer is about 1,000 feet in the area east of the Sandy River and dips westward to about minus 400 feet near downtown Portland. The thickness of the aquifer ranges from 100 to 200 feet but is about 400 feet in the southeastern part of the basin. Wells completed in this unit yield up to 2,500 gallons per minute.

The consolidated gravel aquifer is composed of a poorly- to moderately-cemented sandy conglomerate and includes local accumulations of lavas and a mantling soil horizon. This unit is mapped as only extending into the aquifer service area near Camas. However, it has recently been investigated as a groundwater source in the western part of the service area where Swanson et al (1993) were apparently not able to differentiate it from other units. Its elevation appears to be lower than in the southern part of the basin as described in the following sentences taken from McFarland and Morgan (1996B). The altitude of the top of the unit is about 1,400 feet east of the Sandy River; however, the top of the unit is between altitudes of 100 and 200 feet throughout most of the basin, and its thickness ranges from 100 to 400 feet in most of the area. Wells completed in this unit can yield about 1,000 gallons per minute.

The undifferentiated fine-grained sediments are lithologically similar to confining units 1 and 2. This unit includes all the sediments overlying the older rocks and underlying the consolidated gravel aquifer wherever individual units cannot be discerned either because the individual units are not present or because information is insufficient to map them. Altitude of top of the unit ranges from about 1,200 feet east of Sandy, Oregon to minus 300 feet near the center of the basin, where its thickness is about 1,200. The unit is generally a poor water-bearing formation.

The older rocks unit includes generally low permeability, Miocene and older volcanic and marine sedimentary rock that underlie and bound the basin-filling sediments. The altitude of the top of the unit ranges from land surface in the exposed areas to minus 1,600 feet beneath Vancouver, Washington. This unit bounds the proposed aquifer service area on the east and much of the north.

USGS summarizes storage coefficients that were determined from aquifer tests and published information for each of the hydrogeologic units. Average storage coefficients for each unit were as follows:

- unconsolidated sedimentary aquifer 0.003;
- Troutdale gravel aquifer 0.0008;
- confining unit 1 0.00005;
- Troutdale sandstone aquifer 0.00024;
- confining unit 2 0.00005;
- sand and gravel aquifer 0.0004;
- older rocks 0.0001.

Where these units are at the land surface, water in them can be under water-table conditions. Under water-table conditions, specific yield is commonly in the range of 0.05-0.20.

USGS describes the hydraulic conductivities of the aquifers as follows: The four sedimentary aquifers in the basin have the highest median hydraulic conductivities. The unconsolidated sedimentary aquifer has the highest median value of hydraulic conductivity (200 feet per day) and also the greatest variation in values (0.03 to 70,000 feet per day). It is the most permeable aquifer, as well as the most heterogeneous unit. The Troutdale gravel aquifer, Troutdale sandstone aquifer, and the sand and gravel aquifer all have similar median values of about 7 to 16 feet per day. The Troutdale sandstone and the sand and gravel aquifer have low variation in hydraulic conductivity relative to some of the other units. The Troutdale gravel aquifer, however, has values of hydraulic conductivity ranging over six orders of magnitude."

Ground Water Flow System

The following information is from Columbia et al, 2005.

"In the petitioned area, ground water in the surficial unconsolidated sedimentary aquifer flows from more than 250 feet above sea level along the eastern extent of the aquifer toward the Columbia River and other major streams. (McFarland, 1996). Gradients are generally steepest beneath the break in slope between the terraces and the Columbia River flood plain. A mound in the water table occurs just west of Orchards, where water levels are more than 250 feet above sea level. This mound may be a result of slightly lower hydraulic conductivities in the unconsolidated sedimentary aquifer or could be due to greater recharge to the ground-water system from on-site waste-disposal systems or drywells, both of which are likely to introduce contaminants to groundwater.

Water levels in the Troutdale gravel aquifer are highest in the Mount Norway area on the east side of the aquifer where they exceed 900 feet above sea level. Ground water in the Troutdale gravel aquifer moves southward toward the Columbia River. Throughout the rest of Clark County, water levels generally are highest in the eastern part of the county, along the western flank of the Cascades; ground water moves toward the Columbia River, East Fork Lewis River, and Salmon Creek. Mundorff's (1964) map of water levels in the upper member of the Troutdale Formation shows similar ground-water flow directions; however, some contours have shifted to the north in the past 40 years. This shift is most evident from the 150 foot contour just west of Prune Hill in Camas. Comparison water level contour maps show that this contour is positioned 1.5 to 2 miles to the northeast of the same contour for the 1949-50 map. This comparison would suggest that some stress to the aquifer system had caused the change in water levels, and that the decline possibly has been 10 feet or more. The 100 foot contour also has moved approximately 0.5 miles to the northeast.

The Troutdale sandstone aquifer has the highest water levels in the northeastern and eastern extent of the unit. Water levels are more than 200 feet above sea level and the primary ground-water movement direction is to the southwest toward the Columbia River.

The minimum groundwater age is less than 10 years throughout the extent of the unconsolidated sedimentary aquifer, with the exception of a few areas along the Columbia River at Vancouver (Snyder, Wilkinson and Orzol, 1998). The young minimum groundwater ages in these areas result from the occurrence of the aquifer at the surface and the presence of recharge areas for local and intermediate flow systems. The map of maximum groundwater ages for the unconsolidated sedimentary aquifer shows that most of the water has an age of less than 100 years, with the age of groundwater increasing downgradient to the west and south. Most of the groundwater within the Troutdale gravel aquifer has a minimum age of less than 100 years, with many areas having groundwater less than 10 years old."

BOUNDARIES

The originally petitioned boundaries are presented in Fig.2. During the EPA technical review of the petition, EPA recommended that the boundaries be slightly extended in the south, east, and northern sections of the area to encompass more of the aerial extent of the aquifer system geologic units. The petitioners agreed, and the final proposed boundaries are shown in Fig. 3.

The aquifer system boundaries proposed by EPA to be designated as the Troutdale aquifer system are represented by rivers and the geologic boundary between the aquifer system units and the older rocks unit. The Columbia River forms the southern and western boundaries of the proposed Troutdale aquifer system. The northern boundary follows the North Fork of the Lewis River from its confluence with the Columbia River, east to the confluence of Cedar Creek. Cedar Creek is used as the northeast boundary because its location is the closest geographic representation of the geologic boundary between the Troutdale unit and the older rocks unit, and the creek also most likely acts as a local ground water divide for the upper parts of the aquifer system. The aquifer boundary follows Cedar Creek east where the boundary turns southeast and follows the mapped geologic contact between the Troutdale Formation and the older rocks unit. The eastern boundary follows the geologic contact south to the Little Washougal River, then follows the Little Washougal River to its confluence with the Washougal River. The boundary then follows the Washougal River south to Woodburn Hill, where it turns northwest and follows the geologic contact along a small outcrop of the older rocks unit. The boundary follows the geologic contact through the City of Camas, and meets the Columbia River.

In the northern part of the area, the aquifer system boundary is drawn around Bald Mountain, which is excluded from the aquifer system because it is composed of the older rocks unit.

STREAMFLOW SOURCE AREA

The streamflow source area of an EPA designated sole source aquifer is defined as the upstream headwaters area of streams that flow into the recharge area of the aquifer (U.S. EPA, 1987). EPA usually considers watershed divides upstream from the sole source aquifer geologic boundaries appropriate streamflow source area boundaries, along with any headwaters of streams that lose water to the aquifer. These conditions appear to occur for the Salmon Creek and Lacamas Creek watershed boundaries on the east side of the proposed area (Fig. 3). Groundwater pumping has lowered groundwater levels in these areas, and caused water in the rivers to recharge the aquifer system. Pumping has been curtailed during low flows in the Salmon Creek drainage. The Lacamas Creek drainage occupies the area where the USGS (McFarland and Morgan, 1996A) describes a major shifting of water table contours due to pumping induced lowering of the water table. There is also a small area on the south side of the area that is proposed as a streamflow source area because it encompasses part of the watershed that drains into the area (Fig. 4).

GROUND WATER QUALITY

The quality of groundwater in the proposed aquifer service area is generally good with some exceptions (Turney, 1988). Dissolved-solids concentrations ranged from 12 to 245 milligrams per liter, with a median concentration of 132 milligrams per liter. Most waters can be characterized as soft to moderately hard. Concentrations of nitrate as nitrogen exceeded 1.0 milligram per liter throughout the Vancouver urban area, and were as large as 6.7 milligrams per liter (Maximum Contaminant Level (MCL) is 10 milligrams per liter). Potential nitrate sources are septic systems and fertilizers. According to the 1990 Census, there are more than 31,000 septic systems in Clark County. An analysis of limited historical data indicates that nitrate concentrations may be decreasing in the southwestern part of the county around the Vancouver urban area. A slight increase in nitrate concentrations was noted in rural areas. Nitrate concentrations correlated with sulfate concentrations ($r = 0.61$), indicating similar sources for the two. Volatile organic compounds have been detected in wells in the Vancouver urban area. Compounds identified included tetrachloroethene, l,l,l-trichloroethane, and other solvents. Atrazine and 2,4-D have also been detected in well water. Trace elements and radiochemical constituents were present only at small levels, indicating natural sources for these constituents.

POTENTIAL FOR CONTAMINATION

The aquifer system is vulnerable to contamination because recharge occurs essentially over the entire area, the aquifer is highly permeable, and there are many human activities that have released, or have the potential to release, contaminants to the aquifers. The Washington Department of Ecology (WDOE, 2006) currently lists 204 active cleanup and 12 federal Superfund sites in the proposed aquifer service area. These sites are known to have been contaminated and are undergoing cleanup. Many of these sites include plumes of groundwater contamination. WDOE also lists 625 hazardous waste generators, and 609 underground storage tanks in this area .

- Superfund sites 12
- Active state cleanup sites (MTCA, etc.) 90
- Active voluntary and independent cleanup sites 114
- LUST sites 185
- Hazardous waste sites 625
- UST sites 609

Other sources of contamination include untreated or poorly treated storm water and septic systems. There are about 7,000 septic systems on small lots in the City of Vancouver, all more than 30 years old and likely to be failing. There are tens of thousands of additional septic systems outside the city discharging to the aquifer.

The county is experiencing rapid growth which increases the threat to the quality of the aquifer as well as increases the demand for potable water.

POPULATION AND DRINKING WATER CONSUMPTION

The petitioner estimates that approximately 313,854 people live in the Troutdale aquifer system area (2000 Census). The average drinking water consumption for the area was estimated by multiplying the population by an estimated daily use per capita (Table 1). The petitioners found that households on self-supplied ground water used less water than those on public supplies.

Table 1

	Population	Ground Water (Mgal/day)	Surface Water (Mgal/day)	Total (Mgal/day)	Per Capita Use (gal/day)
Public System	236,514	26.06	0.19	26.25	111.0
Self-Supplied	77,340	6.50	0	6.50	84.03
Total	313,854	32.56	0.19	32.75	104.35

The City of Camas is the only community inside the petitioned area that uses surface water as a drinking water source. Using USGS per capita drinking water use data and the surface water utility data, the petitioners calculated a surface water use of approximately 0.19 million gallons per day for the area (Columbia, 2005). *Note: The population and drinking water use numbers for ground water in this document are slightly higher than numbers presented in the petition, due to the increase in size of the proposed area.

As can be seen from Table 2, ground water from the Troutdale Aquifer System supplies over 99% of the drinking water used in the area, indicating that the proposed Troutdale Aquifer System easily meets the 50% criteria for sole source designation.

Table 2

Source	Daily Volume (Mgal/day)	Percentage
Troutdale Aquifer System	32.56	99.41%
Imported Surface Water	0.19	0.59

ALTERNATIVE DRINKING WATER SOURCES

EPA guidance requires that petitioners demonstrate not only that an aquifer supply 50 percent or more of the drinking water for the area, but also that there are no alternative sources or combination of sources which could physically, legally, and economically supply all those who depend upon the aquifer system for drinking water (EPA, 1987). The petitioners for the Troutdale Aquifer System have adequately demonstrated that there are no additional sources of drinking water that are economically, nor most likely, legally available.

Each of the potential alternative sources that the petitioner evaluated has limitations on quantity or quality of water and/or the feasibility of development (Columbia, 2005). Table 3 summarizes the considerations for each potential source.

Table 3

Summary of Potential Alternative Sources of Water

Alternative Source	Quantity Available	Quality	Water Rights	Environmental Impacts	Technical Feasibility	Relative Costs	Political Complications
Columbia River	Adequate although may be interruptable	Substantial Treatment Required	Likely available, possible curtailment at low flow	Possible ESA, Shoreline and wetlands impacts	Feasible	Substantially higher than current	Environmental, Water quality concerns, Shoreline access, Water Rights
Lewis River	May be adequate	Treatment required	Availability not certain	Possible ESA, Shoreline and wetlands impacts	Feasible	Substantially higher than current	Environmental, Shoreline access, Pipeline route, Water Rights
Washougal River	May not be adequate	Treatment required	Availability not certain	Possible ESA, Shoreline and wetlands impacts, dam and reservoir impacts	Feasibility not certain	Substantially higher than current	Environmental, Shoreline access, Pipeline route, Water Rights
Washougal River delta/Steigerwald Lake lowlands	Limited	Limited treatment required	Availability not certain	Possible ESA, Shoreline and wetlands	Feasibility not certain	Substantially higher than current	Environmental, Shoreline access, Pipeline route, Water Right conflicts
Woodland Bottom	Limited	Treatment required	Availability not certain	Possible ESA, Shoreline and wetlands	Feasibility not certain	Substantially higher than current	Environmental, Shoreline access, Pipeline route, Water Right conflicts
Portland Water Bureau Intertie	Adequate	Treatment by purveyor	Likely available	Possible ESA, Shoreline and wetlands	Feasible	Substantially higher than current	Integration with regional system, Source expansion/development

Of the six potential alternative sources, the Columbia River and the Portland Water Bureau Intertie, appear to offer adequate sources of supply although with significant potential limitations. Both would require extensive legal and political processes before implementation and could not be expected to come online for more than a decade, if at all. These sources would require substantially more treatment than the current groundwater sources. Development and operation/maintenance costs of these alternative sources would also be significantly higher than the costs of current sources.

Most important in evaluating economic feasibility of alternative sources is the fact that replacing the private wells of over 77,000 people with an alternative source would be prohibitively costly, due to the required pipelines and distribution systems needed for individual rural households that are spread over a large land area. Therefore, based solely on the economic feasibility of replacing these rural water sources, none of the potential alternative sources qualify as Alternative Drinking Water Sources as defined in the EPA Petitioners Guidance.

CONCLUSION

A sole source aquifer system must supply at least 50 percent of the drinking water consumed within the natural boundaries of the aquifer system, and there can be no economically or legally available alternative source that could supply the entire population living in the area. The Troutdale Aquifer System supplies over 99% of the drinking water to people living in the petitioned area, and there are no economical and legally available alternative sources of water. The political and legal constraints on available water supplies in the area cause even potentially adequate volumes to be unattainable within any reasonable timeframe. Given these conditions, the Troutdale Aquifer System meets the criteria or EPA designation as a sole or principle source aquifer under Section 1424(e) of the Safe Drinking Water Act.

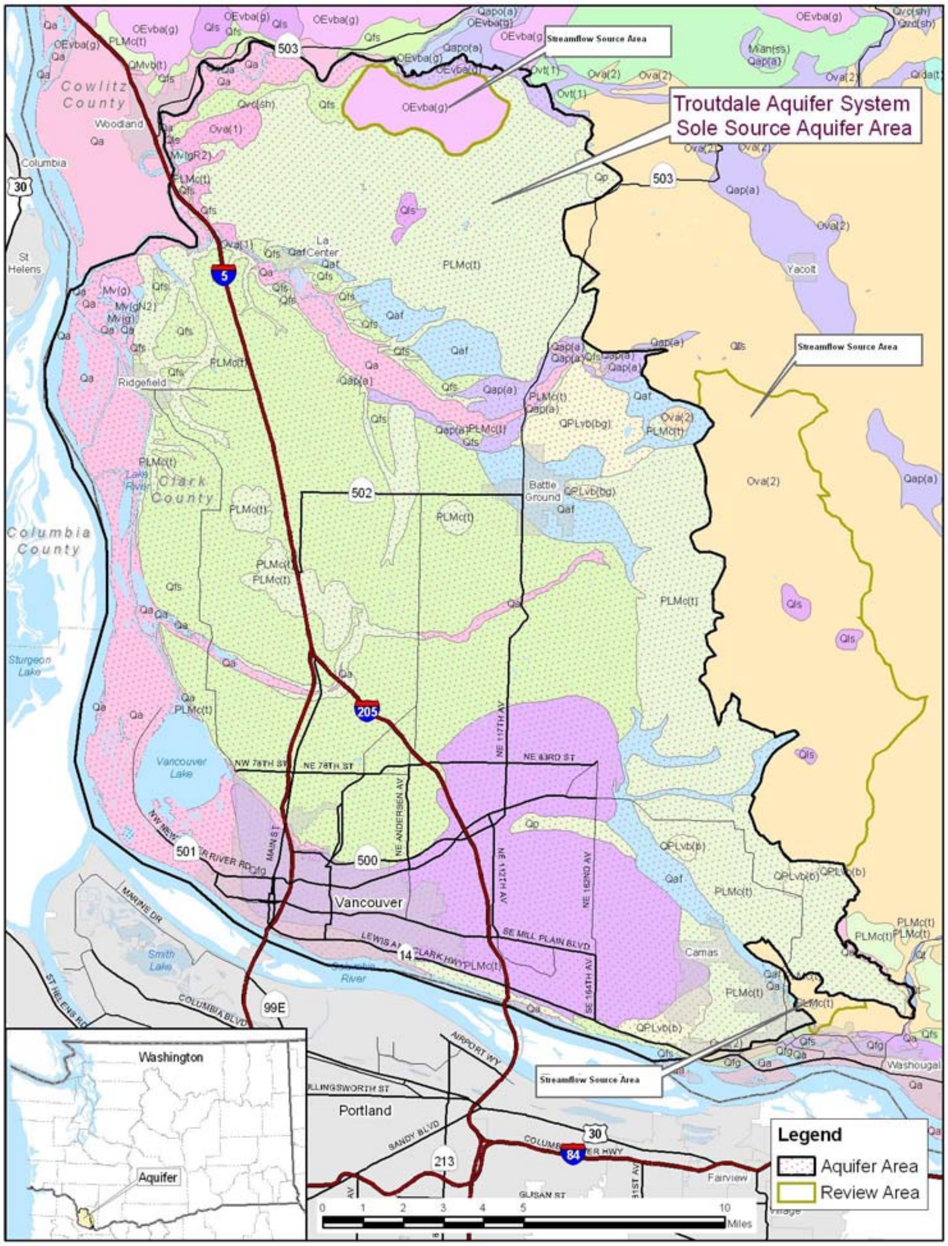

Figure 1. Geology of proposed area, WA. Dept. of Natural Resources. See web site for geologic labels: http://www.dnr.wa.gov/geology/dig100k.htm

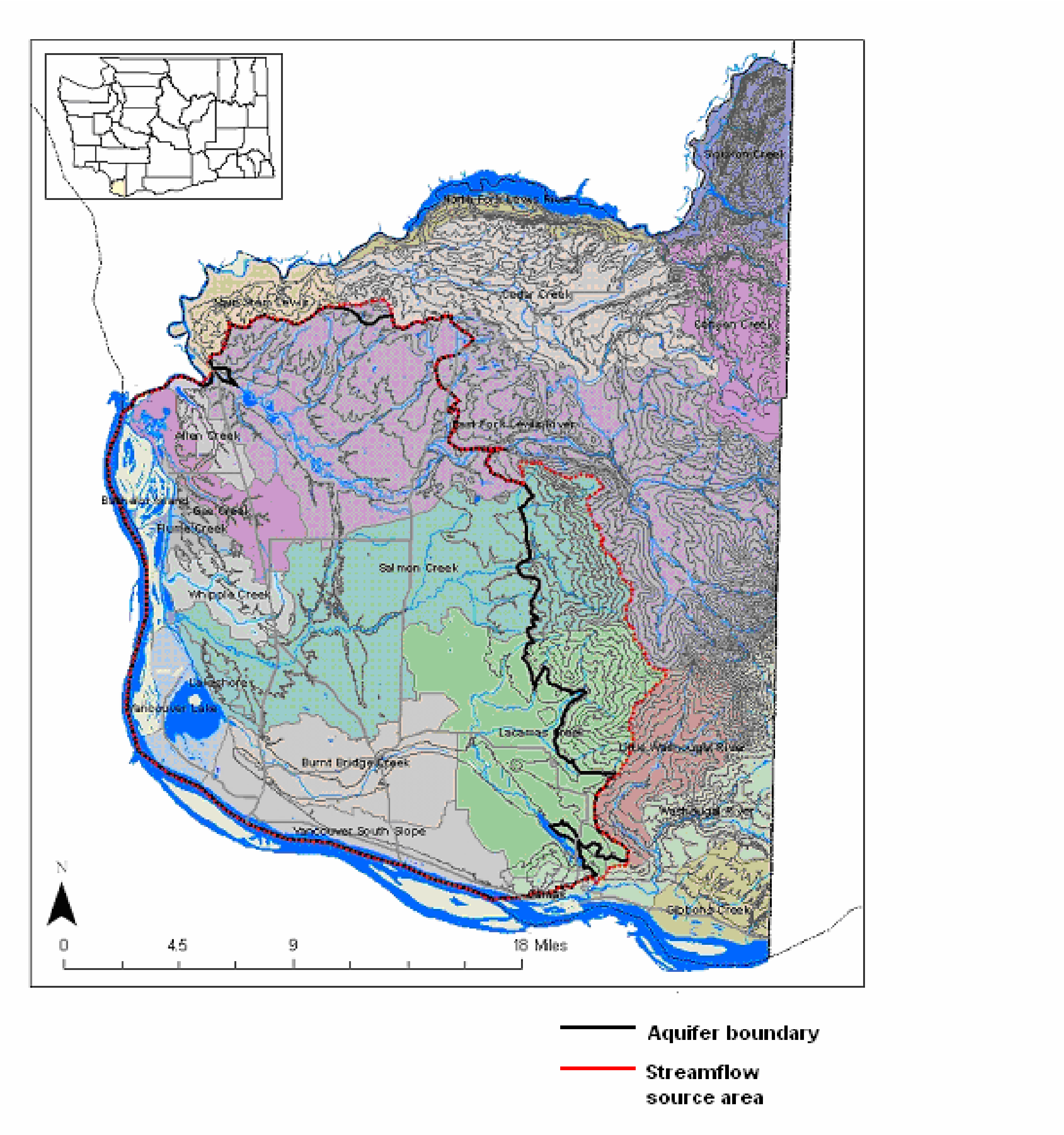

Figure 2. Originally petitioned boundaries (Columbia, 2005).

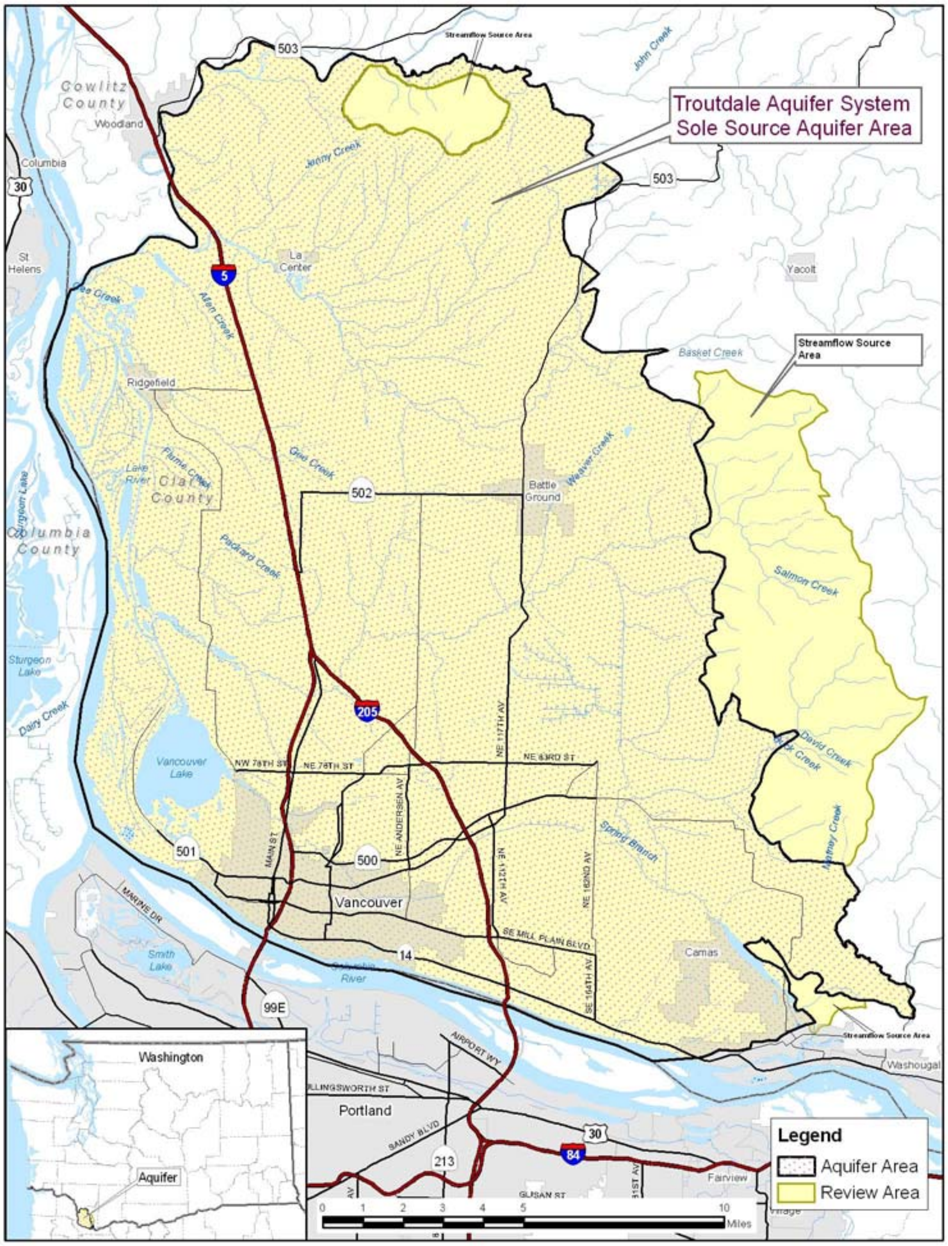

Figure 3. Proposed boundaries for sole source area.

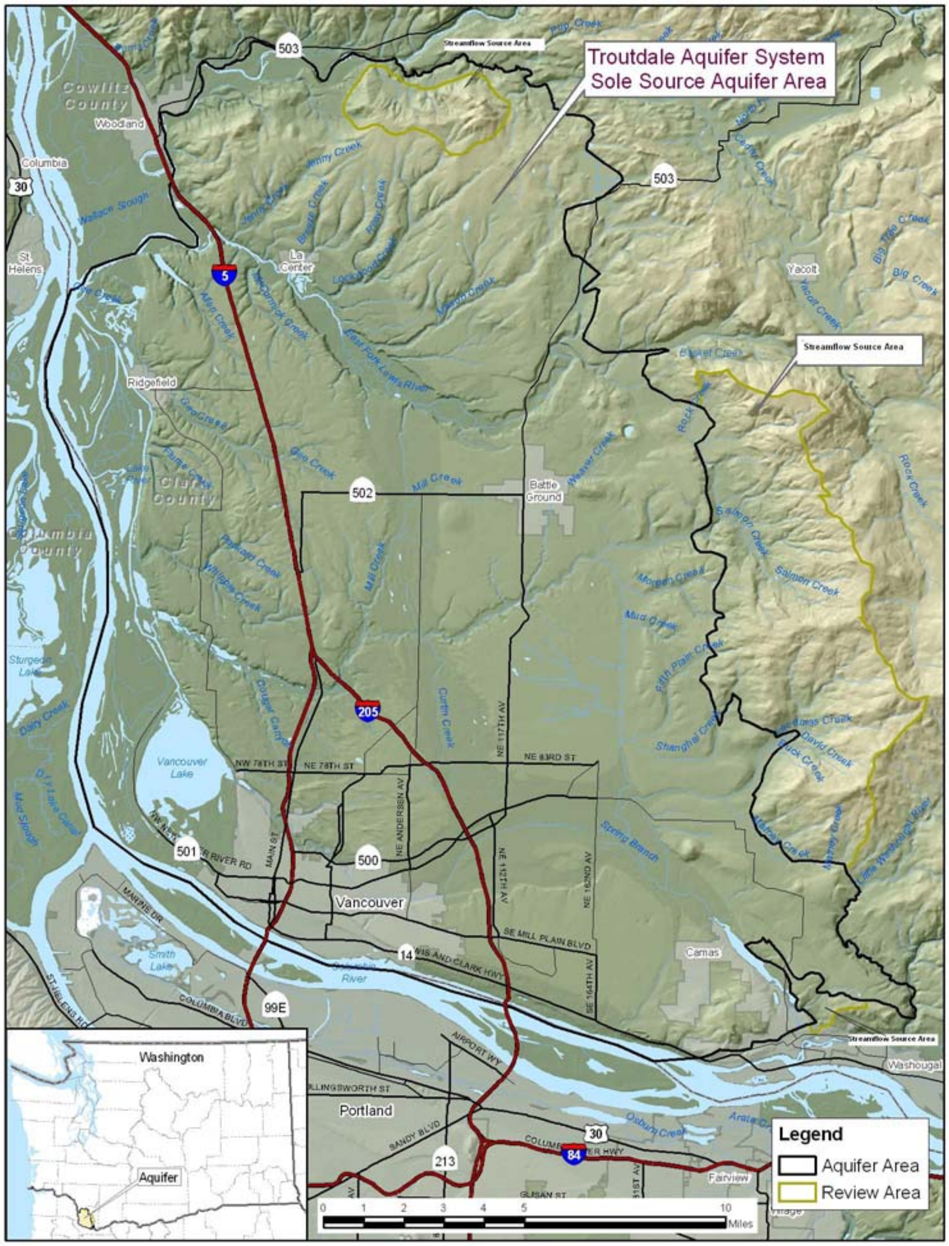

Figure 4. Shaded relief showing streamflow source areas.

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