Phase 1: Benton County Water Analysis and Demand Forecast

"Evaluating the quality and quantity of water resources for all uses, needs and users of Benton County, Oregon."



Benton County Oregon Water Project

Published Materials Compiled and Referenced

City of Adair Village, Water System Master Plan Update, 2008

City of Albany Water Management and Conservation Plan, 2006

City of Albany Hydraulic Modeling Update Plan, 2008

City of Corvallis Water Management and Conservation Plan, 2005

City of Monroe Water Management and Conservation Plan, April 2008

City of Philomath Water System Master Plan, 2005

Ground-Water Hydrology of the Willamette Basin, Oregon. By Terrence D. Conlon, Karl C. Wozniak, Douglas Woodcock, Nora B. Herrera, Bruce J. Fisher, David S. Morgan, Karl K. Lee, and Stephen R. Hinkle. Scientific Investigations Report 2005-5168. Prepared in cooperation with the Oregon Water Resources Department.

Ground Water in the Corvallis-Albany Area, Central Willamette Valley, Oregon. F.J. Frank (1974). Geological Survey Water-Supply paper 2032.

Oregon Department of Human Services- Drinking Water Program:
- Safe Drinking Water Information System: http://170.104.158.45/ .
- Community water system and Drinking Water Source Area information.

Oregon Office of Economic Analysis- Demographic forecast: http://www.oea.das.state.or.us/DAS/OEA/demographic.shtml

Oregon Water Resources Department:
- Point of Diversion Summary Report: http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_summary_pod.aspx
- Water Availability Reporting System- http://apps2.wrd.state.or.us/apps/wars/wars_display_wa_tables/water_availability_analysis.aspx.
- Well Log Query- http://apps2.wrd.state.or.us/apps/gw/well_log/Default.aspx
- Water Rights Query- http://apps2.wrd.state.or.us/apps/wr/wrinfo/

Southern Willamette Valley Groundwater Management Area Action Plan (2006). Southern Willamette Valley Groundwater Management Area Committee submitted report to Oregon Department of Environmental Quality; prepared by Lane Council of Governments.

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Willamette Basin Biological Opinion (July 11, 2008). National Oceanic and Atmospheric Administration- Marine Fisheries Service. http://www.nwr.noaa.gov/Salmon-Hydropower/Willamette-Basin/Willamette-BO.cfm

WDR OR-05-1 Water-Resources Data, Oregon, Water Year 2007, compiled by T.A. Herrett, M.A. Stewart, G.P. Ruppert, and M.L. Courts (includes water reports for Alsea, Long Tom, and Marys Rivers).

Water Quantity Conversion Table

Rates of Flow
One (1) cubic foot per second (cfs) is a rate of water flow which will supply one cubic foot of water in one second and is equivalent to flow rates of:

1 cfs =	7.48 gallons per second
	448.8 gallons per minute
	646,272 gallons per day
	1.98 acre-feet per day

Volume Measurement
One (1) acre-foot (af) is the volume of water which will cover one acre to a depth of one foot and is equal to:

1 af =	43,560 cubic feet
	325,851 gallons

Acknowledgements:

Benton County thanks the organizations and individuals who supported the *Phase 1* Water Project work. Special thanks are due to the members of the Steering Committee, Technical Team, and Outreach and Education Team. Benton County applauds the determination of the Oregon Water Resources Department and other state agency staff that continue to contribute positively to the planning and management of Oregon's vital water resources into the future.

Table of Contents

List of Figures

List of Tables

List of Tables- continued

Appendix

EXECUTIVE SUMMARY

Information collected and produced during the *Phase 1* project is based heavily on federal and state data that is often historic and incomplete. The project report acknowledges inherent uncertainty in data and has made efforts to produce conservative estimates based on published data sources. The next step is to refine information on water quantity and quality and to continue to promote collaboration with adjacent counties and shared watersheds.

Existing major surface water rights allocate water use in Benton County from the Willamette, Santiam (within Linn County), Marys, Long Tom, and Alsea rivers. Existing surface water rights allow:

- 47 percent of water use for irrigation,
- 29 percent for municipal purposes, and
- 10 percent for fish and wildlife purposes.

Instream water rights designated for fish and wildlife, recreation, navigation, and pollution abatement purposes. Additionally there are year round minimum stream flows along the Willamette and Long Tom Rivers. The amount and priority date for instream water rights, range from 10 cubic feet per second (cfs) with a priority date of 6/22/1964 to 277 cfs with a priority date of 6/25/1990. Depending on the river mile location, time of year, and water rights with earlier priority date, the actual amount of instream water right flow varies. The Marys River has the greatest amount of instream water rights allocated to protect stream flow - four instream water rights with 5 to 135 cfs.

The majority of surface water storage rights (42 percent) are allocated for fish and wildlife ponds (e.g. William L. Finley National Wildlife Refuge)

The majority (94 percent) of existing groundwater rights are for irrigation purposes. Specific groundwater use data is not comprehensively available for domestic and irrigation water uses but is estimated for this report.

There is an estimated deficit of surface water available for new year-round water use from streams. Based on estimated stream flows, surface water resources are fully appropriated[1] during the high demand (summer) months for all major streams with the exception of the Willamette River. Future year-round surface water rights are dependent on State and Federal requirements for environmental flows and water quality requirements. Currently several major surface water sources have been identified by State agencies as “water quality limited” for several water quality pollutants with associated Total Maximum Daily Loads (TMDLs) set by Oregon Department of Environmental Quality.

[1] All available water rights have been granted by the State Water Resources Department.

The majority of cities, water districts and non-municipal communities' total maximum day water use are estimated to be within amounts allowed by current water rights.

- The total maximum water demand[2] for all cities within Benton County is currently estimated to be 23 million gallons per day.
- In comparison, the total average daily exempt groundwater use [3] for rural residences outside of community water service areas is estimated to be an average of 2.0 million gallons per day; 4.7 total million gallons per day during the summer (irrigation) season.
- Estimated density of domestic wells is 0-300 per square mile; however the exact number of active domestic groundwater wells requires more research.

While groundwater supply and quality are adequate for most current groundwater users, the location and density of wells affects water quantity and quality across the county.

- Local geology dictates natural water quantity and quality limitations, resulting in groundwater resources impacted by demand exceeding aquifer recharge, well- to-well interference, and areas that may contain elevated concentrations of naturally occurring salts, sulfates, iron, and arsenic.
- Anthropogenic (human caused) contamination of groundwater has occurred and has the potential for continuing, with a range of water quality impacts. Septic tanks, fertilizers, animal waste, wastewater, storm water and unused or poorly constructed wells are the leading sources of water pollution.

For the year 2050, the estimated total maximum water demands (70 to 78 million gallons per day) for cities within Benton County are projected to be within the total current city water rights[5]. However, projected demands based on existing city reports show potential for insufficient supply for future demands when discounting for current and future water right requirements, instream water demands, environmental flows, water quality flows, and other water use issues on a city by city basis.

The option of storing water during the winter season is an allowed use for major surface water sources, and is a viable mitigation where potential water deficits may occur. It is important to note that water conservation and system capacity/efficiency improvements were not factored into projected future demands. Water users conserving water through technology, rates, or other means are likely to decrease water use in the future.

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[2] 'Water demands' and 'water use' are used interchangeably.

[3] Use of groundwater for domestic purposes and non-commercial irrigation that does not require a water right from the State Water Resources Department.

[5] City produced water management reports were compiled and used for projecting future demands.

The total maximum future demand for exempt groundwater use from rural households[6] is projected to increase by 30 to 38 percent (from 4.9 to 5.3 million gallons per day). These groundwater demands may vary substantially depending on annexations of rural areas into city or other water service areas.

The project assumed that industrial and commercial land inside current Urban Growth Boundaries (UGBs) will receive surface water via municipal water systems. Industrial zoned land outside of city limits and UGBs will be dependent on groundwater use. It is highly unlikely that aquifers in Benton County could provide sufficient groundwater to meet industrial requirements except in locations near the Willamette River. However, in these areas much of the groundwater has a direct connection with surface water and State restrictions on groundwater withdrawals would apply to protect surface water flows.

Phase 1 project forecasts suggest that surface water and groundwater availability is likely to be adequate to meet water uses through the year 2050, providing that conservation plans are implemented and some current management practices change. However, the majority of both surface water and groundwater rights are dedicated to irrigation. Current and future water use for irrigation is unknown and will greatly affect water resources within the County.

Water policy, planning, and management must take into account:

- Land use decisions, climate, economics, and many other water related issues that cross political boundaries as well as private and public lands.
- Water conflicts exist within areas of the county and have the potential to increase in the future as demand for irrigation, agriculture, municipal and environmental water uses encounter possible water supply shortfalls.

Urban and rural residents of diverse water user types (irrigation, residential, recreation, etc.) are concerned about water quantity and quality and support collaborative approaches to planning for future water resource issues before conflicts arise among water uses, needs, and users[7]. The leading issues and values captured were:

- Clean water,
- Ensuring water supply for agriculture, and
- Ensuring water supply and quality for the environment including instream surface water flows and wetlands.

The Steering Committee took into consideration community concerns and values and, after reviewing the *Phase 1* report, identified issues and actions to be considered for *Phase 2* project work.

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[6] Data from rural community water systems that track (meter) water use data, was used to estimate exempt groundwater use for rural households.

[7] Water issues and values were captured at five 'Community Water Meetings' that took place throughout urban and rural areas of Alsea, Philomath, Wren, Monroe, and North Albany during the project period in addition to comments submitted to the project website: http://www.co.benton.or.us/boc/water/questionnaire.

The following focus areas are central to the development of a countywide Comprehensive Water Management Plan that addresses the significance of watershed-based planning that must cross political jurisdictions.

1. Continue to promote collaboration with adjacent counties, municipalities, water providers, and other stakeholders to develop the capacity to work collaboratively to address regional water quantity and quality issues. These include but are not limited to: data collection, information sharing, and policy/planning collaboration.
2. Provide the template methods of the *Phase 1* assessment and demand forecast methodology and findings to neighboring counties and interested stakeholders to encourage similar holistic evaluation of water resource issues and elicit responses.
3. Develop scenarios of future water demands for the range of surface water and groundwater users including but not necessarily limited to: land use changes, irrigation, climate change, conservation, and infrastructure scenarios.
4. Evaluate priorities and potential feasibility for water quantity and quality mitigation where groundwater and surface water supplies affect county residents' use of these water resources. It should be noted that any decision to alter natural flows (e.g. storage) can have the impact of affecting other water users and natural processes.

Section 1
Objectives and Approach

Summary

The *Phase 1* report is an overview of the complex water quantity and quality information and issues specific to Benton County. It is a first step toward assessing and planning for future water quantity and quality within Benton County and provides a template for regional water planning.

The report details a collaborative process of data collection and assessment of the supply and demand (use) on surface water and groundwater resources. Forecasting is based on existing Federal, State and local databases. Baseline assessments of technical data related to water supply and demand were provided to an interdisciplinary steering committee and work teams tasked with providing direction and input. All committee and advisory team participation was voluntary.

Engaging community stakeholders and residents was an important component of the project. Five community meetings and distribution of a questionnaire elicited concerns and values of county residents regarding water quantity and quality (**Section 6**). In addition, each steering committee and team meeting included an opportunity for public input where a number of water issues were identified.

The Board of Benton County Commissioners is the convener of this project. The authority of the County Commissioners does not include regulation of water and is not binding upon the political jurisdictions within Benton County. Therefore, consensus is a goal.

1.1 Purpose and Need

The purpose of *Phase I* is to collect data to supplement the Oregon Water Resources Department's efforts to acquire local and regional data on current water supply and projected future demands (use) to the year 2050. *Phase I* also sought public input in determining public concerns about the future of water use within the county. *Phase II* is proposed to identify data gaps, supply deficiencies and strategies to address possible water shortages such as water conservation, wastewater reuse, water quality improvement and water storage.

Current water uses and users are diverse, depending on the location within the county. The quantity and quality of water supplies are equally diverse. Increasingly interdependent surface water and groundwater issues affect the finite renewable supply of water. Water supplies often cross multiple ownership and political boundaries, adding a layer of complexity to the linkage between groundwater and surface water and the current and future water demands for both.

Today, the leading water demands (uses) include:

- Irrigation,
- Municipal,
- Fish and wildlife,
- Industrial and commercial,
- Private domestic wells (also referred to as “domestic exempt” wells), and
- Instream and minimum stream flows.

Many of these water demands share common water supplies which can be dramatically influenced by the following:

- Increases in population,
- Changes in land use,
- Environmental and natural resource requirements,
- Rules and regulations regarding land use, water use and water quality,
- Climate change issues,
- Protection of open space and natural areas including wetlands,
- Streamflow and groundwater resources, and
- Connectivity between groundwater and surface water supply and uses.

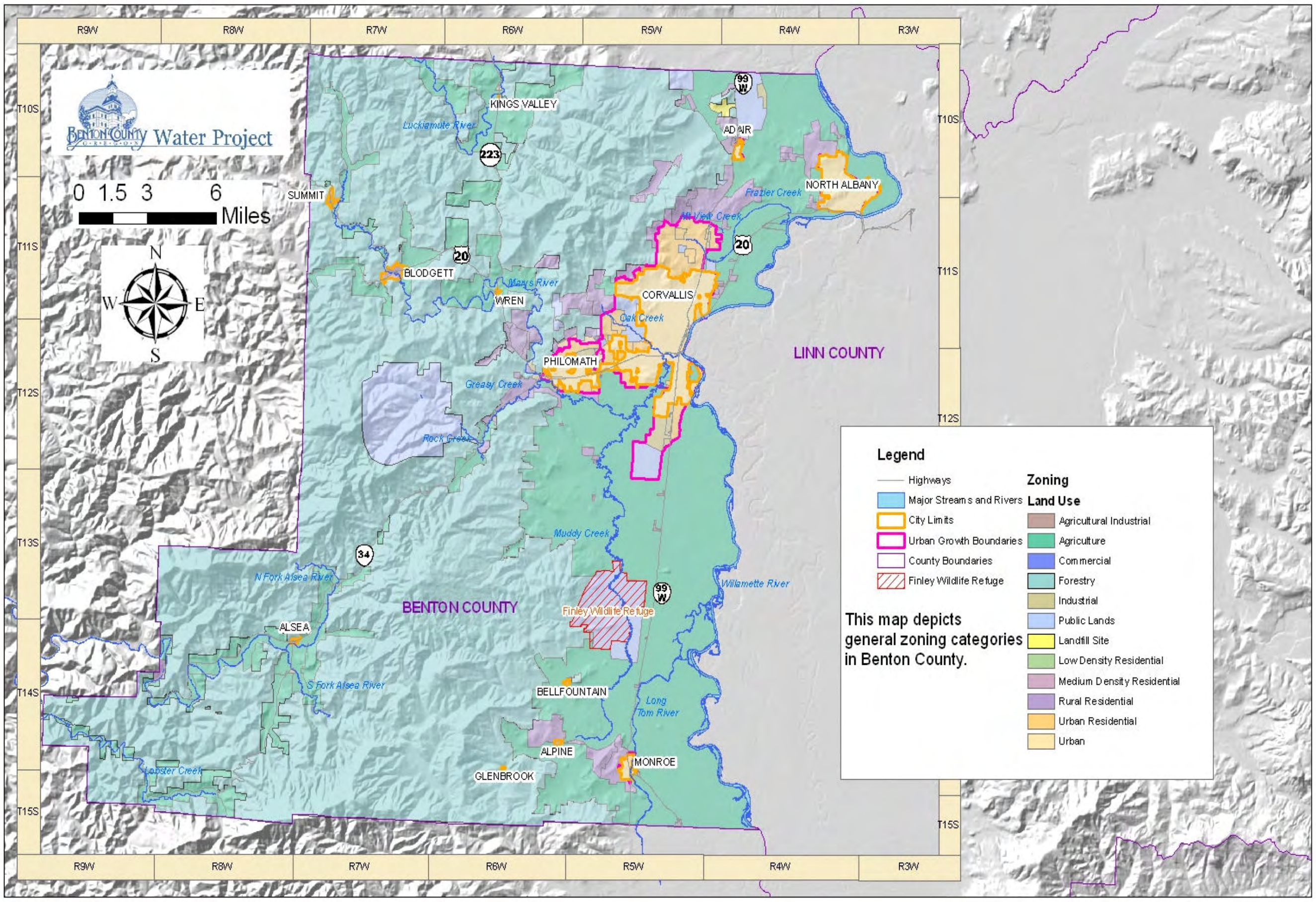
Benton County and the cities have instituted a number of policies within Comprehensive Plans addressing surface water and groundwater (**Appendix A**).

Due to the complexity of the current water resources situation, this baseline countywide assessment of water quality and quantity and the forecast of water demands was needed to evaluate the water quantity and quality issues for use in water planning and future water resources projects within Benton County. The project also provides a template and resource for the Upper Willamette Basin counties, other counties, and communities that are considering or in the process of developing water planning and regional water planning or policy related efforts.

The ‘Benton County *Phase 1* Water Analysis and Demand Forecast’ provides a collaborative baseline assessment, coordinated by Benton County. The complex and interconnected water supply situation calls for current and future stakeholders to work collaboratively towards understanding the water supply situation within and across County boundaries. In *Phase 1*, we have experimented with approaches for involving stakeholders to identify policy and technical issues that need to be considered in the future.

The project demonstrates that county government may be in the best position to convene and coordinate data collection, public outreach and education, and stakeholder collaboration across several political boundaries. The county encompasses many shared watersheds and water sources that all uses and users are dependent upon, calling for a regional approach to water resource assessments and problem solving.

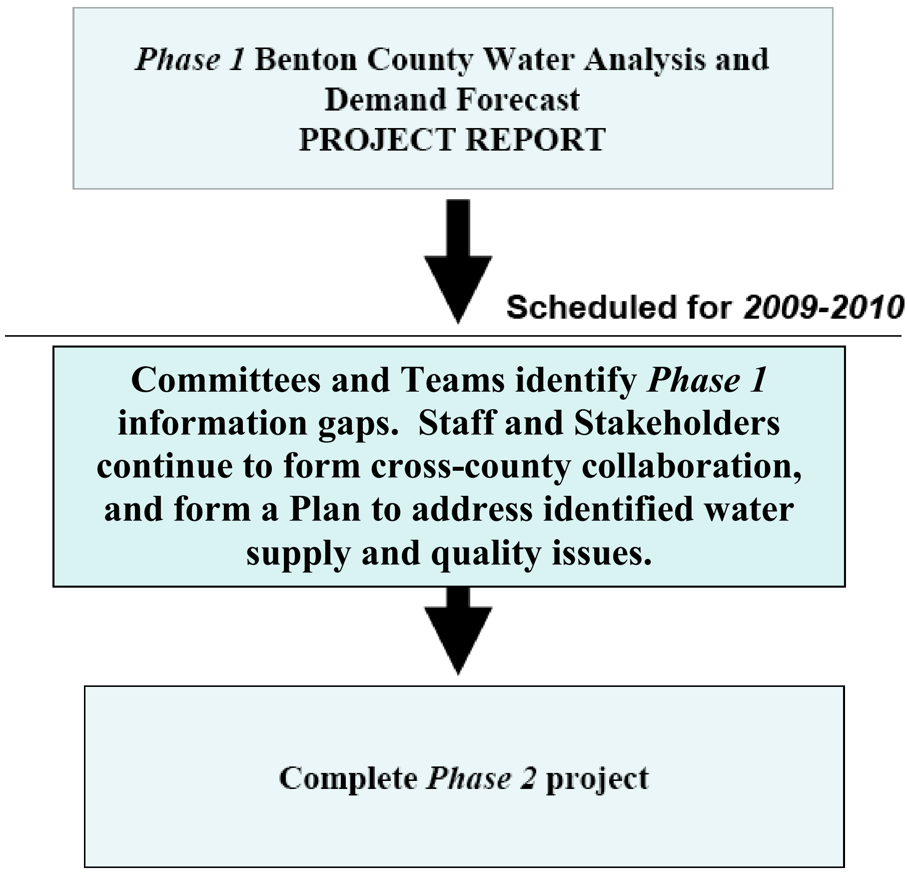
Figure 1 General Land Use Zoning of Benton County Oregon, 2008



Benton County encompasses several cities, large areas of agricultural and forest lands, and rural residential areas. Natural resource lands are vital to county residents to meet current and future natural resource needs. In 2007, the US population census for Benton County totaled 85,300. Approximately 80% of the total population was located within the five incorporated cities: Corvallis, North Albany, Philomath, Adair Village, and Monroe, with the remaining residents dispersed throughout the unincorporated areas of the county. The State of Oregon estimates that by year 2040 there will be a 56 % increase in the population of Benton County (Oregon Office of Economic Analysis, 2007).

1.2 Overview of Approach: Phases I and II

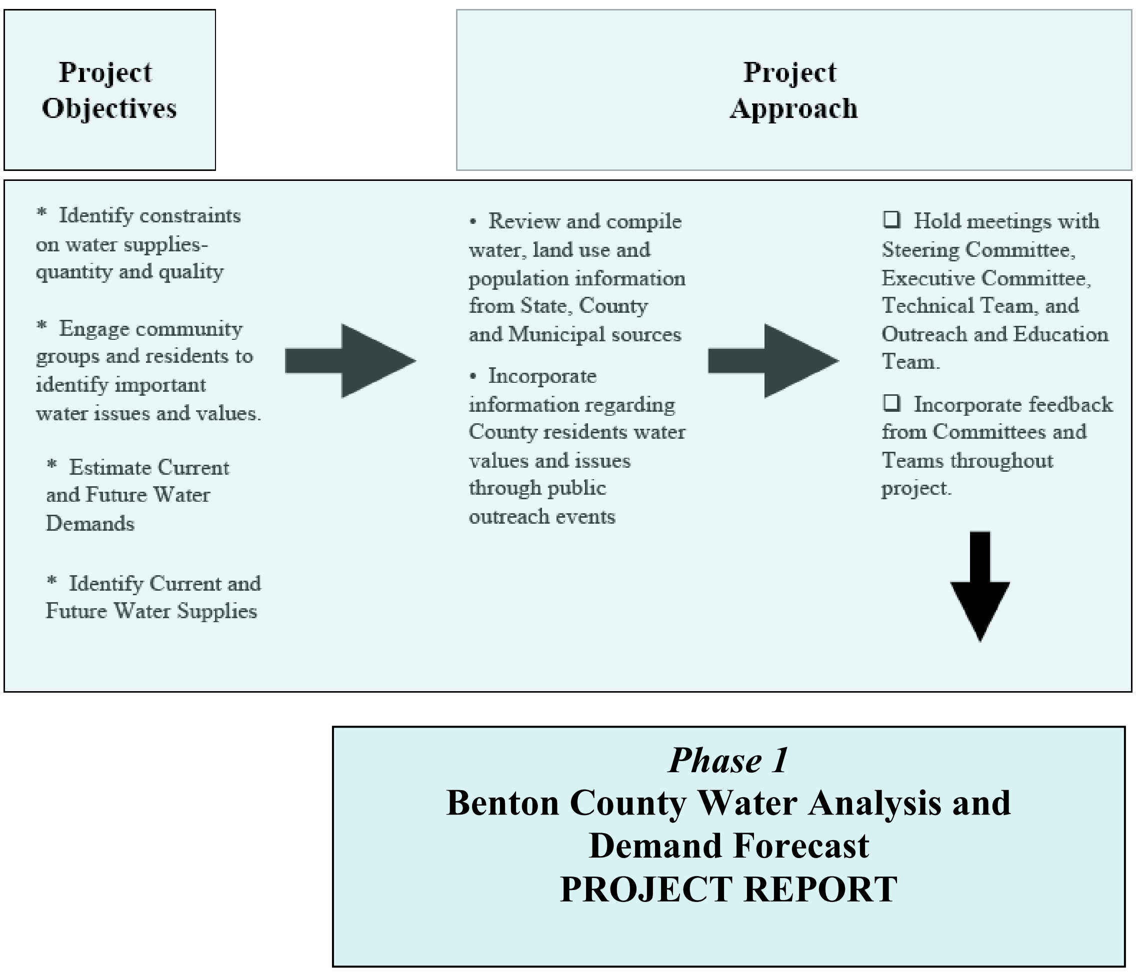
Phase 1 is the first step of a phased project dependent upon the ability to attract resources.



1.3 Project Objectives

The goal of the *Phase 1* Benton County Water Analysis and Demand Forecast was to establish a first step toward assessing and planning for future water resource supplies and demands, including both surface water and groundwater quantity and quality, across Benton County jurisdictions and eventually the Upper Willamette Basin. Benton County expects to build on political structures, outreach and education efforts, and technical data analysis as a catalyst for a *Phase II* process that focuses on facilitating cross-jurisdictional policy and planning for all water uses and users. Focus areas include, but are not limited to:

- Water supply
- Water conservation
- Wastewater
- Water quality



1.4 Scope

The project scope focuses on the assessment of the water resources situation of Benton County through the:

- Formation of the Benton County Water Project Steering Committee, Technical Team, and Outreach and Education Team (**Tables 1-1 through 1-3)** to aid in development and review of technical and outreach work. Participants included members of diverse groups of stakeholders and knowledgeable County and regional residents—often acknowledged experts.
- Public Input: A questionnaire was developed by the Outreach and Education Team and reviewed by the Steering Committee to learn about community issues and values concerning groundwater and surface water. Community meetings were scheduled throughout the county to administer the questionnaire and provide project information. The Benton County Water Project website also provided access to county residents unable to attend meetings. See **Section 6**.
- Compilation of county and regional water quantity and quality information, including existing state and local data to develop a technical assessment focused on countywide demand (use) for surface water and groundwater. See **Section 3**.
- Identification and assessment of the availability of current and future water supplies. See **Section 4**.
- Estimation of current and future surface water and groundwater demands to year 2050 based on documented current ranges of use and population projections See **Section 5**.
- Engaging the services of a local, professional contractor (GSI Water Solutions, Inc.) to work with the County to develop an assessment focused on countywide surface water and groundwater availability and projected demand, including an overview of existing and potential source water quality, quantity, and water rights.

1.5 Contributors

The Oregon Water Resources Department (OWRD) provided grant support through the 2008 Oregon Water Supply and Conservation Initiative (OWSCI) to complete an assessment of Benton County's water supplies and demands. Additional in-kind and cash funding was provided by Benton County, Benton Soil and Water Conservation District (SWCD), Marys River Watershed Council, Oregon State University- Institute for Water and Watersheds, Benton County Extension Service, and other organizations to aid in project outreach, education, and direction.

1.6 Steering Committee and Work Teams

The Benton County *Phase 1* Water Analysis and Demand Forecast project was a collaborative effort among stakeholders across Benton, Lane, and Linn County. The Benton County Board of Commissioners convened the following project committees and teams, to steer and review the 2008 *Phase I*: Benton County Water Analysis and Demand Forecast. (**Tables 1-1 through 1-3**)

Table 1-1 Water Project Steering Committee

Charge: *The steering committee is tasked with providing oversight though project phases, to develop a countywide policy and plan that is applicable and scalable across jurisdictional boundaries within Benton County.*

The steering committee will have an executive team in order to provide direction to project staff and organize direction and advice to the steering committee and work teams during Phase 1 and subsequent project phases.

Name	Affiliation
Bill Currier	Mayor- City of Adair Village
Court Smith*	Oregon State University (OSU) Professor- Anthropology
Dan Sundseth	United States Department of Agriculture- Farm Service Agency
Diane Taniguchi-Dennis	City of Albany- Public Works Director
Denise Kalakay	Lane Council of Governments- Planner; Southern Willamette Valley Groundwater Management Area
Hal Brauner	City of Corvallis- City Councilor
Ken Kenaston	Benton County Planning Commission, Chair
Linda Modrell*	Benton County Commissioner, Chair
Michael Campana*	Director- OSU Institute for Water and Watersheds

* Executive Committee Members

Table 1-2 Water Project Technical Team

Charge: *The technical team is tasked with*

- *Review of contractor(s) and County work deliverables and evaluating data collection methods and the validity of the data and/or estimates.*
- *Identification of information gaps and future information needs and ideas.*
- *Aid in the identification, development, and review of funding proposals.*

Two years is the estimated project duration. Team time commitment will be contingent upon resources.

Name	Affiliation
Christopher Goins	City of Albany; Public Works- Engineering Department
Roger Irvin	Benton County- Public Works Director
Mike McCord	District 16 Water Master- Oregon Water Resources Department
Ron Smith	Benton County Environmental Health Specialist (retired)
Richard Heggen	OSU Institute for Water and Watersheds; Professor Emeritus- University of New Mexico
* Advisory	Mark Taratoot, City of Corvallis- Utilities Division
* Ex Officio Members	Tom Patee, Dennis Nelson- Oregon Drinking Water Program

Table 1-3 Outreach and Education Team

Charge: *It is the vision of the Benton County Commissioners that outreach and education occur throughout the life of the project. The outreach and education team is tasked with*

- *Collection of community values and principles around devising a countywide policy and supply plan and periodically keeping the community up-to-date on the progress of the project.*
- *Development and facilitation of community outreach events throughout Benton County.*

Two years is the estimated project duration. Team time commitment will be contingent upon resources.

Name	Affiliation
Chris Bailey	City of Albany- Water Quality Control Supervisor
Donna Schmitz	Benton Soil and Water Conservation District (SWCD)- Resource Conservationist
Rick Fletcher	Benton County Extension Service- Staff Chair
Karen Fleck Harding	Marys River Watershed Council- Outreach Coordinator; Wren Citizen Advisory Committee member
Megan Kleibacker	OSU- Sea Grant/Watershed Extension
Melissa Fery	Benton County Extension Service- Small Farms
Teresa Matteson	Benton Soil and Water Conservation District (SWCD)- Education and Outreach Coordinator

Section 2
Water Sources

Summary

The surface water bodies in Benton County are located within the Willamette River and the Mid-Coast drainage basins. Gauge data reported by the US Geologic Survey (USGS) for the major rivers shows the highest flows generally occurring during the mid-winter months and the lowest flows being recorded during the late summer months.

Benton County residents receive water from a variety of groundwater and surface water resources. The major water supplies for the incorporated cities within Benton County are surface water. Conversely, unincorporated communities and rural residential land owners use groundwater as their primary source of water (see **Sections 3 through 5**).

2.1 Surface Water Sources

Benton County is approximately 679 square miles in size with Polk County to the north and Lane County to the south. The county's eastern border is the Willamette River and Linn County. At its western border in the Coast Range is Lincoln County. The locations of major surface water bodies within the county are shown in **Figure 2-1**.

Most of the streams within the county are tributaries to the Willamette River that flows to the ocean through the Columbia River. The major streams on the west slope of the Coast Range (e.g. Alsea River) flow directly to the Pacific Ocean. The major streams in the Willamette basin within Benton County include the Willamette, Long Tom, Luckiamute, and Marys rivers, along with Rock and Muddy creeks. The county's major mid-coast drainage basin waterway is the Alsea River.

Two tools were used to obtain information about flows in the major streams within the county.

1) **80 percent exceedance stream flows:** Information describing historic stream flows based on gauges in the rivers and streams was obtained from the U.S. Geological Survey (USGS) Open-File Report 90-118. Following are tables and descriptions of the published historic 80 percent exceedance stream flows. These are the flows expected 80 percent of the time, or eight years out of ten. 80 percent exceedance flow estimates are important as they are a determining factor for the issuance of new year-round water rights by the State. Additionally, the most currently available USGS Water Reports were compiled and included in **Appendix B** for surface water sources that have active USGS stream gauges.
2) **Oregon Water Resources Department's (OWRD) Water Availability Report System** (WARS) web page http://www.wrd.state.or.us/OWEB/PUBS/TollsData.shtml

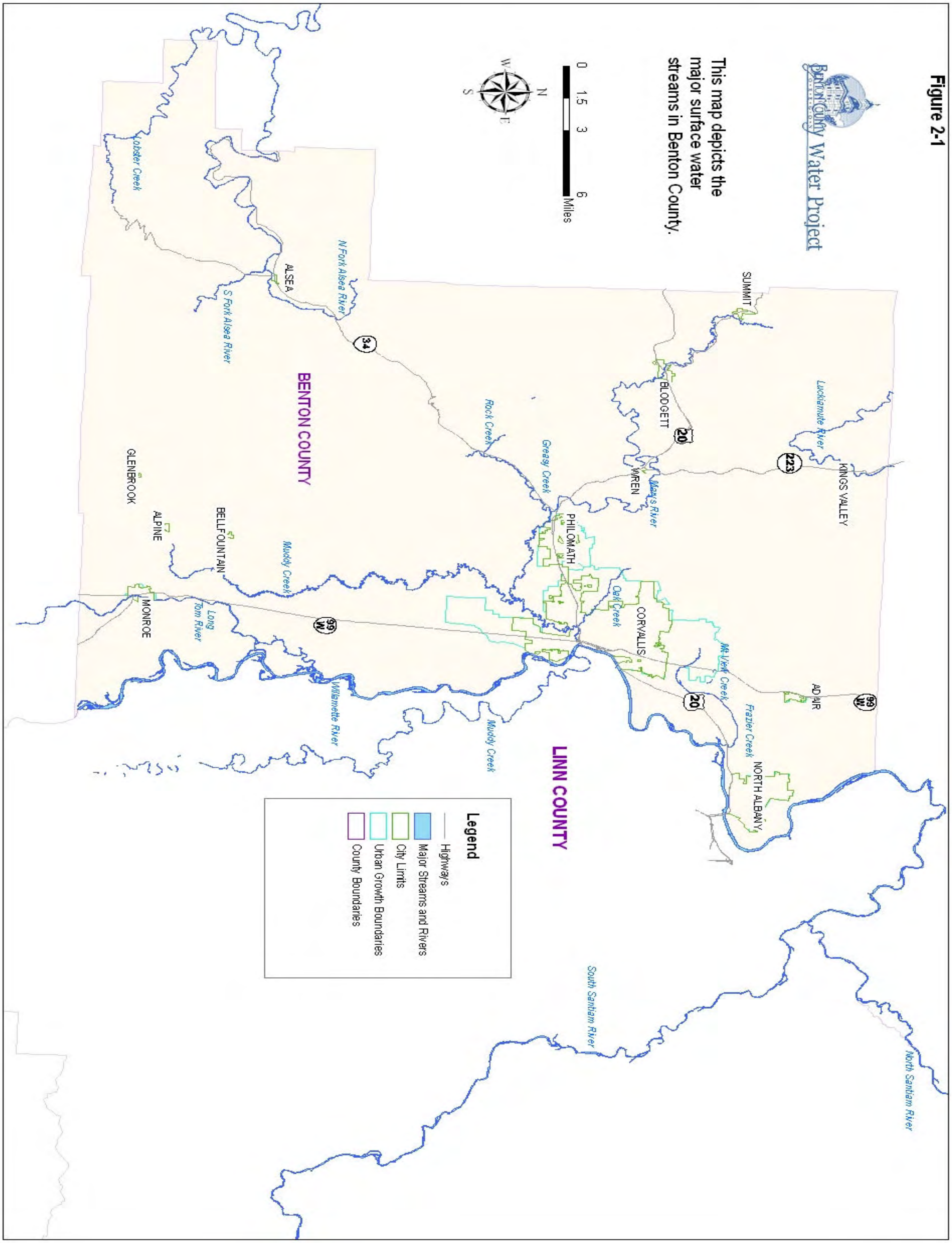


Figure 2-1
Benton County Water Project
This map depicts the major surface water streams in Benton County.
0 1.5 3 6 Miles
N
S
E
W
SUMMIT
KINGS VALLEY
BLODGETT
WREN
PHILOMATH
CORVALLIS
ADAIR
NORTH ALBANY
ALSEA
BELLFOUNTAIN
ALPINE
GLENBROOK
MONROE
BENTON COUNTY
LINN COUNTY
Lobster Creek
N Fork Alsea River
S Fork Alsea River
Luckiamute River
Rock Creek
Greasy Creek
Marys River
Muddy Creek
Oak Creek
Mt View Creek
Frazier Creek
Long Tom River
Willamette River
South Santiam River
North Santiam River
34
20
223
99W
Legend
Highways
Major Streams and Rivers
City Limits
Urban Growth Boundaries
County Boundaries

2.1.1 Willamette River

The Willamette River is a primary source for irrigation and municipal water use in Benton County. It delineates nearly the entire eastern boundary of Benton County between approximate river miles 111 and 158. The Willamette is approximately 187 miles long and flows northward, between the Coast Range and Cascade Mountains into the Columbia River just north of the City of Portland. The watershed's drainage area above (upstream from) Albany is about 4,850 square miles. The discharge of the Willamette River varies seasonally and is regulated by controlled releases of water from upstream dams by the US Army Corps of Engineers. The USGS gauge records at Albany (gauge 14174000) for the years 1942 to 2007 show an average discharge of 14,570 cubic feet per second (cfs) and 10,560,000 acre-feet per year (regulated period) (**Appendix B**). **Table 2-1** lists the 80 percent exceedance flows measured at this gauge from 1969-1987.

To put these flows into context, all the municipal water rights from the Willamette River for use in Benton County authorize a combined maximum rate of diversion of 175 cfs during June. This amount represents approximately 3.5 percent of the river's historic 80 percent exceedance flow during this month.

Table 2-1 Willamette at Albany (1969 to 1987)

Month	80 Percent Exceedance Stream Flow (cfs)
January	12500
February	9230
March	8600
April	7210
May	6790
June	5040
July	4310
August	4910
September	5810
October	7670
November	9030
December	12700

The gauge data shows, not surprisingly, that the highest flows occur during the months of December and January and the lowest flows occur during July and August. The flow during these summer months is approximately 25% of the recorded flows during December and January.

2.1.2 Long Tom River

The Long Tom River begins at the crest of the Coast Range, west of the City of Eugene in Lane County, and flows northward to its confluence with the Willamette River north of the City of Monroe. The Long Tom River has a drainage area of approximately 400 square miles and a stream length of 50 miles. Its flow is regulated by controlled releases of water from Fern Ridge Reservoir south (upstream) of Monroe in Lane County. Information from the Monroe gauge (14170000) from 1942 to 2007 (after completion of Fern Ridge Dam) shows an average discharge over a 66-year period of 767 cfs and 555,900 acre-feet per year.

These recorded stream flows for the Long Tom show a flow pattern similar to that for the Willamette. The highest 80 percent exceedance flows occur in December and January. July and August, again, have the lowest 80 percent exceedance flows, which are 30 cfs for both months. These summer flows are only 8 percent of December flows and 6 percent of January flows.

Table 2-2 Long Tom at Monroe (1942 to 1987)

Month	80% Exceedance Stream Flow (cfs)
January	520
February	262
March	208
April	124
May	81
June	45
July	30
August	30
September	37
October	151
November	178
December	366

2.1.3 Luckiamute River

The Luckiamute River begins in the Coast Range in Polk County and flows east and south into Benton County. The river flows southeast to a location near Hoskins, where it turns north and flows back into Polk County north of Kings Valley. The Luckiamute ultimately flows into the Willamette River about 10 miles north of the City of Albany. Water diverted from the Luckiamute is used primarily for irrigation.

The USGS has a gauge at Pedee (14190000), downstream of where the river flows out of Benton County and back into Polk County. Records from this gauge show that the average flow at that point over a 30-year period was 458 cfs and 331,800 acre-feet per year.

These gauge readings show both the highest flows and the lowest flows occurring slightly later in the year for this unregulated stream. The highest 80 percent exceedance flows are shown to occur in January and February, which are 400 cfs and 430 cfs, respectively. The lowest 80 percent exceedance stream flows historically occur in August and September, which are 17 cfs and 15 cfs, respectively. The lowest months flow is roughly 3.5 percent of the highest months flow.

Table 2-3 Luckiamute River at Pedee (1940 to 1970)

Month	80 Percent Exceedance Stream Flow (cfs)
January	400
February	430
March	323
April	216
May	123
June	66
July	29
August	17
September	15
October	23
November	105
December	344

2.1.4 Marys River

The Marys River provides water to the City of Philomath and to nearby irrigators and industry. Its headwaters are in the Coast Range and it flows southeast until it enters the Willamette River in the southern portion of the City of Corvallis. The Marys River has a drainage area of approximately 300 square miles and is approximately 40 miles in length. The USGS gauge near Philomath (14171000) shows an average flow of 448 cfs and 324,200 acre-feet per year during active USGS gauge years of 1941-1986 and 2001-2007 (see **Appendix B**).

Similar to the Luckiamute, the months with the highest 80 percent exceedance flows are January and February, and the months with the lowest flows are August and September. The lowest 80 percent exceedance stream flow (9.4 cfs) is only slightly over 2 percent of the highest of 413 cfs.

Table 2-4 Marys River near Philomath (1941 to 1986)

Month	80 Percent Exceedance Stream Flow (cfs)
January	376
February	413
March	330
April	216
May	117
June	58
July	21
August	11
September	9.4
October	15
November	55
December	283

2.1.5 Muddy Creek

Muddy Creek flows north, running parallel to the Long Tom River, and enters the Marys River just south of the City of Corvallis. Water is diverted from Muddy Creek during the summer months for irrigation. The USGS does not have a gauge on Muddy Creek.

OWRD has, however, modeled the stream flows at a point on Muddy Creek upstream of Evergreen Creek, a little over a mile south of the Muddy Creek confluence with the Marys River. At that point, OWRD estimates the natural stream flow at 80 percent exceedance to range from a high of 191 cfs in February to a low of 6.1 cfs in September (3.2% of highest flows). Above that point, the river has a drainage area of 109 square miles and a length of 121 miles.

Table 2-5 Muddy Creek above Evergreen Creek

Month	80 Percent Exceedance Modeled Natural Stream Flows (cfs)
January	168
February	191
March	166
April	88
May	51
June	27
July	13.90
August	8.30
September	6.10
October	7.10
November	19.20
December	118

2.1.6 Alsea River

The Alsea River is Benton County's major waterway in the Mid-Coast drainage basin. The river provides water for fish hatcheries and irrigation. The Alsea begins in the Coast Range and flows west-northwest into Alsea Bay and the Pacific Ocean, with a drainage area of 391 square miles. The USGS reports Alsea River gauge data only at Tidewater (river mile 21) in Lincoln County showing an average flow of 1,463 cfs and 1,060,000 acre-feet per year between 1940 and 2007 (**Appendix B**).

The historic gauge data shows that the highest 80 percent exceedance flows are again seen during the months of January and February and the lowest flows are recorded during August and September. The 77 cfs lowest flow is 6.5 percent of the 1380 cfs highest flow.

Table 2-6 Alsea River at Tidewater (1939 to 1987)

Month	80 Percent Exceedance Stream Flow (cfs)
January	1240
February	1380
March	1150
April	757
May	444
June	251
July	137
August	89
September	77
October	99
November	325
December	1080

2.1.7 Rock Creek

Rock Creek is a tributary to the Marys River. Flows for Rock Creek are included because it is the secondary source of municipal water for the City of Corvallis. Its headwaters are located within the Coast Range on forest land managed by USFS and the City of Corvallis. Rock Creek flows southwest until it enters Greasy Creek, which flows into the Marys River just outside the southwest city limits of the City of Philomath. Rock Creek has a drainage area of approximately 14.6 square miles. The USGS gauge near Philomath (17090003) shows an average flow of 51.6 cfs and 37,090 acre-feet per year during the period of 1946-1979. The months with the highest 80 percent exceedance flows are February and March, and the months with the lowest are August and September. The .5 cfs lowest flow is 1% of the 47 cfs highest flow.

Table 2-7 Rock Creek near Philomath (1946-1979)

Month	80 Percent Exceedance Stream Flow (cfs)
January	26
February	47
March	46
April	25
May	14
June	5.6
July	2.5
August	0.6
September	0.5
October	1.3
November	5.2
December	36

2.2 Groundwater Sources

Much of the information presented describes the subsurface geology because the properties of the rocks and sediments in the subsurface control groundwater yield to wells as well as natural water quality. The geologic formations are grouped by water bearing zones of similar characteristics called 'principal hydrogeologic units'. The information is based primarily on studies conducted by the US Geological Survey (USGS), Oregon Water Resources Department (OWRD), and Oregon Department of Environmental Quality (DEQ). Additional information was obtained from well records, hydrogeologic reports, and individual well owners.

2.2.1 Overview of Groundwater Conditions

The geology of Benton County is diverse and groundwater availability and quality varies depending on location. **Figure 2-2**. This figure is helpful in describing the hydrogeology because it illustrates the land surface features (topography, cities and rivers) and subsurface geology that controls groundwater supplies.

The easterly low-lying portions of the county are near the Willamette River and are part of the Willamette's alluvial plain. The elevations of this relatively flat area lie between approximately 200 and 300 feet. Land in this region is occupied by irrigated and non-irrigated farms, rural residences, and portions of the cities of Corvallis, Monroe, and North Albany. Wells in this area produce groundwater from alluvial sediments at depths generally fewer than 100 feet below land surface.

The western two-thirds of the county are comprised of the foothills and mountains of the Coast Range. The geology and groundwater conditions in this area are very different from the low-lying valley sediments. Most of the groundwater in this region of the county occurs in volcanic rocks and consolidated marine rocks. Several small communities (Alsea, Summit, Blodgett, Kings Valley, and Wren), ranches and farms are located in alluvial valleys within in this area. Groundwater is the primary source of water to homes and ranches. Because much of the western county is typified by agricultural or forest land, there are limited opportunities for residential or commercial developments.

The groundwater sources in Benton County are described as four principal hydrogeologic units based on the geology of the area. These hydrogeologic units are shown on the map in **Figure 2-3** and are comprised of:

- Younger Alluvium (QYAL)
- Older Alluvium (QOAL)
- Marine siltstone and sandstone (TSS)
- Volcanic Rocks (TSR)
- Intrusive igneous rock (TI) – limited in extent; provides local sources of construction rock - not important as a groundwater supply and not discussed further in this report.

The general properties of these hydrogeologic units, including typical well yields and water quality, follow.

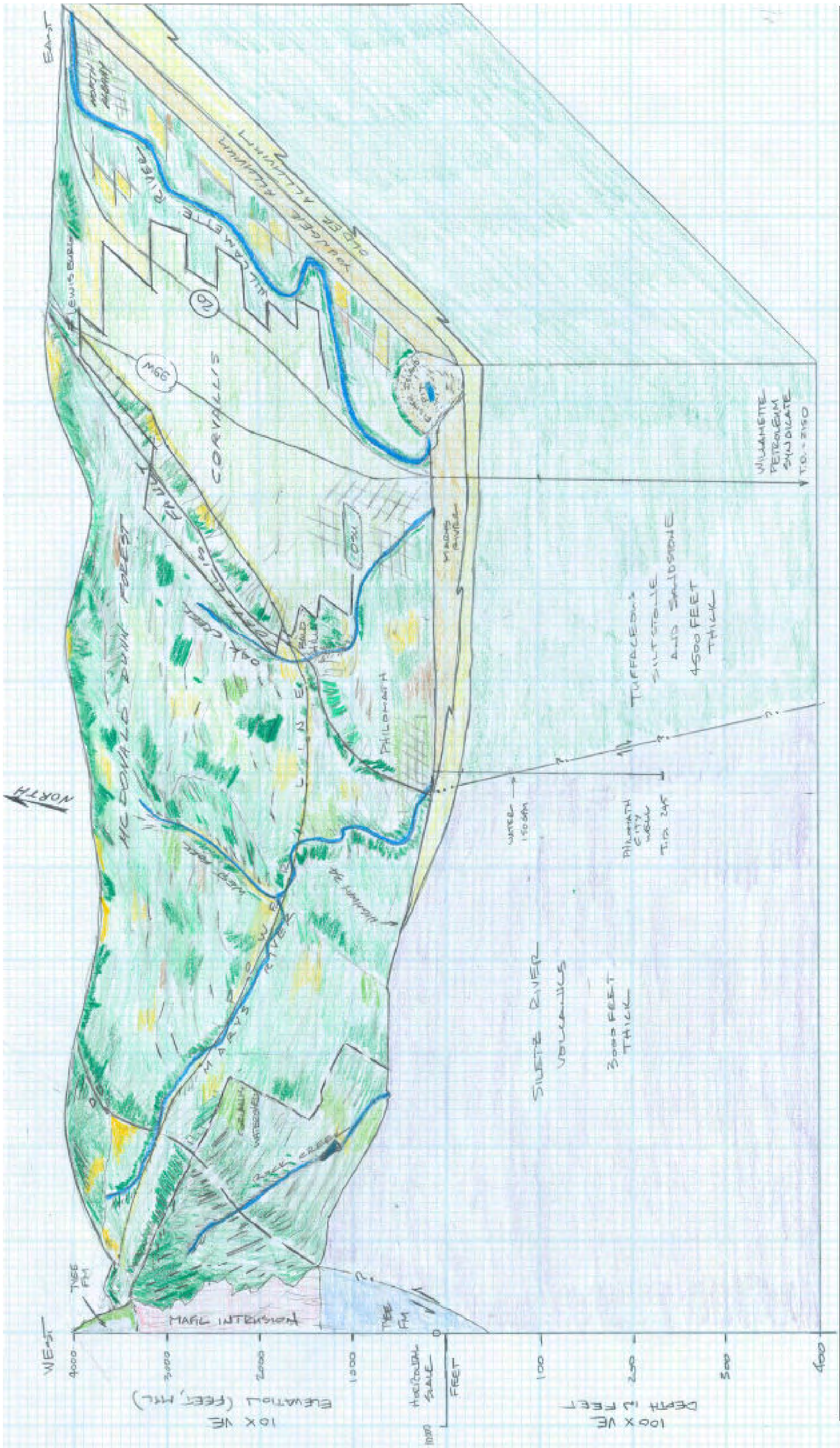


Figure 2-2 Benton County Conceptual Hydrogeology Diagram. Courtesy of Dr. Todd Jarvis, OSU- Institute for Water and Watersheds

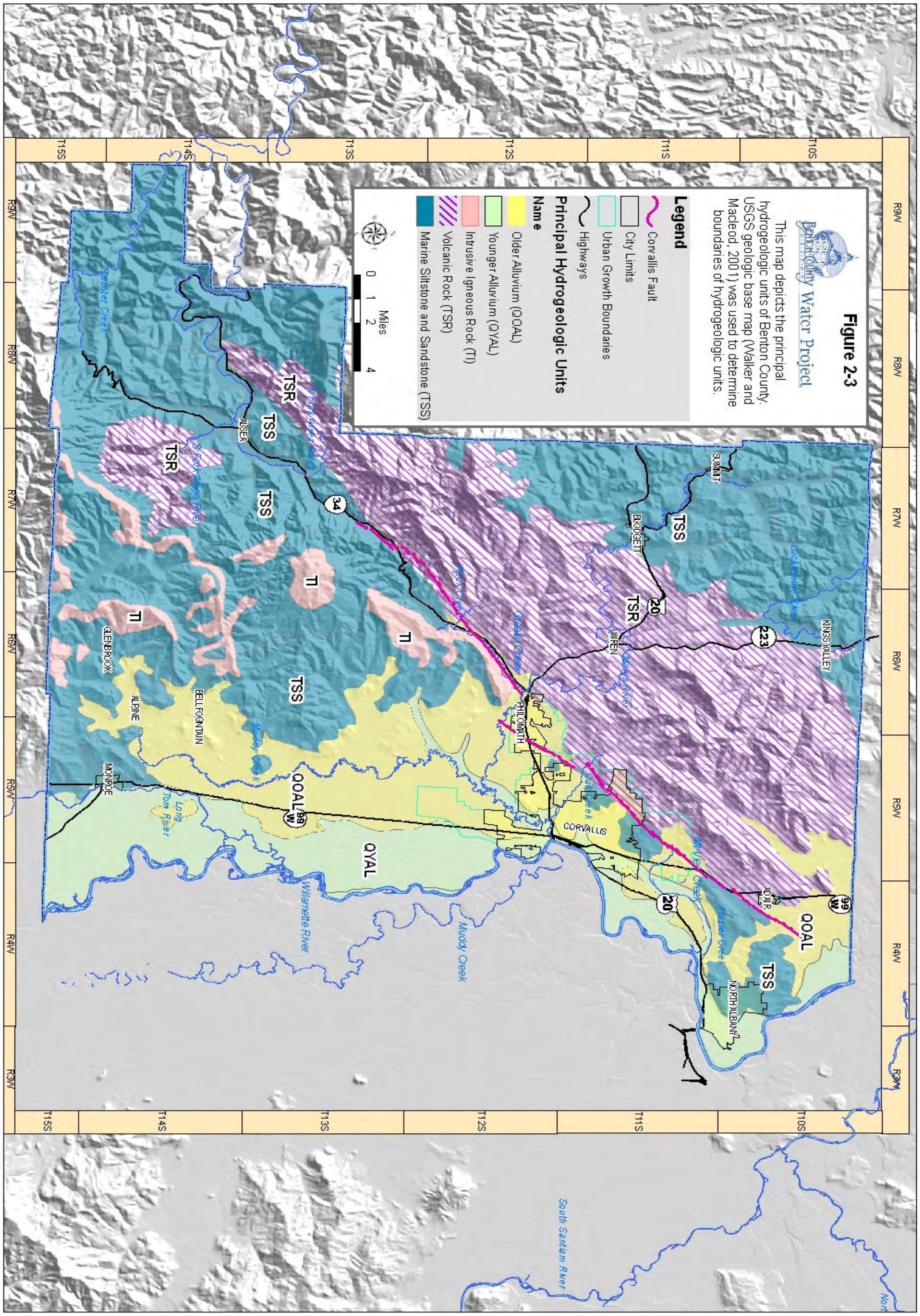


Figure 2-3
Benton County Water Project
This map depicts the principal hydrogeologic units of Benton County. USGS geologic base map (Walker and Macleod, 2001) was used to determine boundaries of hydrogeologic units.
Legend
Corvallis Fault
City Limits
Urban Growth Boundaries
Highways
Principal Hydrogeologic Units
Name
Older Alluvium (QOAL)
Younger Alluvium (QYAL)
Intrusive Igneous Rock (TI)
Volcanic Rock (TSR)
Marine Siltstone and Sandstone (TSS)
Miles
0 1 2 4
CORVALLIS
PHILOMATH
NORTH ALBANY
MONROE
ALPINE
BELLFOUNTAIN
GLENBROOK
KINGS VALLEY
BLODGETT
SUMMIT
Willamette River
South Santiam River

2.2.2 Younger Alluvium (QYAL)

The highest-yielding wells in Benton County are found in the shallow sand and gravel aquifers that comprise the younger alluvium. This hydrogeologic unit was deposited by the Willamette River and its major tributaries as the channels meandered over time in the valleys. These sediments form an unconfined aquifer (volume of stored water changes according to seasonal cycles) with a variable thickness up to 100 feet; however, the more typical thickness is fewer than 40 feet (Frank, 1974).

The greatest lateral extent of younger alluvium in Benton County generally occurs from Corvallis to Monroe between the Willamette River and Highway 99W (**Figure 2-3**). In this area, the alluvium provides large quantities of groundwater for agricultural use and is the primary domestic supply for rural residents. Deposits of younger alluvium are also found along Highway 20 between Corvallis and Albany.

Recharge to the young alluvium occurs seasonally by direct infiltration of precipitation, irrigation return, and bank storage in the area immediately adjacent to the rivers. Recharge also occurs year-round by regional groundwater flow from the Coast Range foothills as groundwater moves toward the Willamette River and its major tributaries.

Water Quantity

The coarse texture of the geologic materials is highly permeable, resulting in well yields of several hundreds of gallons per minute depending upon site-specific geologic conditions and well construction. Portions of this aquifer near the Willamette and other major rivers are in direct hydraulic connection with the surface water. High yield wells of 500 to 1000 gallons per minute (gpm) may be found in gravel zones during high streamflow periods. Development of groundwater supplies in direct connection with surface water, however, may be restricted by OWRD based on the availability of surface water in the adjacent rivers and streams (see **Section 4** for more details on groundwater restrictions).

Water Quality

The quality of the groundwater in the younger alluvium zone has been impacted by human activities because of the shallow depth to groundwater and lack of a continuous overlying confining unit, Oregon Department of Environmental Quality has designated much of this aquifer as the Southern Willamette Valley Groundwater Management Area (GWMA) spanning Benton, Linn, and Lane counties. The boundaries of the GWMA (**Figure 2-4)** align with the distribution of the Younger Alluvium in Benton County. This designation was based upon areas with a 15 percent or greater frequency of nitrate values exceeding 7 milligrams per liter (mg/l).

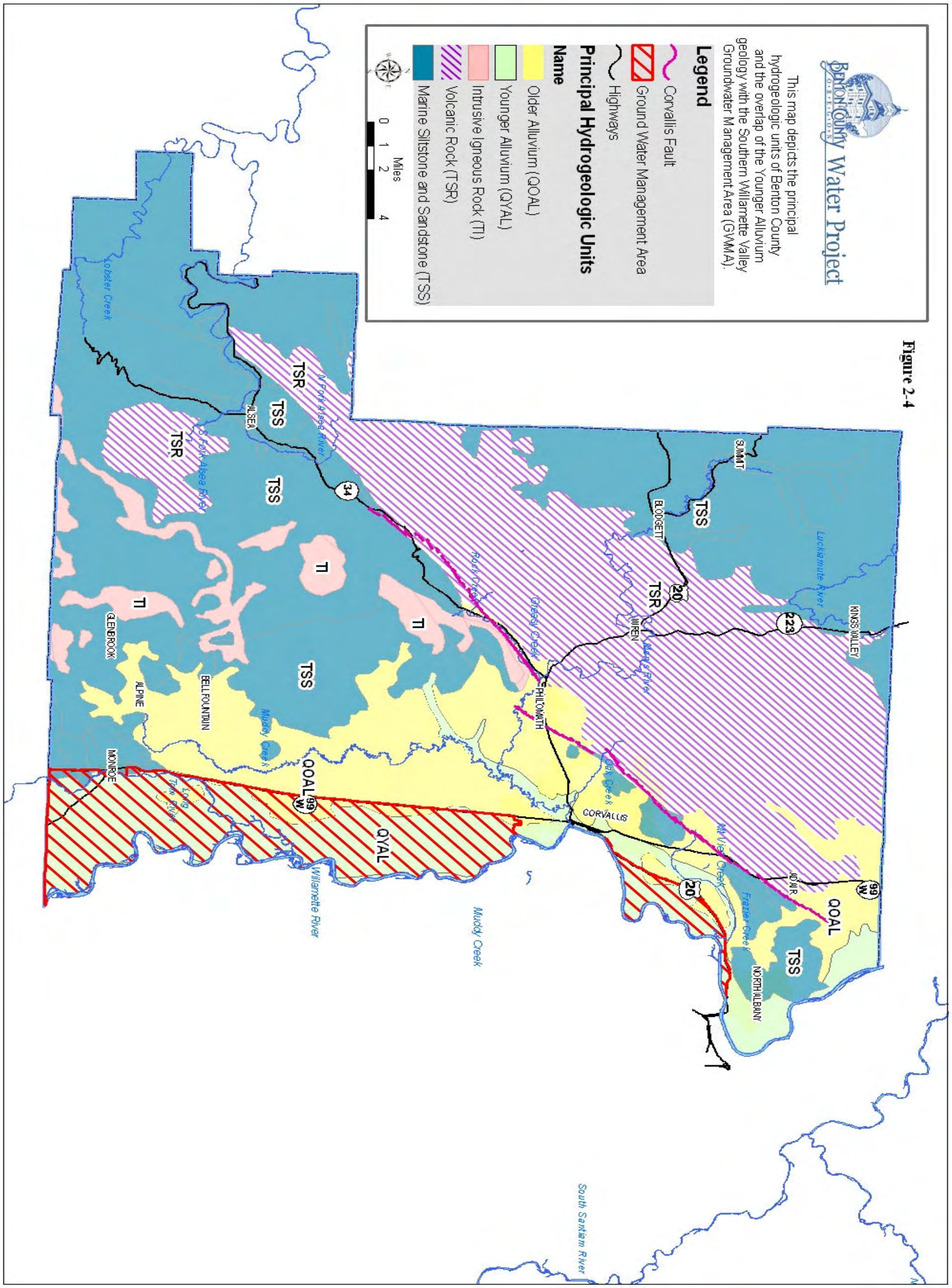

Benton County Water Project
This map depicts the principal hydrogeologic units of Benton County and the overlap of the Younger Alluvium geology with the Southern Willamette Valley Groundwater Management Area (GWMA).
Legend
Corvallis Fault
Ground Water Management Area
Highways
Principal Hydrogeologic Units
Name
Older Alluvium (QOAL)
Younger Alluvium (QYAL)
Intrusive Igneous Rock (TI)
Volcanic Rock (TSR)
Marine Siltstone and Sandstone (TSS)
Miles
0 1 2 4
TSR
TSS
TI
QOAL
QYAL
ALSEA
SUMMIT
BLODGETT
KINGS VALLEY
WREN
PHILOMATH
CORVALLIS
ADAIR
NORTH ALBANY
BELLFOUNTAIN
ALPINE
GLENBROOK
MONROE
34
20
223
99W
Willamette River
Muddy Creek
South Santiam River
Luckiamute River
N Fork Alsea River
S Fork Alsea River
Lobster Creek
Rock Creek
Frazier Creek
Long Tom River

Figure 2-4

2.2.3 Older Alluvium (QOAL)

The older alluvium in Benton County generally underlies the younger alluvium near the middle of the Willamette Valley and is exposed at the land surface several miles away from the river. The older alluvium was deposited over thousands of years by streams and rivers draining the Coast Range and Cascades Range. These alluvial materials were deposited directly over the eroded bedrock surface of marine siltstones and sandstones that underlie the valley floor.

The uneven surface of the bedrock causes the thickness of this unit to vary considerably within relatively short distances. The upper portion of the older alluvium is composed of the Willamette Silt. This is the dark brown, clay-like material that mantles much of the valley floor. The Willamette Silt yields little water to wells and is not a viable water bearing unit. The deposits underlying the Willamette Silt consist of unconsolidated to semi-consolidated deposits of silt, sand and gravel.

Water Quantity

The older alluvium deposits are highly variable in texture and prediction of water yield is difficult without site-specific drilling. In general, the sediments of the older alluvium yield much less water than the younger alluvium because of their finer grain size, greater degree of consolidation, and the occurrence of clay and iron oxides in the matrix between the sands and gravels.

This unit may be suitable for residential or small farm use. Well yields up to 10 gpm can be expected, however agricultural water wells in the older alluvium have experienced water loss and there has been a shift to non-irrigated crops or use of surface water (pers. comms. Dan Sundseth, USDA- Farm Service Agency).

Water Quality

The water quality produced from older alluvium deposits is suitable for most uses. However, high concentrations of iron and manganese may be expected depending on local conditions.

2.2.4 Marine Sedimentary Rocks (TSS)

Marine sedimentary rocks comprise much of the land surface in the Coast Range foothills south of Philomath and also form the small hills and ridges extending north from Corvallis toward North Albany. Logsdon Ridge and elevated potions in North Albany are formed by these marine sediments. As illustrated in **Figure 2-3**, marine sediments also comprise extensive portions of the Coast Range in the western part of the county.

This hydrogeologic unit is composed of two primary geologic formations known as the Tyee and Spencer formations. Because these formations are similar in age, depositional origin and hydrologic properties, they are described as a single hydrogeologic unit for the purposes of this report.

The rocks that comprise the marine sedimentary rocks are typically fine-grained sandstone, siltstones and shale. The marine sedimentary rocks are especially important because they are a water bearing zone near the population centers of North Albany, Adair Village, Corvallis, Philomath and Monroe, where additional development outside the Urban Growth Boundary (UGB) may occur (see **Section 5 Future Demands**).

Water Quantity

The marine siltstones generally yield small quantities of water to wells. Well yields sufficient for domestic use may be obtained (up to 10 gpm), but higher yields suitable for agriculture or multiple domestic connections are unlikely.

Water Quality

Natural water quality in the marine siltstones may be poor due to the low permeability that limits fresh water recharge to this marine formation. This is especially true in deeper portions of this unit where saline water may be encountered. The best opportunity for good quality water from the Marine Siltstones is from relatively shallow wells (generally fewer than 100 feet) where recharge from surface infiltration may occur. In general terms, the deeper water is older water and will contain higher concentrations of dissolved minerals that are present in this marine formation.

2.2.5 Siletz River Volcanics (TSR)

The Siletz River Volcanics form the ridges and mountains of most of central Benton County and are separated from the alluvium and marine formations by the Corvallis fault (**Figure 2-3**). This unit is a critical water supply because it is the aquifer that underlies many subdivisions and single family homes in the uplands and foothills outside of the Urban Growth Boundaries (UGBs) of Corvallis and Philomath. For example, groundwater from the Siletz River Volcanics is the only source of water to residents in the Vineyard Mountain-Lewisburg area, portions of Soap Creek, Oak Creek (outside the Corvallis UGB), and Marys River Estates and Wren Hill Estates near Philomath. Additionally, this aquifer provides water to rural residents, farms and ranches in portions of Kings Valley.

The volcanics consist of thick sequences of pillow lavas and basalt flows with discontinuous interbeds of tuffaceous siltstone and shale. This geology tends to form multiple layers of permeable zones that may be laterally discontinuous. Recharge occurs by infiltration of precipitation to the permeable zones in the volcanic sequence.

Water Quantity

In general, these volcanic rocks are a highly reliable water supply for domestic purposes with typical yields between 10 to 20 gpm. Higher yields up to 50+ gpm may be achieved by drilling wells several hundred feet deep that penetrate multiple water bearing zones. These larger yield wells are suitable for community systems (e.g. Ridgewood Improvement District).

The main concern with this groundwater supply is over-development of the aquifers and well spacing. Volcanics typically have high permeability and low storage capacity. The consequence is that well yields are favorable, but mutual interference between or among wells occurs more readily than in a sand or gravel aquifer.

Water Quality

Water quality in the Siletz Volcanics is generally very good. Some areas contain high concentrations of iron; however, this is does not present a drinking water concern and levels are significantly less than that found in the marine siltstones or older alluvial units.

2.3 Water Sources for Communities

There are five incorporated cities (municipalities) and ten non-municipal communities (e.g. community water districts) within Benton County, using surface water, groundwater, or a combination of these sources to supply the community service area see **Figure 2-5**. The *Phase 1* project focused on current State of Oregon Drinking Water Program defined community water systems **-** a water system which has at least 15 service connections or which supplies drinking water to 25 or more of the same people year-round in their residences (e.g. cities, water districts, rural subdivisions).

Focus was placed on assessing these community water systems because:

1. Municipal communities (cities) are where the highest populations are located relative to the rest of the county and are likely to be the areas of increased growth into the future relative to the rest of the county (see **Section 5 Future Water Demands**).
2. Non-municipal communities provide data representative of rural groundwater use across a range of lot sizes, property values and geographic locations within the county.

2.3.1 City Water Sources

Current water rights and water sources for municipalities within Benton County are shown in **Table 2-8.** The following sections describe these water rights and associated water supplies, specific to each city within Benton County.

Figure 2-5

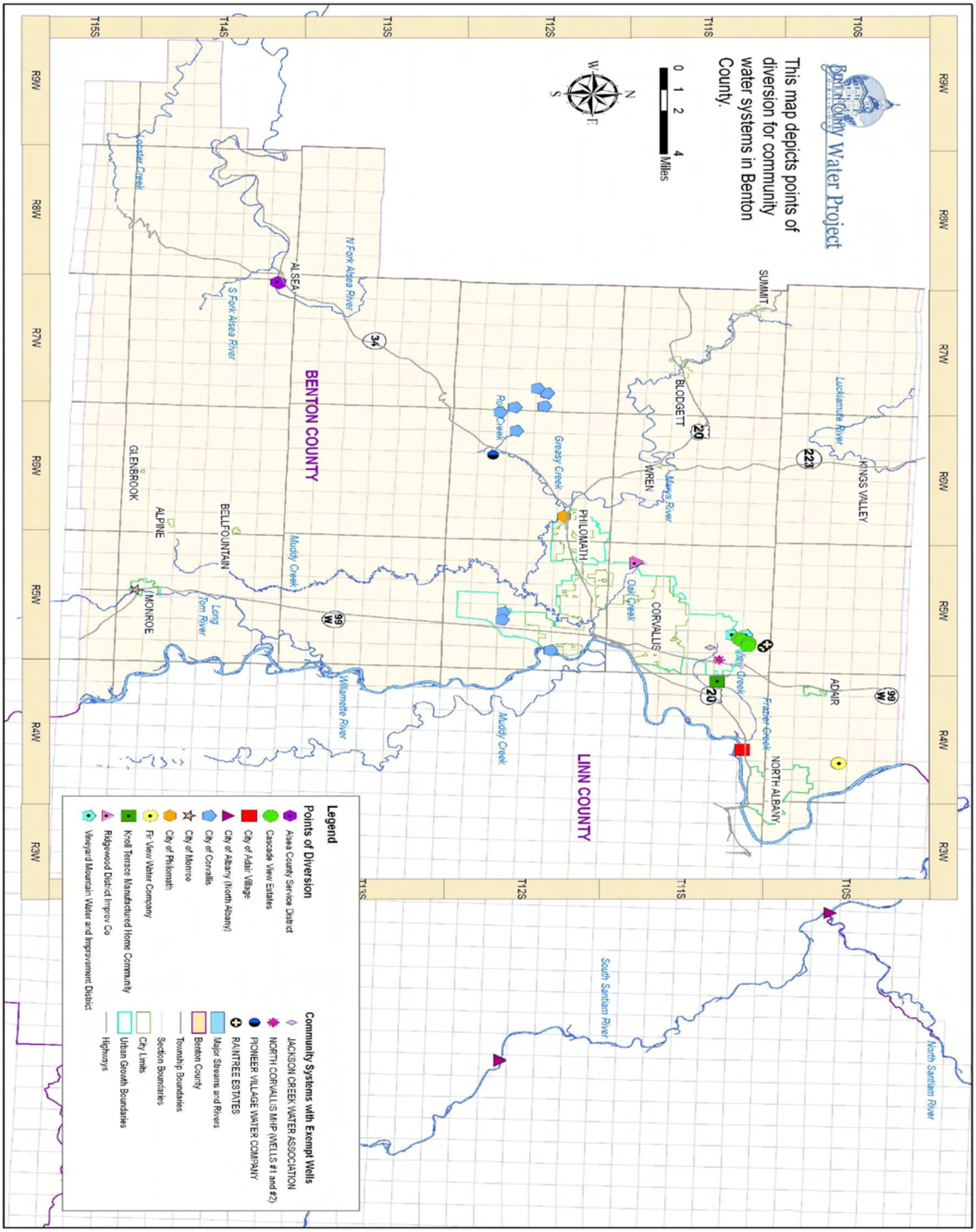

Benton County Water Project
This map depicts points of diversion for community water systems in Benton County.
0 1 2 4 Miles
N
E
S
W
BENTON COUNTY
LINN COUNTY
SUMMIT
ALSEA
BLODGETT
WREN
KINGS VALLEY
PHILOMATH
CORVALLIS
ADAIR
NORTH ALBANY
GLENBROOK
ALPINE
BELLFOUNTAIN
MONROE
Luckiamute River
Marys River
Greasy Creek
Rock Creek
N Fork Alsea River
S Fork Alsea River
Lobster Creek
Muddy Creek
Oak Creek
Long Tom River
Willamette River
Jackson Creek
Frazier Creek
South Santiam River
North Santiam River
T10S
T11S
T12S
T13S
T14S
T15S
R9W
R8W
R7W
R6W
R5W
R4W
R3W
Legend
Points of Diversion
Alsea County Service District
Cascade View Estates
City of Adair Village
City of Albany (North Albany)
City of Corvallis
City of Monroe
City of Philomath
Fir View Water Company
Knoll Terrace Manufactured Home Community
Ridgewood District Improv Co
Vineyard Mountain Water and Improvement District
Community Systems with Exempt Wells
JACKSON CREEK WATER ASSOCIATION
NORTH CORVALLIS MHP (WELLS #1 and #2)
PIONEER VILLAGE WATER COMPANY
RAINTREE ESTATES
Major Streams and Rivers
Benton County
Township Boundaries
Section Boundaries
City Limits
Urban Growth Boundaries
Highways

Table 2-8 Municipal Community Water Rights -- Benton County (2008)

City	Maximum Authorized Rate-cfs (mgd) [1]	Source Name(s) [1]	Certificate # [1]	Permit # [1]
City of Adair Village	3.0 (1.9)	Willamette River	15077	
City of Adair Village* (assigned by City of Albany)	82.0 (53)	Willamette River		S35819
City of Albany (North Albany)	21 (13.6)	South Santiam, Santiam Rivers	49386	
City of Albany (North Albany)	29 (18.8)	South Santiam, Santiam Rivers		S44388
City of Corvallis (Willamette River)	25.0 (16.2)	Willamette River	59051	
City of Corvallis (Willamette River)	16.25 (42.0)	Willamette River		S 35551
City of Corvallis (wells)*	0.13 (0.08)	Well #1	37061	
City of Corvallis (wells)*	0.46 (0.30)	Wells #2, #3, #4		GR- 272
City of Corvallis (Rock Creek Watershed)*	7.43 (4.81)	South Fork Rock Creek, North Fork Rock Creek, Griffith Creek	37061; 24694; 50182; 33340; 2356; 3245;	
City of Monroe*	0.78 (0.50)	Long Tom River		S54261
City of Monroe (wells)	0.20 (0.13)	Well #1	43629	
City of Monroe (wells)*	0.63 (0.41)	Well #2, #3		G4184; G10890; G13575
City of Philomath**	0.78 (0.5)	City of Corvallis (Rock Creek)	**	**
City of Philomath	3.5 (2.27)	Marys River		S49245
City of Philomath	1.0 (0.65)	Marys River		S13556
City of Philomath *	1.0 (0.65)	Marys River	48112	
City of Philomath *	0.19 (0.12)	Marys River	33572	
City of Philomath (well)	0.78 (0.51)	11th Street Well	62441	

*** = Secondary and/or unused water source**
**** = Corvallis-Philomath water supply line inter-tie**
1. Oregon Water Resources Department (OWRD)- Water Rights Information System (2008)

City of Adair Village

The City of Adair Village is located in northeast Benton County. The City of Albany reassigned to Adair Village the county's largest water right for municipal purposes (Permit S-35819) which authorizes the use of up to 85.0 cfs (54.9 MGD). This large water permit is due to the larger population of Camp Adair during World War II (~50,000 people). Adair Village currently holds a certificate to use 3.0 cfs (1.9 MGD) of water from the Willamette River. The point of diversion for this water right (**Figure 2-5**) is located in Benton County's Hyak Park. Raw water is piped several miles to the city's water treatment plant located on the eastern side of the city limits.

City of Albany (North Albany)

The majority of the City of Albany is in Linn County and is located on the east side of the Willamette River. The City of Albany, however, provides the water supply across the Willamette River to residents of North Albany, which is within Albany's city limits but located in Benton County. The City also supplies water to the North Albany County Service District (NACSD) and Dumbeck Water Company.

Albany holds two water rights for municipal purposes (Permit S-44388 and Certificate 49386), which authorize use of up to a total of 50 cfs (32.4 MGD). The South Santiam River is the source for both water rights (**Figure 2-5**). The City is allowed to withdraw water at either the Santiam-Albany Canal diversion point above Lebanon on the South Santiam River or at the confluence of the North Santiam and South Santiam rivers, where the jointly-owned City of Albany and City of Millersburg water treatment plant is located.

The South Santiam River is not located in Benton County and, accordingly, is not included in the description of Benton County water sources. Nonetheless, the South Santiam provides water for municipal use within Benton County. Its headwaters begin high in the Cascades in eastern Linn County. The South Santiam drains approximately 1,040 square miles and runs generally east to west. The Middle Santiam joins the South Santiam at Foster Lake, which is impounded by Foster Dam. Further upstream on the Middle Santiam River, Green Peter Dam creates Green Peter Lake. The South and North Santiam Rivers converge to form the mainstem of the Santiam River approximately eight miles northeast of the City of Albany. The Santiam River then flows approximately 10 miles to the Willamette River.

Flows on the South Santiam have been regulated since 1966 by Green Peter and Foster dams. The U.S. Geological Survey (USGS) has a gauge on the South Santiam at Waterloo, which is downstream from both dams. Flows measured at the gauge since 1967 range from a minimum flow of 470 cfs in July 1967 to a maximum of 12,900 cfs in December 1978. The USGS reports the flow recorded 80 percent of the time is 3200 cfs in January and 595 cfs in July.

The South Santiam River water is delivered to Albany's Vine Street Water Treatment Plant via the Santiam-Albany Canal (Canal). The Canal originates around South Santiam River mile 29 and travels approximately 18 miles through the cities of Lebanon and Albany and unincorporated portions of Linn County before reaching the Vine Street Water Treatment Plant.

City of Corvallis

Corvallis is the largest water provider in Benton County. There are two primary surface water sources for the City - Rock Creek (including Rock and Griffith Creeks) and the Willamette River. The water production facilities for the city consist of two water treatment plants (WTP), relying on surface water sources (**Table 2-8**). The Rock Creek WTP takes water from three intakes located on the east side of Marys Peak. These intakes include the North and South Forks of Rock Creek as well as Griffith Creek. The Taylor WTP is located in southeast Corvallis and draws water directly from the Willamette River. The Willamette is currently the city's primary source of water.

The City of Corvallis also holds groundwater rights for five wells. These wells are located at the Corvallis Municipal Airport south of town. The City has not used them since 1986 when the water distribution system was extended to the airport. The City does not anticipate using these wells in the future due to water quality concerns. Within the Corvallis Urban Growth Boundary, it is very common for wells to have high levels of iron and manganese, resulting in poor drinking water quality and requiring expensive treatment.

City of Monroe

Monroe is the smallest city within Benton County, and is located in the southeast corner of the county. Monroe currently holds water rights for groundwater and surface water sources.

Groundwater from Well No.1 (Certificate 43629) is the primary source for water according the City's 2008 Water Conservation and Management Plan.

Well No. 2 (see **Table 2-8**) has poor quality water and is only used in an emergency.

Well No. 3 was added in 2002, but was never connected to the water system due to high total dissolved solids of approximately 2400 parts per million (ppm).

Historically, the city used water from Kyle Springs and Belknap Springs, but use of these water rights was discontinued due to the poor condition of the raw water line to the city. It is considered not cost effective to replace the water line due the low quantity of water supplied by the springs, and for these reasons the associated water rights for these spring water sources are not discussed in this report.

On May 25, 2006, the City of Monroe received a water right permit (S54261) to divert approximately .50 mgd from the Long Tom River. Construction of the City's new membrane filtration water treatment plant for water from the Long Tom is near completion and the plant is scheduled to begin operating in November 2008 (pers. comms. Jeff Houchin, Water/Wastewater Operator for the City of Monroe). The Long Tom surface water source will become the primary source of water for Monroe, once water treatment plant construction is completed.

A condition of the water right permit is that the City must secure a long-term contract for the use of stored water from the US Army Corps of Engineers (USACE) if stored water becomes available for such use. When such new municipal water contracts are made available, the USACE would supply stored water from the Fern Ridge Reservoir to the City of Monroe between June 15 and October 15 of each year, as required by OWRD.

City of Philomath

Philomath is located immediately west of the City of Corvallis Urban Growth Boundary (UGB). The City currently holds four surface water rights (two of which are developed) and one groundwater right (**Table 2-8**).

The City of Philomath's primary source water is supplied through permits S49245 and S13556, allowing for diversion of up to 4.5 cfs from the Marys River.

The City's certificated water right is for the use of groundwater from the 11th Street well (certificate 62441). Groundwater is currently only used as a supplemental and backup/emergency supply when required.

Additionally, the city's largest undeveloped water rights for the Marys River were gained via a water rights transfer completed in 2006 of irrigation water rights to municipal. Certificate 33572 with a maximum rate of diversion of 0.19 cfs and total quantity of 38.5 acre-feet of water diverted during the time April 1 to September 30 of each year. A second transfer included certificate 48112 with a maximum rate of diversion of 1.0 cfs and a maximum total quantity of 202.0 acre-feet of water diverted during the time April 1 to September 30 of each year. The completed changes and full beneficial use of water are scheduled to be made by October 1, 2011.

According to the Philomath and Corvallis Public Works Departments, there is currently a functioning water supply pipeline inter-tie between the City of Corvallis and the City of Philomath. Currently, Philomath purchases water from Corvallis when required during maintenance and emergency supply situations, with the potential for increased future supply (**Section 5**).

2.3.2 Non-Municipal Community Water Sources

Municipalities are not the only entities serving water to customers for domestic purposes. Water supply districts provide domestic water supplies in areas outside municipal service areas.

The Oregon Department of Human Services (ODHS) - Drinking Water Program reports that 10 community water supply systems provide drinking water to customers within Benton County (**Appendix C**). All of these water providers use groundwater as their source of water. According to ODHS, these water providers serve a total of 707 connections, and a total population of 1,785.

The water rights and sources for these Benton County communities are shown in **Table 2-9**. The approximate locations of these communities throughout the county are shown in **Figure 2-5**. Current water demands for the communities are discussed in **Section 3**.

Table 2-9 Non-Municipal Community Water Rights -- Benton County (2008)

Community	Maximum Rate of Diversion- cfs (mgd) [1]	Source Name(s) [1]	Certificate # [1]	Permit # [1]
Alsea County Service District	0.1 (0.06)	Well (East), Well (West)		G11354
Alsea County Service District	0.5 (0.32)	North Fork Alsea River		S31214
Cascade View Estates County Service District	0.08 (0.052)	Wells #1- #4		G12309
Fir View Water Company	0.13 (0.08)	Well #1-#3	60447	G13753
Jackson Creek Water Association	*	Domestic-Exempt well(s)	*	*
Knoll Terrace Manufactured Home Community	0.18 (0.12)	Well #1, Well #2		G15806
North Corvallis- Mobile Home Park	*	Domestic-Exempt well(s)	*	*
Pioneer Village Water Co.	*	Domestic-Exempt well(s)	*	*
Raintree Estates	*	Domestic-Exempt well(s)	*	*
Ridgewood District Improvement Company	0.37 (0.24)	Wells #1-#5	57134	G10094; G11930; G11995; G13112
Vineyard Mountain Water and Improvement District	0.3 (0.19)	Wells #1-#3		G12315

*** = No water right (exempt groundwater use)**
****= Secondary and/or unused water source**
1. Oregon Water Resources Department (OWRD)- Water Rights Information System (2008)

Section 3
Current Water Demand (Use)

Water is used in Benton County for a variety of purposes, which include: municipal, agricultural, industrial, domestic, fish and wildlife and other purposes. The need for water varies seasonally and is met by both diverting water from a surface water or groundwater source and putting it to immediate use, or by diverting water for storage and later use.

In addition, water is needed for instream uses such as maintaining river flows for fish, wildlife, and recreation.

With the exception of municipal water use, there is limited data available regarding actual quantity of water use. Therefore, for the purposes of this study, the estimates of water use within Benton County were developed based on the maximum withdrawals allowed by existing water rights and, for exempt uses of groundwater, by estimating per capita use based on available metered well data. The following sections provide separate estimates of the current use of surface water, groundwater, and water storage from points of diversion within Benton County.

Summary

The estimates of current water rights and uses for communities and rural areas of Benton County provide an overview of the range of current needs for water. Estimates of current water use for other purposes, such as irrigation, agriculture, and wildlife, was limited to a review of existing water rights. Since most water rights do not require reporting of use for these purposes, the water rights information provides an estimate of the maximum water use expected.

The estimated water use for cities, communities, and rural areas using surface water and groundwater sources is based on past recorded water use information. This provides an indication of the current uses for each of these purposes.

Current estimated maximum daily demands for Benton County communities were compared to the total permitted rate allowed under the current full water right(s) of a given community.

Irrigation Water Uses

The use of water for irrigation purposes is the largest percentage of the water use in the county from both surface water and groundwater sources, based on records of water rights. OWRD records show that surface water rights for irrigation authorize use of up to 314.1 cfs, and groundwater rights for irrigation authorize use of up to 218.9 cfs.

The total maximum use of water within Benton County under irrigation water rights is up to 533.0 cfs. If the estimated exempt use of groundwater for irrigation of non-commercial lawns and gardens is included, the total water use for irrigation in the county is up to 537.2 cfs.

Municipal Water Uses

Based on existing city water management plans the range of current total (residential, industrial, commercial) city water demands is an average of 11.5 to 23 million gallons per day (mgd). Furthermore, based on city water reports and population census data, the total city population (residential only) water demands were estimated to be 5.9 to 11.8 million gallons per day. See **Section 3.3**.

Non-Municipal Community Uses

Based on compiled community water system demand estimates data from communities spanning a range of micro-climates, tax lots, and property sizes within the county, an average total peak month demand for these communities was estimated at 416,478 gallons per day (gpd). The average low month demand for non-municipal communities within the county was estimated at 122,478 gpd. See **Section 3.4**.

Self-Supplied Domestic Water Uses

Rather than obtaining water for domestic purposes from a municipality or a community water supply system, many residents of Benton County obtain water directly from surface water or groundwater. Households with self-supplied domestic water are located almost exclusively in rural areas. This water use may be authorized by a water right to use surface water or groundwater, or it may occur as an “exempt use” of groundwater.

According to OWRD records, water rights for domestic use of surface water in the county authorize a total use of up to 6.8 cfs. The groundwater rights for domestic uses in Benton County authorize use of up to 2.1 cfs. Finally, the exempt use of groundwater for domestic purposes within the County is estimated at 1.7 cfs. This yields a total estimated domestic use of water in Benton County of up to 10.6 cfs (6.7 million gallons per day).

Commercial Water Uses

Both surface water and groundwater sources are utilized to meet the commercial water needs in the county. The “commercial use” category includes water rights authorizing the use of water for commercial, industrial/manufacturing, and log deck sprinkling purposes. OWRD has issued 39 water rights for commercial purposes with points of diversion in the county. These water rights authorize the use of up to 43.051 cfs, and 7.74 acre-feet of water. Surface water is the major source of this water, with a total maximum authorized rate of up to 40.61 cfs. The majority of these surface water rights are from the Willamette and Marys rivers.

Instream Water Uses

A portion of the surface water demand in Benton County is for the use of water instream. There are currently instream water rights on the Luckiamute, Marys, and Alsea rivers. Additionally there are year round minimum stream flows along the Willamette and Long Tom rivers. The amount and priority date for given instream water rights, range from 10 cfs (cubic feet per second) with a priority date of 6/22/1964 to 277 cfs with a priority date of 6/25/1990. Depending on the river mile location, time of year, and water rights that have an earlier priority date, the actual amount of instream water right flow varies. See **Section 3.1.2**.

Other Water Uses

The remaining categories of uses constitute a minor portion of the total water demand (use) for Benton County and include such uses as agriculture, fish culture and wildlife, livestock, power development and recreation.

According to data from OWRD's Point of Diversion Summary Report, the total maximum rate authorized for agriculture water rights is slightly over 23 cfs. The "agriculture" category includes rights authorizing the use of water for dairy barn, greenhouse, nursery, temperature control, and general agriculture purposes. Unlike an irrigation water right, agriculture rights are generally not limited to use during the irrigation season (OWRD, Water Rights Information System, 2007).

Water rights for fish culture and wildlife purposes have a combined maximum rate of over 68 cfs, the largest maximum rate within these remaining categories. OWRD's information also shows that it has issued surface water rights to meet the water demand for power development, recreation and livestock in the county. These rights have maximum rates of up to 12.855 cfs, 1.832 cfs and 0.374 cfs, respectively.

Information Inset

Water Rights in Oregon

Groundwater and surface water in Oregon is publicly owned and therefore belongs to the citizens of the state. With a few exceptions, the use of water in Oregon requires the user to obtain a water right from Oregon Water Resources Department (OWRD).

The administration of water rights by OWRD is based on the doctrine of prior appropriation. Under this doctrine, in times of shortage the first person to have obtained a water right permit (the senior appropriator) is the last to be limited during low water conditions.

The date of application for the water right permit usually establishes the "priority date" or place in line of an appropriator. In water-short times, the senior appropriator can demand the full amount of their water right regardless of the needs of junior appropriators. If there is surplus beyond the needs of the senior appropriator, the next most senior appropriator can take as much water as needed to satisfy their right and so on down the line until there is no surplus. An OWRD watermaster oversees which junior appropriators must stop using water so that senior users can be satisfied.

The right to use water is typically first granted in the form of a water use permit. The permit describes the priority date, the amount of water that can be used, the location and type of water use and often a number of water use conditions. The permit allows the water user to develop the infrastructure (e.g. pipes) needed to put the water to full beneficial use – a requirement of Oregon water law. When the report of beneficial use, called a Claim of Beneficial Use (COBU), is approved by OWRD, a water right certificate is issued confirming the status of the right. Water right permits typically have timelines for making full beneficial use of the water. If more time is needed than provided in the permit, the permit holder may request an "extension of time" from OWRD.

There are two processes that allow modification of a water right. When a water right is in the permit phase (still being developed), the permit holder may modify the water use by changing the location of use and the point where water is appropriated through an application for a permit amendment. For a water right certificate, the water right holder can modify the location of use, the point where water is diverted and the type of use made under the water right through an application for a water right transfer.

As previously mentioned, OWRD recognizes some exceptions to the requirement that the use of waters of the state requires a water right. These uses are referred to as exempt uses. There are different exempt uses for groundwater than for surface water.

Among the allowed exempt uses of groundwater are domestic use and irrigation of up to one-half acre of non-commercial lawn and garden. This exemption authorizes the beneficial use of groundwater up to 15,000 gallons per day for each well or water system. No OWRD authorization is required for such uses of water, although the wells must still be constructed according to state requirements and the water must be put to beneficial use without waste.

The exceptions that allow the use of surface water without a permit or certificate are very narrow. These exceptions allow the use of surface water for uses such as emergency fire fighting, some nonemergency fire fighting training, fish screens, fishways and fish bypass structures, certain land management practices, some livestock watering operations and limited forest management activities.

3.1 Surface Water Use

The majority of the uses of surface water within Benton County require a water right from OWRD, because exempt uses are very limited (see information inset above). Therefore, the existing use of surface water within the county has been estimated using the current water rights, ignoring authorized exemptions. The following information was compiled using the Point of Diversion Summary Report tool available on OWRD's web page http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_summary_pod.aspx) and the water right information system also available on OWRD's web page http://apps2.wrd.state.or.us/apps/wr/wrinfo/).

The OWRD Point of Diversion Summary Report provides information about water rights authorizing the use of water from a point of diversion within the county from particular surface water sources. The search results include the types of uses, the maximum rates, and maximum volumes (if any) that the identified water rights authorize. The following information was obtained through a query that identified June 1 as the point of time during the year when the water rights were to be in effect. This date was used in order to capture irrigation water rights, which would not be in use during winter months. Therefore, the search results capture the maximum rates authorized during June, which for some water rights may not be the maximum rate authorized at other times during the year.

Some use of water in Benton County occurs from points of diversion outside of the county and some points of diversion within the county may actually serve water to locations (places of use) outside of the county. In addition, the search results include both permits and certificates, which are combined without differentiation in the following discussion. The permits could, however, ultimately be certificated for maximum rates and volumes significantly less than authorized in the permits. Complex systems such as the point of diversion report must be expected to include some errors. Groundwater Solutions, Inc. (GSI) has corrected all identified errors, but the following information must be understood to be a generalization of the water rights within the county. Nonetheless, OWRD's point of diversion summary report is a valuable tool for generating estimates of existing water rights and related water use within the county.

Due to the limited nature of exempt uses of surface water, as previously described, and the lack of available data related to these uses, this subsection does not attempt to include water use in the county for these exempt uses.

3.1.1 Existing Surface Water Rights, Excluding Instream Water Rights

OWRD's Point of Diversion Summary Report indicates that over 1000 surface water rights have been issued with points of diversion in Benton County. These rights, excluding instream water rights, authorize a total maximum rate of diversion of 665.031 cfs. Water rights for irrigation purposes constitute nearly one-half of this maximum authorized. Municipal water rights are the second largest category, comprising almost one-third of the maximum total authorized rate. Water rights for fish and commercial purposes account for 14 percent of the total maximum authorized rate.

Combined, the 811 water rights within these four types of uses constitute 90 percent of the maximum authorized rate for the appropriative surface water rights in Benton County. The remaining approximately 267 water rights, which comprise the remaining seven categories, authorize the use of up to 68.666 cfs, 10% of the total maximum authorized rate.

Figure 3-1

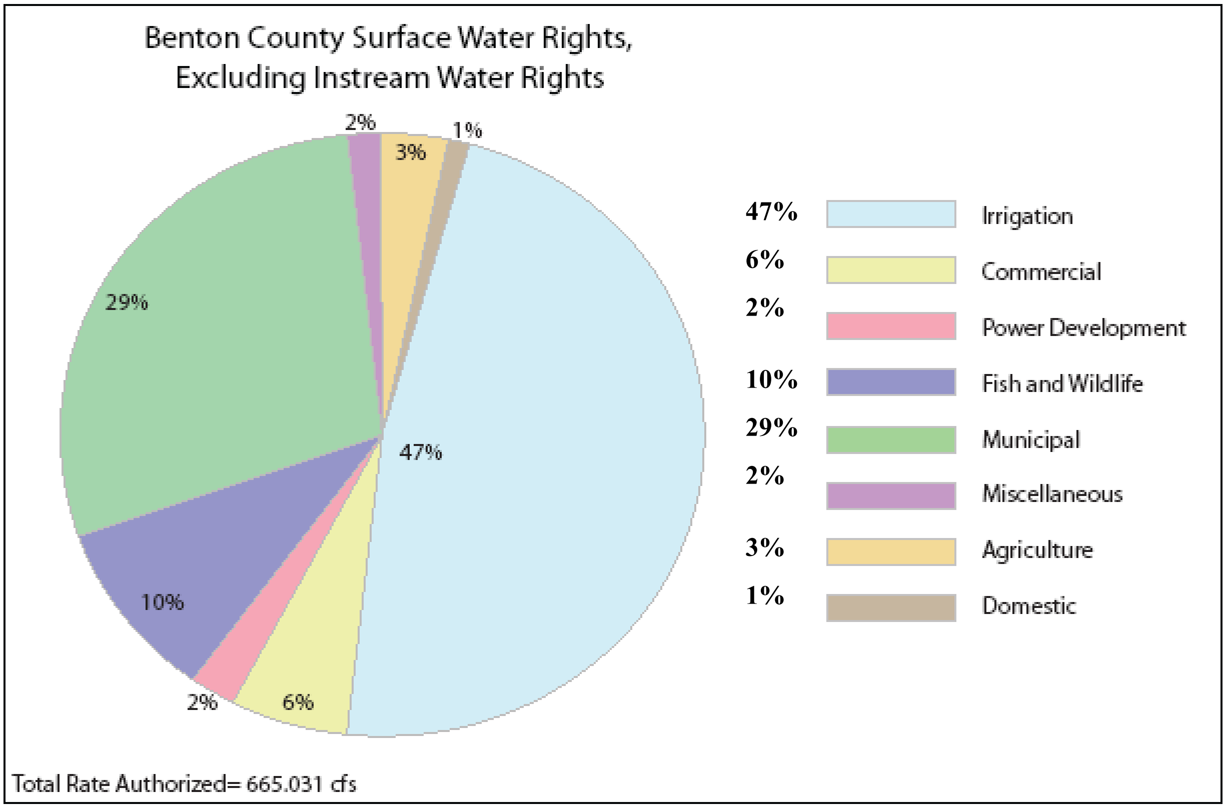


Table 3-1 provides a summary of existing surface water rights with a point of diversion (POD) in Benton County, excluding instream water rights. For reasons described in detail below, the following discussion focuses on water rights that generally authorize out-of-stream appropriations of water. The exceptions are the water rights authorizing use of water for hydropower and some fish and wildlife rights.

Water rights are grouped according to general categories of authorized beneficial purposes. The table also describes the more specific uses included in the water rights that fall within these broader categories. For example, the broader category of agriculture use includes water rights that authorize the use of water for dairy barns and greenhouses, as well as agriculture. The table describes the total combined maximum authorized rate for all of the water rights within each category. This is not necessarily the amount of water that is actually used at any point in time. Finally, if applicable, **Table 3-1** provides the total volume of water (in acre-feet) that may be used during the authorized period of use. This amount of water is referred to as the "duty" and is most often seen in water rights for irrigation use.

Table 3-1 All Surface Water Rights with a Benton County Point of Diversion (POD)*

Use Allowed by Water Right (June 1)	# of Water Rights (approx.)	Total Rate (cfs)	Total acre-feet
Agriculture: agriculture; dairy barn; and greenhouse	7	22.083	
Domestic: domestic incl. lawn & garden; domestic expanded; domestic; domestic & livestock; and human consumption	152	6.783	
Irrigation: irrigation; irrigation & domestic; irrigation, livestock & domestic; and primary & supplemental irrigation	746	314.135	3,880.810
Commercial: commercial; industrial/manufacturing; and log deck sprinkling	26	40.61	
Recreation: campsite; and recreation	15	1.832	
Power development	7	12.855	
Fish: fish & wildlife; and fish culture	23	50.240	20.000
Livestock:	56	0.374	
Municipal:	16	191.394	
Wildlife:	9	14.211	20.000
Miscellaneous: aesthetics; fire protection; pond maintenance; and road construction	21	10.514	
Total		**665.035**	**3,920.81**

* Information current as of July 17, 2008

As previously stated, the summary of surface water rights provided above includes all surface water rights with a point of diversion within Benton County, according to OWRD records. To better understand the use of water from the major waterways within the county, the following tables were developed using the Point of Diversion Summary.

It is important to understand that surface water rights are not the only Point of Diversions listed by OWRD within Benton County, and will not equal the sum of total water rights listed in **Table 3-**1. It is also important to note that water rights for tributaries defined by OWRD, such as the Muddy Creek (tributary to the Marys River) will not always be reported in the total County POD summary report.

Willamette River

Table 3-2 shows that water rights for the Willamette River, with points of diversion in Benton County, having a total combined rate of over 301 cfs. The majority of the total authorized rate from the Willamette River is for irrigation, which authorizes use of up to almost 88 cfs, and the cities of Corvallis and Adair Village have rights of up to 172.0 cfs.

The water rights for irrigation and municipal uses authorize up to a total of approximately 260 cfs, or 86 percent of the maximum authorized rate (301.739). Eight water rights in the commercial category authorize a maximum rate of 24.72 cfs, or approximately 8 percent of the total maximum rate. The remaining ten water rights, in five use categories authorize the use of up to approximately 17 cfs.

Table 3-2 Willamette River with a Benton County POD*

Surface Water Right Allowed Use (June 1)	# of Water Rights (approx.)	Total Rate (cfs)	Total acre-feet
Agriculture	1	7.333	
Domestic: domestic; and domestic incl. lawn & garden	2	3.010	
Irrigation: irrigation; and primary & supplemental irrigation	76	87.972	1,339.310
Commercial: industrial/manufacturing	8	24.720	
Fish Culture	1	2.315	
Municipal	4	172.000	
Wildlife	1	2.315	
Miscellaneous: aesthetics; and fire protection	5	2.315	
Total		**301.980**	**1,339.310**

* Information current as of July 17, 2008

<u>Long Tom River</u>

As shown in **Table 3-3**, OWRD records show that the water from the Long Tom River and its tributaries from points of diversion in Benton County are used almost exclusively for irrigation under 52 water rights. The remaining four water rights authorize the use of approximately 1.4 cfs, or 6 percent of the total maximum rate authorized.

Table 3-3 Long Tom River and its tributaries with a Benton County POD*

Surface Water Right Allowed Use (June 1)	# of Water Rights (approx.)	Total Rate (cfs)	Total acre-feet
Irrigation: irrigation; and primary & supplemental irrigation	52	32.619	1,107.500
Commercial: industrial/manufacturing	2	0.355	
Municipal:	2	1.030	
Total		**34.004**	**1,107.500**

* Information current as of July 17, 2008

Luckiamute River

In Benton County, water from the Luckiamute River and its tributaries is used primarily for irrigation and power development, according to data from the OWRD Point of Diversion Summary Report. The water rights in these categories authorize use of up 25.07 cfs or approximately 73 percent of the total maximum authorized rate from the Luckiamute River in Benton County. The two water rights for power development authorize the use of water to provide power for domestic purposes. Water rights for domestic use constitute less than 1 percent of the maximum authorized rate. The remaining water rights authorize the use of 9.2 cfs of maximum authorized rate.

Table 3-4 Luckiamute River and its Tributaries with a Benton County POD *

Surface Water Rights Allowed Use (June 1)	# of Water Rights (approx.)	Total Rate (cfs)	Total acre-feet
Domestic: domestic incl. lawn & garden; domestic expanded; domestic; and domestic & livestock	27	0.280	
Irrigation:	69	17.150	150.200
Commercial: commercial; and industrial/manufacturing	7	4.205	
Recreation:	1	0.500	
Power development	2	7.920	
Fish culture	3	0.047	20.000
Livestock:	16	0.100	
Wildlife:	6	1.896	20.000
Miscellaneous: Fire protection; pond maintenance; and road construction	6	2.430	
Total		**34.528**	**190.200**

* Information current as of July 17, 2008

Marys River

According to its records, OWRD has issued water rights for the use of water from the Marys River and its tributaries for a wide variety of purposes, authorizing a total maximum rate of diversion of up to 136.059 cfs.

The majority of these water rights (342) authorize the use of up to a total 85.315 cfs for irrigation, or about 63 percent of the total authorized maximum rate. Eight municipal water rights authorize the use of up to 17.824 cfs and are held by the cities of Corvallis and Philomath. Nine commercial water rights authorize use of up to a total of 11.04 cfs. The remaining water rights, comprising eight different categories, authorize the use of up to 28.9 cfs, or approximately 21 percent of the total maximum authorized rate.

Table 3-5 Marys River and its Tributaries with a Benton County POD *

Surface Water Right Allowed Use (June 1)	# of Water Rights (approx.)	Total Rate (cfs)	Total acre-feet
Agriculture: agriculture; and dairy barn	5	0.080	
Domestic: domestic incl. lawn & garden; domestic expanded; domestic; domestic & livestock; and human consumption	83	3.000	
Irrigation: irrigation; irrigation & domestic; and primary & supplemental irrigation	342	85.315	33.250
Commercial: commercial; industrial/manufacturing; and log deck sprinkling	9	11.040	
Recreation: campsite; swimming; and recreation	9	1.189	
Power development	4	4.935	
Fish: aquaculture; fish & wildlife; and fish culture	9	0.124	
Livestock:	29	0.161	
Municipal:	8	17.824	
Wildlife:	2	10.000	
Miscellaneous: fire protection; and pond maintenance	7	2.391	12.000
Total		**136.059**	**45.250**

* Information current as of July 17, 2008

Muddy Creek

The water rights that authorize diversion of water from Muddy Creek and its tributaries from a POD in Benton County have a total maximum authorized rate of 66.559 cfs, according to OWRD's Point of Diversion Summary Report. The majority of these water rights authorize use of almost 47 cfs for irrigation. This constitutes 70 percent of the total maximum authorized rate.

Water rights for domestic purposes authorize the use of up to 1.442 cfs, or approximately 2 percent of the maximum authorized rate. Four water rights, the majority of which are in the name of lumber companies, authorize the use of up to 3.91 cfs for commercial purposes. The remaining water rights authorize the use of up to 14.321 cfs for uses in the remaining seven categories, including power development, recreation and livestock.

Table 3-6 Muddy Creek and its Tributaries with a Benton County POD *

Surface Water Right Allowed (June 1)	# of Water Rights (approx.)	Total Rate (cfs)	Total acre-feet
Agriculture: agriculture; and dairy barn	3	0.065	
Domestic: domestic; domestic incl. lawn & garden; and domestic expanded	36	1.442	
Irrigation: irrigation; irrigation & domestic; irrigation, livestock & domestic; and primary & supplemental irrigation	160	46.886	33.250
Commercial: industrial/manufacturing; and log deck sprinkling	4	3.910	
Recreation:	3	0.059	
Power development	3	3.930	
Fish culture	3	0.049	
Livestock:	22	0.118	
Wildlife:	2	10.000	
Miscellaneous: fire protection; and pond maintenance	25	0.100	
Total		**66.559**	**33.250**

* Information current as of July 17, 2008

Alsea River

Based on information from OWRD's Point of Diversion Summary Report, the water rights from the Alsea River with a POD in Benton County authorize a maximum rate of diversion of up to 75.074 cfs.

The largest portion of the maximum authorized rate is for fish culture water rights, which authorize the use of up to 47.12 cfs. For the most part, these rights are held by the Oregon Department of Fish and Wildlife for fish hatcheries. The next largest portion of the maximum authorized rate is from the 102 water rights authorizing the use of water for irrigation. These water rights authorize a total maximum rate of up to 26.601 cfs. The remaining water rights authorize the use of up to 1.353 cfs for the remaining categories of authorized uses, including domestic, commercial and municipal purposes.

Table 3-7 Alsea River and its Tributaries with a Benton County POD *

Surface Water Rights Allowed Use (June 1)	# of Water Rights (approx.)	Total Rate (cfs)	Total acre-feet
Agriculture: greenhouse	1	0.004	
Domestic: domestic incl. lawn & garden; domestic expanded; domestic; and human consumption	30	0.346	
Irrigation: irrigation; and irrigation & domestic	102	26.601	
Commercial: industrial/manufacturing	2	0.290	
Recreation:	2	0.120	
Fish culture	4	47.120	
Livestock:	7	0.053	
Municipal:	2	0.540	
Miscellaneous: fire protection	1	0.000	
Total		**75.074**	

* Information current as of July 17, 2008

Information Inset

Estimated Surface Water Use

The previous tables describe the existing surface water rights in the county, as well as those water rights from the county's most significant waterways and their tributaries. The tables reflect the maximum rates and volumes identified in the relevant water rights. In other words, the tables show the maximum rate at which water could be legally diverted at any time from these waters under the existing water rights, and the total amount of water that could be diverted in the relevant season in a single year.

These amounts of water, however, are not usually diverted under an existing water right. Water is rarely diverted at a constant maximum rate. For example, a water right for a dairy barn may authorize a maximum rate of diversion of 0.02 cfs. In such a case, the water is generally diverted at a rate of up to 0.02 cfs when it is needed for dairy operations, such as cleaning equipment and washing the floors. The water would not be constantly diverted at a rate of 0.02 cfs for 24 hour per day and 365 days per year. Similarly, water rights are not necessarily used every year. An irrigation right for a certain field might be used one year, but not used the next year when the field is fallow or a crop not requiring irrigation is grown. Finally, the full amount of water that is diverted from a stream is not necessarily permanently removed from the stream system. Generally, a portion of the diverted water returns to the stream. For example, a portion of the water used to irrigate a field will usually return to the stream as groundwater discharging to the stream. As another example, a portion of the water diverted for municipal or industrial use may be returned to the stream as treated effluent. "Consumptive use" is the term used to describe the use of water diverted from a stream but not returned to that water body; it is the proportion of water withdrawn that is evaporated, transpired by plants, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment.

When determining whether to allow new diversions of water from a river or stream, OWRD must determine whether more water is available for additional use from that source. As part of these water availability calculations, the agency must subtract the existing uses of water from the estimated natural stream flows. (More information about this process is provided in the section below.) For the reasons described above, OWRD does not subtract the full total maximum rate of the existing water rights. Instead, the agency uses the estimated consumptive portion of use of those water rights and makes other assumptions to better reflect the expected demands from the existing water rights.

OWRD's consumptive use coefficients (estimated proportion of the right actually used) for municipal uses in the Willamette Valley are 0.45 in the summer and 0.15 in the winter. For irrigation, OWRD estimates the expected use by considering crop types, estimated acres irrigated and distribution of the crop water demand. For more details see OWRD Open File Report SW 02-002.

OWRD uses the following consumptive use coefficients to estimate the consumptive portion for minor out-of stream uses. The consumptive use is estimated by multiplying the consumptive use coefficient by the maximum diversion rate allowed for the water right.

Table 3-8 OWRD Consumptive Use Coefficients

Use	Coefficient
Industrial	0.10
Domestic	0.20
Commercial	0.15
Livestock	0.50
Agricultural	0.50

Thus, although the water rights authorizing the use of water in Benton County contain a maximum authorized rate, this is not the amount of water that is generally used by the holder of those water rights, and not necessarily a good indicator of expected use. For this reason, OWRD estimates the consumptive use portion of these water rights. The most important reason to understand the consumptive use portion of the existing water rights is for the purposes of determining whether water is generally available in a particular surface water source for new uses of water. This water availability calculation for the *Phase 1* project is discussed in detail in **Section 4**.

Information Inset

Instream Water Rights

Instream water rights are a special type of water right that can only be applied for by three state agencies - Oregon Department of Environmental Quality, Oregon Department of Fish and Wildlife, and Oregon Parks and Recreation Department. These water rights protect water in the stream for fish and wildlife, recreation, navigation or pollution abatement purposes. Once approved, the water right is held by OWRD in trust for the people of the state of Oregon.

Although instream water rights are entitled to the same protections as other water rights, they are dealt with separately in this report for several reasons.

First, instream water rights are not generally additive. This means that if a stream reach has one instream water right with a priority date of 1950 for 10 cfs and a second instream water right with a priority date of 1960 for 5 cfs, the State watermaster would generally protect 10 cfs instream, not 15cfs.

Second, instream water rights are often for a limited reach. As a result, a stream may have multiple instream water rights in a series from its headwaters to its mouth. These rights would each protect the identified amount of water only within the reach to which that right applies. If all of the maximum rates of these water rights were totaled, the result would show a misleadingly large proportion of the total authorized rate as being for instream water rights.

Third, the “use” of water for instream purposes does not reduce the availability of that water downstream from the protected reach for other uses.

Finally, the rate of protected flow authorized by instream water rights often varies throughout the year, making generalized comparisons particularly difficult. For these reasons, this report describes instream water rights separately in this subsection.

Instream water rights, as with other water rights, authorize the use of water within the prior appropriation system. As a result, an instream water right is not a guarantee that water will be protected instream. Water rights senior in priority to an instream water right are not affected by the instream water right. Consequently, the effectiveness of an instream water right is closely linked to the water right’s priority date in relationship to the other rights on the stream system.

Before the Oregon legislature enacted legislation authorizing the creation of instream water rights, the Oregon Water Resources Commission adopted minimum perennial streamflows on some waterways through an administrative rulemaking process. These streamflows were included in the basin program rules in an effort to protect water for instream purposes. They were not water rights, however, and are of limited value as a result. A number of these minimum perennial streamflows have been converted to instream water rights. Once these flows become water rights, OWRD can regulate junior water users to protect the authorized rights instream.

3.1.2 Instream Water Rights

A portion of the surface water demand in Benton County is for the use of water instream. There are a number of instream water rights, as well as minimum perennial streamflows within Benton County, as described below. Instream water rights must be taken into consideration when determining whether a stream will generally have water available for further appropriation. See also **Section 4**.

Willamette River

There are no certificated instream water rights on the section of the Willamette River within Benton County, although there is a minimum perennial stream flow (MF 184) for 1750 cfs year-round, which is measured at the USGS gauge (14174000) in Albany.

Long Tom River

Similarly, the Long Tom River does not have any certificated instream water rights, although there is a minimum perennial stream flow for 370 acre-feet of stored water released from Fern Ridge Reservoir.

Luckiamute River

There is one instream water right (Certificate 59743) with a priority date of 6/22/1964 on the Luckiamute River above Kopplein Creek, which protects 10.0 cfs instream year-round to support aquatic life. This instream right is measured at the gauge near Hoskins. There is another instream water right (Certificate 59480) with a priority date of 6/22/1964 on the Luckiamute River above McTimmonds Creek, which protects flows of 20.0 cfs year-round for supporting aquatic life. This instream water right is measured above gauge 14-1900 near Pedee.

Marys River

There are four certificated instream water rights in Marys River. Certificate 59713 protects 5.0 cfs between the confluence with the Willamette River and 1.0 mile above the confluence. The right is to support aquatic life with a priority date of 6/22/1964.

Certificate 59714 protects 10.0 cfs instream above USGS gauge 14-1710 near Philomath with a priority date of 6/22/1964. The right is for the purpose of supporting aquatic life.

Certificate 72589 protects water instream for fish purposes between the East Fork of the Marys River at river mile 40.0 and Blakesley Creek at river mile 20.0. The maximum rate of this right varies through the year, with a maximum rate of 75.0 cfs from mid-November through May and a minimum of 6.0 cfs from mid-July through September with a priority date of 10/11/1990.

Certificate 72588 protects water between Blakesley Creek at river mile 20.0 and the mouth for anadromous and resident fish rearing. The maximum rate of this right varies throughout the year, with a maximum rate in the months of November 15 through May of 135 cfs, and a minimum rate of 15 cfs from July 15 through September 30 with a priority date of 10/11/1990. Tables further describing the protected flows are provided in **Appendix D**.

Muddy Creek

There are no instream water rights on Muddy Creek.

Alsea River

There are two certificated instream water rights on the Alsea River in Benton County. Certificate 73139, protects water from river mile 43.2 to Five Rivers at RM 20.9 for fish rearing, and has a maximum rate that ranges from 56.5 cfs to 277.0 cfs, depending upon the month with a priority date of 3/25/1990. Certificate 59574 protects flows from the confluence with the South Fork Alsea River to river mile 17.2 for supporting aquatic life and recreation. The right protects between 25 and 140 cfs, depending on the month, and has a priority date of 3/26/1974. Tables further describing the protected flows are provided in **Appendix D**.

Rock Creek

There are currently no instream water rights on Rock Creek. The City of Corvallis discussed transferring select municipal water rights to instream water rights in the City's 2005 Water Management and Conservation Plan. No action to implement this transfer has occurred.

3.1.3 Water Rights for Storage

In addition to surface water rights for immediate use, there are also water rights authorizing storage of water for later use. The most common scenario is that surface water is diverted and stored in a reservoir during winter months, when surface water flows are higher. The stored water is used in the summer, when stream flows are lower and demand is higher. OWRD issues water rights that authorize the use of water for storage (See **Section 4**).

This subsection describes the existing storage rights with points of diversion in Benton County. As in the previous subsection describing surface water rights, this information was compiled from the Point of Diversion Summary Report tool available on OWRD's web page (http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_summary_pod.aspx) and the water right information system also available on OWRD's web page (http://apps2.wrd.state.or.us/apps/wr/wrinfo/). The following information was obtained through a query that identified January 1 as the point of time during the year when the water rights were to be in effect. This date was used because it is generally within the "storage season," or the time of year when a storage water right authorizes the diversion of water for storage. The search results included the types of uses and maximum volumes the identified water right authorized. The limitations of this search are similar to those described for surface water right queries and, as a result, the following information must be understood to be a generalization of the storage water rights from points of diversion within the county. These estimates are, nonetheless, informative for understanding water storage in Benton County.

Summary

OWRD's Point of Diversion Summary Report indicates that the agency has issued water rights with a point of diversion in Benton County that authorize storage of up to 3,745.453 acre-feet. OWRD reports that the majority of the storage rights authorize storage for fish and wildlife purposes. These rights constitute 42 percent of the total maximum authorized storage. A significant portion of the total maximum authorized storage is from water rights for miscellaneous purposes such as aesthetics, fire protection, forest management, multiple purposes, and unspecified storage purposes. Storage rights for municipal purposes constitute only 7 percent of the total authorized maximum storage.

Figure 3-2

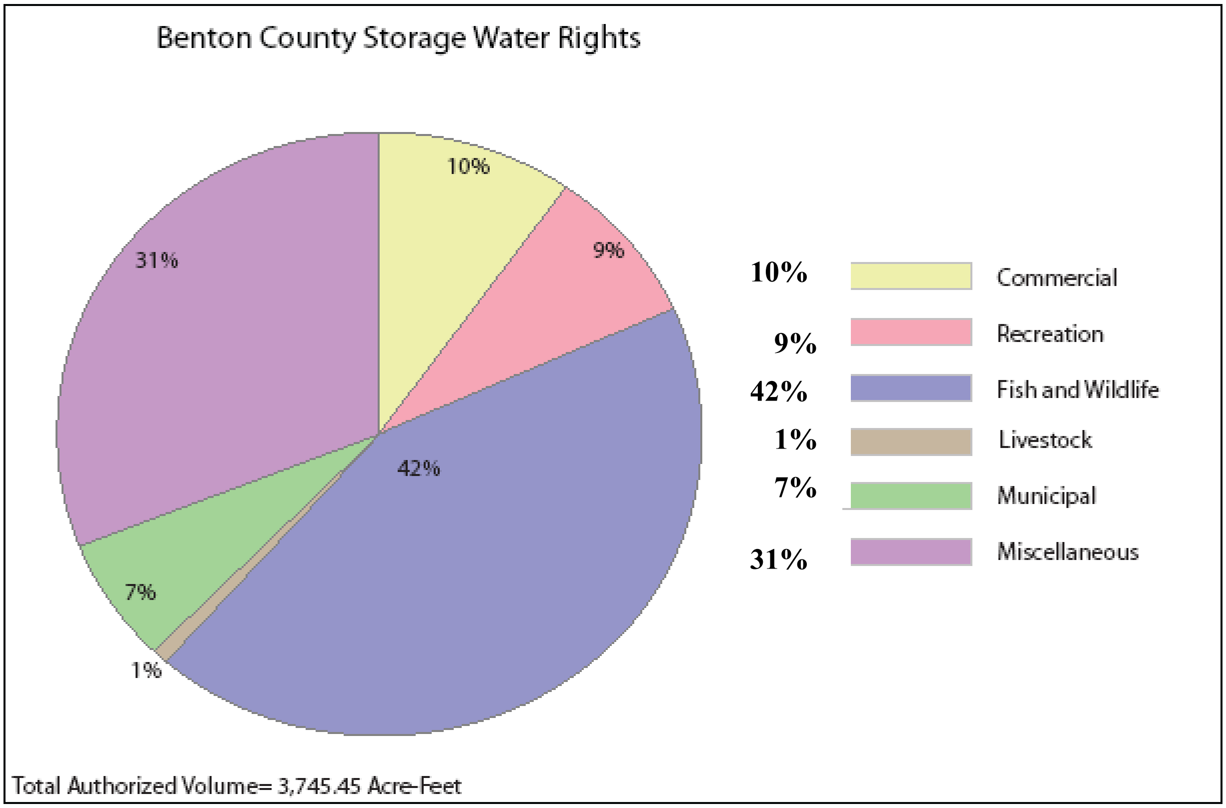


Table 3-9 Totals for Benton County POD *

Storage Water Right Allowed Use (January l)	# of Water Rights (approx.)	Total acre-feet
Irrigation:	1	0.400
Commercial: industrial/manufacturing	6	370.800
Recreation: recreation; and swimming	33	319.472
Fish: aquaculture; and fish culture	34	274.476
Livestock:	16	23.863
Municipal:	1	257.000
Wildlife:	66	1,338.274
Miscellaneous: aesthetics; fire protection; forest management; multiple purpose; and storage	75	1,161.168
Total	**232**	**3,745.453**

* Information current as of July 17, 2008

Willamette River

According to OWRD's Point of Diversion Summary Report, the agency has issued only four storage rights from the Willamette River with points of diversion in Benton County. The reported rights authorized storage of up to a total of 21.61 acre-feet. Two of these rights are for aesthetic purposes, and the other two are for unspecified purposes.

Table 3-10 Willamette River with a Benton County POD *

Storage Water Right Allowed Use (January 1)	# of Water Rights (approx.)	Total acre-feet
Miscellaneous: aesthetics; and storage	4	21.610
Total	**4**	**21.610**

* Information current as of July 17, 2008

Long Tom River

OWRD's Point of Diversion Summary Report for the Long Tom River and its tributaries identifies only one storage right, which authorizes the storage of up to 12.6 acre-feet for an unspecified purpose.

Table 3-11 Long Tom River and its Tributaries with a Benton County POD *

Storage Water Rights Allowed Use (January 1)	# of Water Rights (approx.)	Total acre-feet
Miscellaneous: storage	1	12.600
Total	**1**	**12.600**

* Information current as of July 17, 2008

Luckiamute River

According to OWRD's Point of Diversion Summary Report, the Luckiamute River and its tributaries have approximately 56 storage rights with PODs in Benton County. These reported rights authorize total maximum storage of 798.339 acre-feet.

The majority of these storage rights (26 rights) authorize storage of over 327 acre-feet for wildlife purposes. Many of these rights are held by ODFW for wildlife management areas and wetland restoration purposes. These storage rights authorize storage of up to 302.665 acre-feet for miscellaneous purposes such as aesthetics, fire protection and multi-purpose storage.

Table 3-12 Luckiamute River and its Tributaries with a Benton County POD *

Storage Water Right Allowed Uses (January 1)	# of Water Rights (approx.)	Total acre-feet
Commercial: industrial/manufacturing	2	61.000
Recreation:	4	64.760
Fish: aquaculture; and fish culture	7	41.310
Livestock:	1	1.000
Wildlife:	26	327.605
Miscellaneous: aesthetics; fire protection; multiple purpose; and storage	16	302.665
Total	**56**	**798.340**

* Information current as of July 17, 2008

Marys River

According to its records, OWRD has issued numerous storage rights from the Marys River and its tributaries with points of diversion in the county. These rights authorize total maximum storage of over 2,349 acre-feet.

This is the largest total reported for the surface water systems in Benton County that were queried. As was reported for the Luckiamute River, the majority of the authorized storage (up to 977.254 acre-feet) is for wildlife purposes. In addition, storage rights for fish purposes authorize storage of up to 193.074 acre-feet.

OWRD also reports that the Marys River and its tributaries have a significant storage right for municipal purposes, which authorizes the City of Corvallis to store up to 257 acre-feet from the North Fork of Rock Creek. Storage rights for commercial purposes are authorized up to 309.8 acre-feet and for recreation purposes (including campsite and swimming), for over 220 acre-feet.

Table 3-13 Marys River and its Tributaries with a Benton County POD *

Storage Water Rights Allowed Uses (January 1)	# of Water Rights (approx.)	Total acre-feet
Commercial: industrial/manufacturing	4	309.800
Irrigation:	1	0.400
Recreation: campsite; swimming; and recreation	18	220.446
Fish: aquaculture; and fish culture	17	193.074
Livestock:	10	17.342
Municipal:	1	257.000
Wildlife:	32	977.524
Miscellaneous: aesthetics; fire protection; forest management; multiple purpose; and storage	39	373.844
Total	122	2,349.430

* Information current as of July 17, 2008

Muddy Creek

OWRD's Point of Diversion Summary Report identifies numerous storage rights in the county from Muddy Creek and its tributaries. The rights reported authorize storage of up to 1,237.906 acre-feet for a number of uses. As previously seen, the rights authorizing storage for wildlife purposes allow the greatest maximum amount of storage, which totals over 966 acre-feet. Many of these storage rights are held by the U.S. Fish & Wildlife Service for Finley Wildlife Refuge. A significant portion of the total maximum storage authorized is for miscellaneous purposes such as aesthetics, fire protection, and multi-purpose storage.

Table 3-14 Muddy Creek and its Tributaries with a Benton County POD *

Storage Water Rights Allowed Uses (January 1)	# of Water Rights (approx.)	Total acre-feet
Irrigation	1	0.400
Commercial: industrial/manufacturing	1	9.000
Recreation: swimming; and recreation	9	23.992
Fish culture	5	6.406
Livestock	6	12.772
Wildlife	20	966.005
Miscellaneous: aesthetics; fire protection; multiple purpose; and storage	25	219.331
Total	**67**	**1,237.906**

* Information current as of July 17, 2008

Alsea River

OWRD reports a limited number of storage rights from the Alsea River with points of diversion in the county. The reported rights authorize total maximum storage of only 37.21 acre-feet. Five of these rights authorize storage of up to 24.85 acre-feet for recreation purposes, which is 66 percent of the total authorized storage. The remaining water rights authorize storage for a variety of purposes, including fish culture, livestock and wildlife purposes.

Table 3-15 Alsea River and its Tributaries with a Benton County POD *

Storage Water Right Allowed Uses (January 1)	# of Water Rights (approx.)	Total acre-feet
Recreation	5	24.850
Fish culture	2	8.090
Livestock	2	1.690
Wildlife	1	0.000
Miscellaneous	2	2.580
Total	**12**	**37.210**

* Information current as of July 17, 2008

3.2 Use of Groundwater

Groundwater can be used in Oregon based on a water right issued by OWRD, or as an "exempt use" of groundwater.

Water rights are needed for groundwater uses such as commercial irrigation and municipal supplies. The exempt uses of groundwater include wells for domestic use and shared domestic purposes up to 15,000 gallons per day, and up to one-half acre of irrigation for non-commercial lawn and garden. While there are other uses of groundwater that do not require a permit or certificate from OWRD, these are the most common. Since these exempt uses of groundwater are prevalent in Benton County, subsection **3.2.2** describes them further. The following subsection describes the uses of groundwater authorized by water rights issued by OWRD.

3.2.1 Existing Groundwater Rights

The Oregon Water Resources Department (OWRD) issues water rights that authorize the use of groundwater. These water rights are only an indicator of the use of groundwater in Benton County. OWRD's Point of Diversion Summary Report was again used to compile information about the groundwater rights in the county. The system was queried for groundwater rights that authorize water use as of June 1 of each year.

The limitations of this type of search are the same as those described in the surface water section. Nonetheless, the following search results provide valuable insight into the use of water in the county for which OWRD has issued water rights.

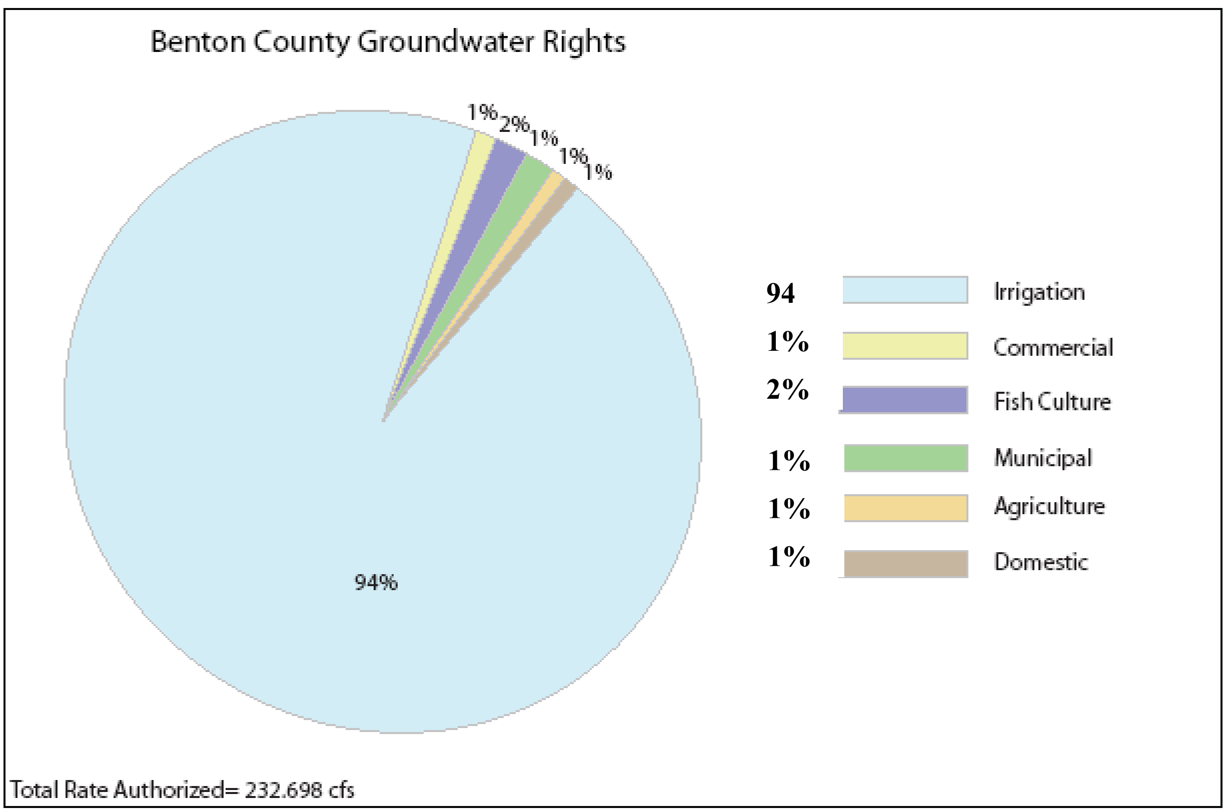
OWRD's Point of Diversion Summary Report indicates that the vast majority of groundwater rights with points of appropriation in the county authorize the use of water for irrigation purposes (see **Figure 3-3**).

According to these records, the irrigation water rights make up 94 percent of the total maximum authorized rate of diversion. Groundwater rights for fish culture authorize the next highest total maximum rate of appropriation at slightly over 4 cfs. Corvallis, Monroe, Philomath and the Alsea County Service District have municipal groundwater rights authorizing use up to 3.27 cfs. Domestic water rights are at slightly more than 2 cfs.

Table 3-16 Summary of Groundwater Rights

Use Allowed by Water Right (June 1)	# of Water Rights (approx.)	Total Rate (cfs)	Total acre-feet
Agriculture: agriculture; greenhouse; nursery; and temperature control	7	1.205	
Domestic: domestic; domestic expanded; and group domestic	18	2.108	
Irrigation: irrigation; irrigation & domestic; and primary & supplemental irrigation	430	218.869	77.000
Commercial: commercial; and industrial/manufacturing	13	2.441	7.740
Fish culture	3	4.005	
Municipal:	10	3.270	
Miscellaneous: pond maintenance	1	0.800	
Total	**482**	**232.698**	**84.740**

Figure 3-3



3.2.2 Estimate of Domestic and Non-Commercial (Exempt) Uses of Groundwater

To fully understand the use of groundwater in Benton County, the analysis cannot be limited to considering the groundwater rights issued by OWRD. The significance of "exempt uses" of groundwater must also be factored into the water use estimate. **Figure 3-4** shows the estimated density, at the section level, of exempt groundwater use wells throughout Benton County. For the purposes of this report, only the most prevalent exempt uses, domestic and non-commercial irrigation, will be described. Because actual water use from exempt wells is not recorded, estimating the water pumped is an approximation based on population data and estimates of consumptive water use.

Although exempt domestic uses of groundwater are allowed to use up to 15,000 gallons per day (GPD), this figure is not helpful in estimating the amount of groundwater actually used because water must be put to beneficial use without waste. It would be practically impossible for a single household to put 15,000 GPD to beneficial use for domestic purposes. The 15,000 GPD limit, therefore, is likely only truly limiting for group users sharing wells that are operating under the exempt use provision.

Based on available information, exempt uses of groundwater were estimated at the Benton County level using two methods. For both methods, several assumptions were necessary to obtain a planning-level estimate of the exempt use of groundwater. In particular, these methods assume that all people living in rural Benton County who do not receive water through a community water system that reports to the Oregon Drinking Water Program receive water under an exempt use of groundwater. It is recognized that this approach disregards rural residents that obtain water for domestic purposes under water right permits or certificates for either groundwater or surface water sources. Nonetheless, these methods allow for the development of an estimate of the magnitude of groundwater use in comparison to other water uses in the county.

<u>Method 1</u> – Extrapolation of Data from Rural Community Water Systems
Exempt groundwater use in rural Benton County was estimated using actual water use information from three water service districts in rural Benton County: Ridgewood District Improvement Company, Cascade View County Service District, and Alsea County Service District. The data from these community water systems were evaluated to obtain average daily and peak water use by service connection (residence). These data were also used to determine the proportions of groundwater used for domestic and for irrigation uses. The data used for this analysis are considered representative for this study because they span a range of lot size, property value and location within the county.

The household water use estimates were then multiplied by the number of households in rural Benton County that are not served by a community water system to obtain an estimate of exempt groundwater use. Results are shown in **Table 3-17**.

<u>Method 2</u> - Per Capita Estimates from Literature
This approach relies on per capita (individual use) estimates provided by the USGS explicitly for Benton County to estimate exempt domestic use of groundwater. The per capita estimate was multiplied by the number of rural residents that are not served by a community water system to obtain a county-wide estimate of exempt groundwater use.

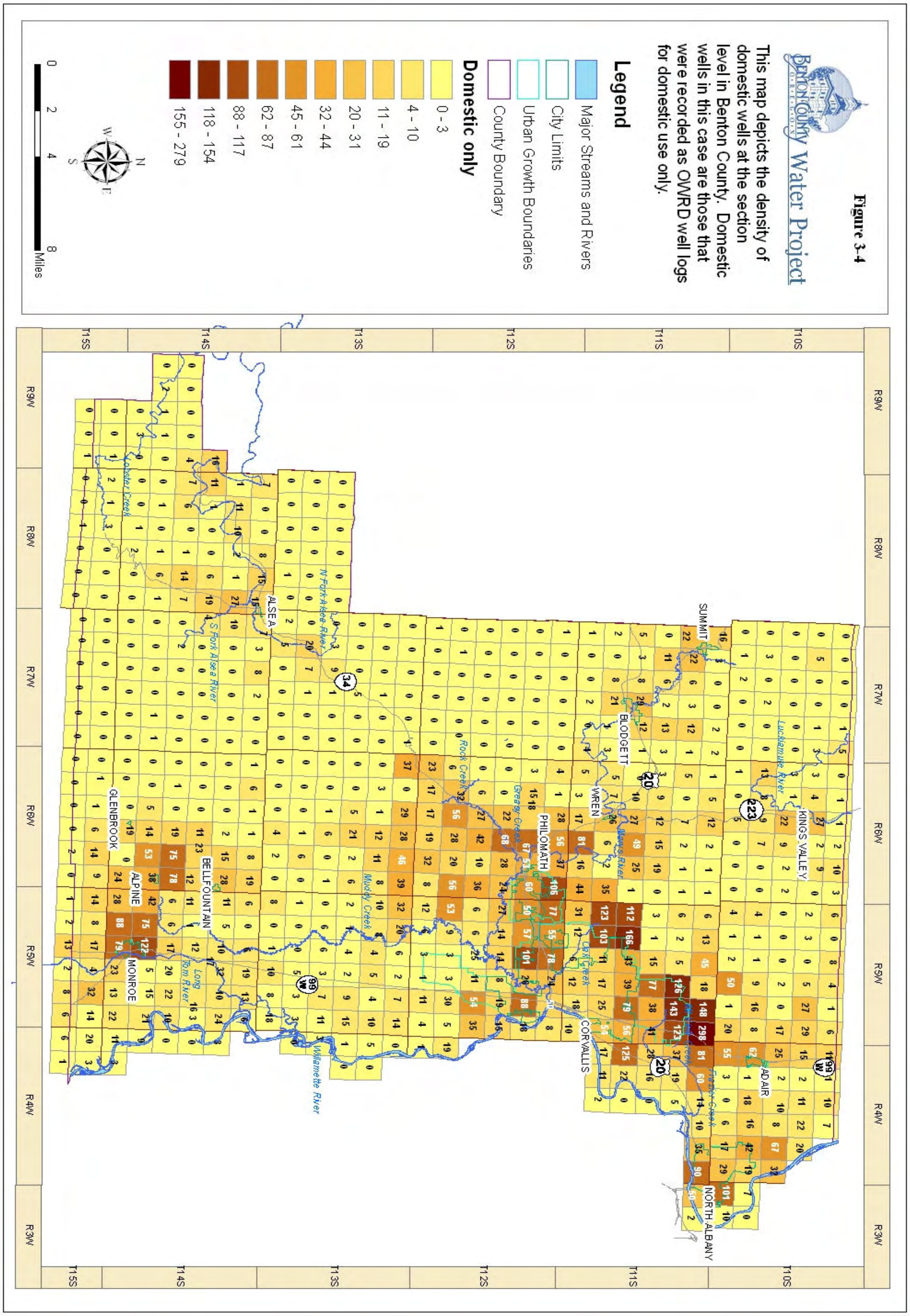


Figure 3-4
Benton County Water Project
This map depicts the density of domestic wells at the section level in Benton County. Domestic wells in this case are those that were recorded as OWRD well logs for domestic use only.
Legend
Major Streams and Rivers
City Limits
Urban Growth Boundaries
County Boundary
Domestic only
0 - 3
4 - 10
11 - 19
20 - 31
32 - 44
45 - 61
62 - 87
88 - 117
118 - 154
155 - 279
0
2
4
8
Miles
N
S
E
W
SUMMIT
KINGS VALLEY
BLODGETT
WREN
PHILOMATH
CORVALLIS
ADAIR
NORTH ALBANY
ALSEA
BELLFOUNTAIN
ALPINE
MONROE
GLENBROOK
Willamette River
Luckiamute River
Marys River
Muddy Creek
Long Tom River
Rock Creek
Greasy Creek
N Fork Alsea River
S Fork Alsea River
Lobster Creek
T10S
T11S
T12S
T13S
T14S
T15S
R9W
R8W
R7W
R6W
R5W
R4W
R3W

Results- Estimate of Domestic Uses of Groundwater

Method 1

July 2007 population data from Portland State University show a total rural population of 17,726 residents in Benton County. Information from the Oregon Drinking Water Program show there are 1,785 people served by community systems. The remaining rural population of 15,941 is assumed to obtain water under an 'exempt use' of groundwater.

The US Census report for 2006 shows that the estimated average household size in Benton County was 2.24 people. Using this estimate, and a population of 15,941, the number of rural households relying on exempt groundwater use is projected to be 7,117. Using this estimate and the water use estimates in **Table 3-17**, the estimated average daily exempt use of groundwater in Benton County is approximately 2.0 million gallons per day (MGD) and the peak daily demand is projected to be up to 3.8 MGD.

In addition to calculating average and peak demands, the household and irrigation components of the exempt uses were estimated from data in **Table 3-17**. Domestic household use (washing, bathing, cooking, drinking and sanitation) was estimated from January data assuming that no irrigation would occur during the winter. Using the average January use of 153 gallons per household, the total domestic use is projected to be 1.1 MGD.

The irrigation use was estimated by subtracting the January use data from peak summertime data to isolate the component that would primarily be attributable to irrigation (see **Table 3-17**). The results from this calculation for each community system were then averaged, and the average (380 gallons) was applied to the estimated number of households using exempt groundwater. The results show estimated exempt use of groundwater for irrigation during the summer is approximately 2.7 MGD.

Table 3-17 Estimates of Household Water Use in Rural Benton County

Community Water System	Average Use per Household (gallons/day)	Average January Use per Household (gallons/day)	Average Peak Use per Household (gallons/day)	Seasonal Irrigation Use per Household (gallons/day)
Cascade View County Service District	300	150	600	450
Alsea County Service District	200	130	300	170
Ridgewood District Improvement Co.	330	180	700	520
Total Averages	**277**	**153**	**533**	**380**

Method 2

The U.S. Geological Survey estimates a per capita water use for Benton County of 100 gallons per day. Applying this per capita use to the population estimate of 15,941 rural residents assumed to rely on exempt groundwater use, results in an average daily rural water use of 1.6 MGD. This total is approximately 20 percent less than the estimate obtained using Method 1, which extrapolates water use from actual rural water system data.

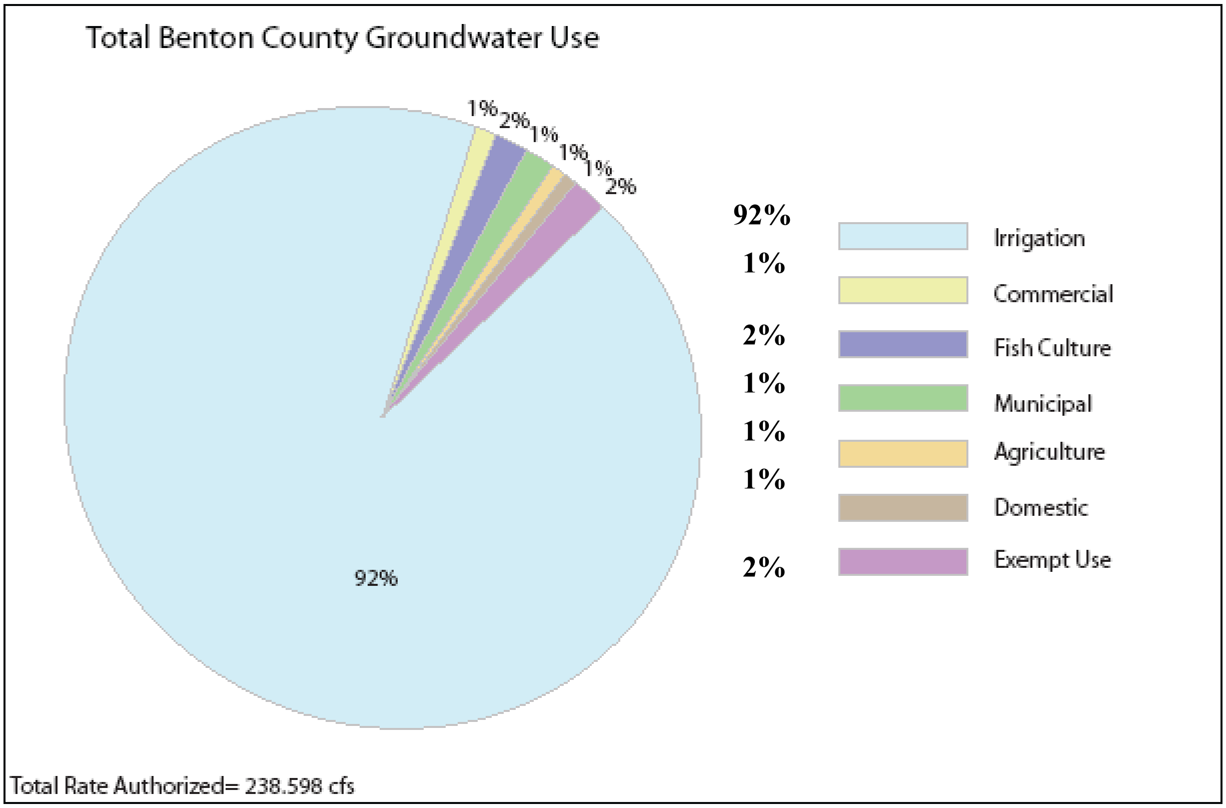
Since this method does not allow the differentiation between summertime and wintertime water use, it is not possible to distinguish between domestic and irrigation uses under this method. For this reason, the following discussion of total current demand for groundwater in the county will rely on water use estimates developed using Method 1.

3.2.3 Total Current Demand (Use) for Groundwater

The peak quantity of groundwater extracted for exempt uses in rural Benton County is estimated to be 3.8 MGD (5.9 cfs). This total represents the exempt use of groundwater for both domestic and non-commercial irrigation purposes. The estimated exempt use of groundwater for domestic purposes only in Benton County is 1.1 MGD (1.7 cfs). The estimated exempt use of groundwater for non-commercial irrigation is 2.7 MGD (4.2 cfs).

As discussed in the subsection above summarizing groundwater rights in the county, the total maximum authorized rate under these rights is 232.7 cfs. If the estimated exempt use of groundwater is added to this total, the combined maximum use of groundwater is calculated to be 238.6 cfs. The estimated exempt use of groundwater (5.9 cfs) is only 2.5 percent of this total maximum groundwater rights (potential total use), as shown in **Figure 3-5**. While this comparison may be slightly skewed because it compares the maximum authorized rate of groundwater rights with calculations based on actual exempt uses, these figures indicate that exempt uses of groundwater are currently a relatively small portion of the total groundwater use that is allowed within the county.

Figure 3-5 Groundwater Rights and Estimated Exempt Use in Benton County



3.3 Municipal Community Water Demands (Uses)

Existing water demands for communities are dependent on a range of variables including but not limited to: climate, land use, service area, storage, technology, policies, and socioeconomics. It is important to note that water use varies seasonally. Water demands for communities in Benton County peak during the summer months.

Water demands (use) are based on demand information compiled from existing reports and databases at the local and state level. Existing water demands for municipalities and non-municipal communities, whose water sources were described in **Section 2**, are described in the following sections.

3.3.1 Existing Municipal Community Water Use

NOTE: The water demands described below are conservative estimates based on existing city water management reports, intended to address the range of current municipal water uses in Benton County.

Generally, a water use permit is issued for up to 5 years. After that time, the permit holder is expected to submit evidence that the water use has been fully developed (perfected) and is ready for a water right certificate. It is not uncommon for communities to have undeveloped water rights. As municipalities grow, perfecting undeveloped portions of water rights is important to the local economy and residents.

Under qualifying circumstances, a permit may be extended for the amount of time needed to complete construction of the water diversion, treatment, and distribution system and to put all of the water to beneficial use. In the case of municipalities, there is a twenty-year permit period allowed to complete construction and put the water to beneficial use. It is important to note that all permit extensions issued during this time have a requirement of completing a Water Management and Conservation Plan (WMCP) prior to diverting more water than currently being used (ORS 537.230).

Existing Water Management and Conservation Plans (WMCPs) were compiled for all Benton County municipalities and used to determine the existing water use for incorporated cities countywide. If WMCPs were not available or these planning reports yielded insufficient information to estimate current water use, other water management and planning reports were used. For example, the City of Philomath and the City of Adair Village currently have not created WMCPs so the cities' water master plans, state water use databases, and other available information were used to estimate current water use.

Demands (uses) are reported in various forms by each community and are based on various data depending on the community type. For example, all of the incorporated cities have different water use classes (e.g. residential, commercial and industrial) to estimate total demand. Municipalities estimate and report the Average Day Demand (ADD) and Maximum Day Demand (MDD) for the full range of water use that occurs within a municipal service area.

For every city within Benton County, on a city-by-city basis, a "high" (MDD) and a "low" (ADD) was used to determine current uses and for forecasting annual future uses (see

Section 5). "Low"- Average Day Demands (ADD) was estimated at half the "High" Max Day Demand (MDD) for the purposes of this study. The 2007 estimated populations from Portland State University Population Research Center (see **Appendix E**) combined with the data from existing city water use reports were used to estimate residential uses. Total water uses within a given city (residential, commercial, industrial, etc.) were gathered from existing water plans and reports produced by each city and used to produce a simple linear regression to estimate water demands in year 2050 (see **Appendix F** for linear regression model/data).

The following sections describe current water uses based on data and the previously mentioned assumptions. We begin with current estimated population (residential) uses **(Table 3-18)**, demand multipliers **(Table 3-19)**, and current total use estimates **(Table 3-20)**. **Section 5** presents future water use forecasts based on these estimates, operating on projected population and land use assumptions.

Table 3-18 Current Estimated Residential (Population Only) Water Use

	Demands (Uses) Cubic feet/second (cfs) Million gallons/day (mgd)	
City	**High (MDD) cfs (mgd)**	**Low (ADD) cfs (mgd)**
Adair Village	1 (0.66)	0.51 (0.33)
Corvallis	12 (7.9)	6.1 (4.0)
Monroe	0.55 (0.36)	0.28 (0.18)
North Albany	2.8 (1.8)	1.3 (0.87)
Philomath	1.7 (1.1)	0.86 (0.55)
TOTAL	18.2 (11.82)	9.2 (5.93)

Max Day Water Demands (MDD) = Estimated Population X MDD multipliers; **Average day demand (ADD)** multiplier = half of MDD multiplier

Table 3-19 Current Estimated Residential (Population Only) City Water Use Multipliers (rounded estimates)

	Demand Multipliers	
City	**High (MDD)**	**Low (ADD)**
Adair Village	0.000731	0.000366
Corvallis	0.000144	0.000072
Monroe	0.000587	0.000294
North Albany	0.000271	0.000136
Philomath	0.000245	0.000123

* See descriptions below for method of finding current demand multipliers by City

Table 3-20 Estimated Total Water Uses for Benton County Cities

	Demands (Uses)	
City	**High (MDD)- cfs (mgd)**	**Low (ADD)- cfs (mgd)**
Adair Village	1.5 (1.0)	1.2 (0.75)
Corvallis	25 (16)	12.5 (8.1)
Monroe	0.55 (0.36)	0.28 (0.18)
North Albany	2.8 (1.8)	1.3 (0.87)
Philomath	5.0 (3.2)	2.5 (1.6)
TOTAL	35.5 (23)	17.8 (11.5)

Sources for Estimating Current Population and Total Maximum Day Water Demands for Cities

1. Adair Village Water Master Plan (update 2008)
2. City of Corvallis Water Distribution Facility Plan (1998); Corvallis Water Management and Conservation Plan (2005)
3. City of Monroe Water Management and Conservation Plan (2007)
4. City of Albany- Water System Hydraulic Modeling Update (2008)
5. City of Philomath Water Master Plan (2005)

3.3.2 Descriptions of Current City Water Demand (Use) Estimates

City of Adair Village

The City of Adair Village reported using an average of 285,489 gallons per month in 2007 to the Oregon Water Resources Department (OWRD). Based on the City of Adair Village current Water Master Plan update (May 2008), the City's maximum daily demand (MDD) determined in 2006 was 661,587 gallons per day (gpd); 0.661587 million gallons per day (mgd).

Based on this information, an MDD multiplier of 0.000731 (0.661587 million gallons per day/905 people) and an Average Daily Demand (ADD) multiplier of 0. 0.000366 were produced. The 2007 population according to Portland State University (PSU) Population Research Center is equal to that of 2006, making current MDD of 1.02 cfs: cubic feet per day (0.66 mgd) and current ADD of 0.51 cfs (0.33 mgd).

The 2008 ADD included only the current population (905) inside of the City's current Urban Growth Boundary (UGB). It is important to note that water is currently served to a population of approximately 170 people outside of the current UGB with possible water service connection to an industrial property also outside of the UGB (see **Section 5**).

City of Albany (North Albany)

In 2007, the City of Albany reported using an average of approximately 265 million gallons of water per month to the OWRD. The highest water use was reported in July with approximately 407 million gallons used. The City's current water management plan projects the full use of both the City's water rights (permit and certificate) by 2063 (**Section 3**).

North Albany currently receives water from the City of Albany. The current city limits of North Albany align with the UGB of the City of Albany and are part of the city's water service area. The City also supplies water to the Dumbeck Water Company, which distributes this water inside and outside the city limits in the North Albany area. The City also supplies water to the North Albany County Service District (NACD).

In 2008 the City of Albany conducted a Water System Hydraulic Modeling Update which clarified current and future water uses of North Albany. The study found that the existing MDD for North Albany, including the Dumbeck Water Company, is 2.8 cfs (1.79 mgd) and the ADD is 1.34 cfs (0.87 mgd).

City of Corvallis

In 2007, the City of Corvallis reported to the OWRD an average use of approximately 180 million gallons per month of Willamette River water. September is the month of highest water use of approximately 309 million gallons.

The City of Corvallis 2005 Water Management and Conservation Plan (WMCP) predicted the future maximum day demand (MDD). The WMCP used the Willamette as the sole source; the production from Rock Creek Water Treatment Plant (WTP) was assumed to provide no water to meet the peak day demand projection. Under these assumptions, Corvallis would utilize its full existing water certificate (59051) and current permit (S35551) by year 2035 (**Section 3**).

Based on the Corvallis WMCP and Corvallis Water Distribution System Facility Plan, the City's average daily demand (ADD) over a 5-year period (1992-1997) was 11.6 cfs (7.49 mgd). The MDD for the same 5-year period was 22.3 cfs (14.45 mgd).

The City showed a steady increase in annual average water demand from 7.06 mgd in 1992-1993 to 7.90 mgd in 1996-1997. This average annual demand and average peak day demand includes residential, commercial, industrial, and public/institutional water uses.

To plan for the water demands of current and future populations, the City of Corvallis determined:

- the average residential water demand for years 1992-1993 was 3.42 mgd (~48% of total water demand; see Corvallis Water Distribution System Facility Plan)
- commercial/industrial water demand was 2.33 mgd (~32% of total water demand);
- Oregon State University water demand averaged .80 mgd (~11% of total water demand); and,
- Hewlett-Packard (HP) annual average demand was .63 mgd (~9% of total water demand).

The City of Corvallis determined that the average daily water demand (ADD) with a population of 50,000 in year 1998 was 7.5 mgd. Based on the 48 percent estimate of residential water demand, 3.6 mgd (48% X 7.5 mgd) was the ADD for the residential population. This forms an ADD multiplier estimate of 0.000072 (3.6 mgd/50,000) and MDD multiplier of 0.000144 (.000072 X 2).

Based on historical demands, demand multipliers were used to determine the 2007 ADD to be 6.1 cfs (8.2 mgd) (54,890 (2007 PSU Population X 0.000072). The MDD was estimated to be 12.19 cfs (7.9 mgd).

City of Monroe

In 2005, the City of Monroe reported an average monthly water use from the Well No. 1 water source, totaling approximately 2.1million gallons. The month of highest reported water use was July with 3.1 million gallons of water used. Monroe projects the full use of the Long Tom surface water right by year 2027 (see **Section 2 Water Sources**).

The City of Monroe completed a Water Management and Conservation Plan (WMCP) in April 2007 detailing current maximum day demand (MDD) of 0.57 cfs (0.367 mgd).

The MDD multiplier is equal to 0.000587 (2007 population- 625/.367 mgd). The estimated ADD multiplier is 0.000294 forming a current ADD estimate of 0.28 cfs (0.1835 mgd). It should be noted that the residential and total demands shown in **Tables 3-18** and **3-20** are equal for the City of Monroe. This is due to the current demand only from residential and school users.

City of Philomath

In 2006, Philomath reported an average monthly water use of approximately 14.6 million gallons from the Marys River. An additional average monthly water use of approximately 1.2 million gallons from the groundwater source was also reported to the OWRD. The highest water use from the Marys River totaled 27.97 million gallons during the month of July 2006.

In 2005, the City of Philomath completed a Water System Master Plan estimating current and future water demands (uses) based on historical per capita population demands. The plan determined that the 2005 MDD for the City population of 4,220 was 1.6 cfs (1.03 mgd), with an ADD of 0.77 cfs (0.50 mgd). This forms a MDD multiplier of 0.000245 (4,200/ 1.03 mgd) and ADD multiplier of .000123.

The current 2007 MDD for Philomath is estimated at 1.7 cfs (1.11 mgd) (PSU Population- 4,530 X 0.000245024). The current estimated ADD is 0.86 cfs (0.55 mgd). According to the City Public Works Departments for Corvallis and Philomath, there is a functioning water supply pipeline inter-tie between the two cities. Currently water is purchased by Philomath from Corvallis when required during maintenance and emergency supply situations.

3.4 Non-Municipal Community Water Demands (Use)

Municipalities are not the only entities serving water to customers for domestic purposes. Community water supply districts also provide domestic water supplies in areas outside municipal service areas. The Oregon Department of Human Services (DHS) reports 10 community water supply systems provide drinking water to customers within Benton County. All but one of these water providers uses groundwater as their source of water. According to DHS, these water providers serve a total of 707 connections and a total population of 1,785.

Table 3-21 shows the estimated water uses for non-municipal communities based on methods and findings shown in **Table 3-17**. For each community, an average peak and average low use per household was found using the average peak and low use estimated for metered County and community service districts plus the community water system data. In the case of Alsea County Service District, Cascade View County Service District, and Ridgewood District Improvement Company, specific peak water uses from metered data gathered during the project period were used in place of average system estimates.

Table 3-21 Current Estimated Water Uses for Non-Municipal Communities

Community	Permitted rate- cfs (mgd)[1]	Source Name(s) [1]	Estimated Pop[2]	Estimated Average # of HHs	Average Peak Month Demand (gpd)	Average Low (January) Demand (gpd)
Alsea County Service District	0.6 (0.38)	Well (East), Well (West), north fork of Alsea River	200	89	26,700	13,350
Cascade View Estates County Service District	0.08 (0.052)	Wells #1- #4	160	71	42,600	10,650
Fir View Water Company	0.13 (0.08)	Domestic-Exempt well(s)	180	80	42,640	12,240
Jackson Creek Water Association	*	Domestic-Exempt well(s)	45	20	10,660	3,060
Knoll Terrace Manufactured Home Community	0.18 (0.12)	Well #1, Well #2	500	223	118,859	34,119
North Corvallis-MHP	*	Domestic-Exempt well(s)	100	45	23,985	6,885
Pioneer Village Water Co.	*	Domestic-Exempt well(s)	115	51	27,183	7,803
Raintree Estates	*	Domestic-Exempt well(s)	50	22	11,726	3,366
Ridgewood District Improvement Company	0.37 (0.24)	Wells #1-#5	110	49	34,300	8,820
Vineyard Mountain Water and Improvement District	0.3 (0.19)	Wells #1-#3	325	145	77,825	22,185
		TOTALS	**1785**	**797**	**122,478**	**416,478**

*** = No water right (exempt groundwater use); ‘HHs’ = households**
1. Oregon Water Resources Department (OWRD)- Water Rights Information System (2008)
2. Oregon Department of Human Services (ODHS)- Drinking Water Program Database (2008)

Section 4

Water Sources Reliability:

Quality, Availability and Other Issues

After considering the water sources available within the county, and the current demands on those resources, the next step in the analysis is to determine whether there are water resources available for future water needs. This analysis must consider both natural limitations in the resource (e.g., stream flow and water quality) and administrative limitations, such as Oregon Water Resources Department (OWRD) regulations that would limit issuance of new water rights. These issues are further described below for both surface water and groundwater.

Summary

Considering current OWRD water allocation policy, surface water is generally not available within Benton County for new surface water (live flow) rights on a year-round basis (see Summary **Table 4-1** below). However, water is generally available for new winter-time storage rights. The future use of water from these waterways may be further limited, however, due to the basin program classifications and other regulations. See **Section 4.1.1**.

Table 4-1 Water Availability Summary for Major Surface Water Sources

Water Body	80% Exceedance		50% Exceedance (for storage)	
	Year-round Availability?	**Months When Water Is Available**	**Year-round Availability?**	**Months When Water Is Available**
Willamette R. (above Periwinkle Cr.)	Yes	Jan. through Dec.	Yes	Jan. through Dec.
Long Tom R. (at mouth)	No	Sept. through July	Yes	Jan. through Dec.
Luckiamute R. (above McTimmonds Cr. & above Kopplein Cr)	No	Oct. through June	No	Oct. through July
Marys R (above Muddy Cr. & above Blakesley Cr.)	No	Dec. through April	No	Nov. through May, & July
Marys R. (at mouth)	No	Dec. through May	No	Nov. through July
Muddy Cr. (above Evergreen Cr.)	No	Dec. through May	No	Nov. through July
Alsea R. (above Five Rivers)	No	Dec. thru June	No	Nov. through July

A potentially limiting factor for the use of water is water quality. Poor water quality can limit the usefulness of water; degraded quality can reduce or prevent new water rights. DEQ's 303(d) list indicates that the rivers and tributaries within Benton County do not meet state water quality standards for several parameters. See **Section 4.1.2**

The National Oceanic & Atmospheric Administration (NOAA) biological opinion (BIOP) for the Willamette Basin includes minimum flow objectives for the Willamette River and its tributaries. It is not yet known how these flow objectives will impact new water right applications on affected waterways in the Willamette Basin. See **Section 4.1.3**

The most significant natural groundwater quality impacts in Benton County occurs in areas of high salinity associated with the Marine Siltstones and in wells drilled too deep attempting to increase yields. Additionally, a portion of the county has been designated as a Groundwater Management Area due to high levels of nitrates in groundwater wells. A more detailed evaluation of potential groundwater contamination outside of city UGBs should be a consideration for subsequent phases of this study. The primary concern for potential contaminants of surface water sources include contaminated runoff, stormwater, and waste water discharge. For groundwater sources, the primary concern is contaminated water from storage tanks, high density septic systems, improperly discarded chemicals, transportation related spills, and agricultural activities that has infiltrated from the surface into the aquifer. See **Section 4.2**

A number of other considerations could affect the ability to obtain more water to meet future demands, including climate change and the National Oceanic and Atmospheric Administration's Biological Opinion (BIOP) for the Willamette Basin, which includes minimum flow objectives for the Willamette River and its tributaries. See **Section 4.2.3**

Information Inset

Oregon Water Resources Department – Water Allocation Policy

Under the OWRD Water Allocation Policy, the agency must review its Water Availability Report System (WARS) to determine if water is available for the proposed use. For live flow water right applications, OWRD must find that water is available for a new use at 80 percent exceedance (water available 80 percent of the time, or eight years out of ten). For water right applications to store water, OWRD generally must find water is available for a new use at 50 percent exceedance (or five years out of ten), although the agency is not strictly limited to following this approach for storage rights.

Further, OWRD's basin program rules "classify" surface water to identify the uses that are allowed. While the Oregon Water Resources Commission may allow exceptions to these classifications in some limited circumstances, OWRD will generally not approve a water right application for a use that is not a classified use.

OWRD developed WARS modeling to assist the agency with processing of water right applications. This tool includes estimations of stream flows to determined availability calculations for proposed new uses of water. On larger waterways, OWRD calculates water availability at several locations and applies those results to new applications according to their location within a basin. Each of these areas is called a "water availability basin" (WAB).

OWRD begins its water availability calculations by:

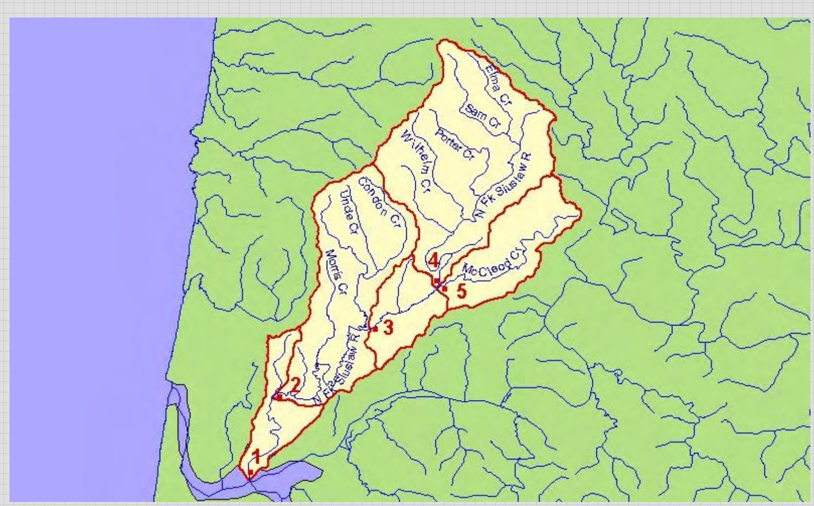
1. Average natural stream flows on a monthly basis or the estimates of water in the stream prior to any diversions for beneficial use. For proposed uses of <u>live flow</u>, estimate the amount of water at 80 percent exceedance. For proposed new <u>storage projects</u>, calculate the amount of water that would be available at 50 percent exceedance.

2. Subtract from the estimated natural flow, an estimate of consumptive use, as well as the flows needed for instream water rights for each month.

3. The difference between 1 and 2 indicate whether water is available for new appropriations for each month in that WAB.

4. Finally, OWRD considers downstream water users. Since the WABs are nested, water is only available for additional appropriation during months when there is net flow available from the proposed diversion location all the way downstream. **Figure 4-1** below demonstrates how the WABS are nested as the water flows downstream in a watershed.

Figure 4-1
Nesting WABS Example



Example Figure courtesy of Rick Cooper, Oregon Water Resources Department

4.1 Surface Water

4.1.1 Water Availability and Basin Program Classification

Regulatory constraints limit new uses (water rights) of surface water. The two primary regulatory constraints are water availability and basin program classifications.

In order to provide some insights into whether surface water sources in Benton County may be available for future water use, the following subsection describes both water availability (at 80 and 50 percent exceedance), and the basin classifications for the major surface water sources. Water availability information was obtained from the OWRD water availability report system (WARS) web page: http://apps2.wrd.state.or.us/apps/wars/wars_display_wa_tables/water_availability_analysis.aspx.

Appendix D contains complete 80 and 50 percent numerical tables, showing the estimated stream flows for major water sources within Benton County.

A review of OWRD's water availability information from WARS for the county's major waterways shows that surface water is generally not available for new surface water (live flow) rights on a year-round basis. The WARS information does show, however, that water is generally available for new winter-time storage rights. The future use of water from these waterways may be further limited, however, due to the basin program classifications. These opportunities and limitations are further described below for each of the six major streams that were identified as the major sources within the county.

Willamette River -- Water Availability

OWRD estimates water availability on the Willamette River at a number of locations, including above Periwinkle Creek at USGS gauge 1417400. (Periwinkle Creek flows into the Willamette at Albany.) The water availability information for a proposed new water use from the Willamette River will depend on where the water is to be diverted from the system. Most uses of water from the Willamette River in Benton County would be within the water availability basin (WAB) above Periwinkle Creek.

OWRD estimates that the natural stream flow at 80 percent exceedance at Periwinkle Creek ranges from 11,600 cfs in February to 2,540 cfs in September, as shown in **Table 4-2**. OWRD then calculates the estimated consumptive uses for the appropriative water rights and the flow required to meet instream water rights. As shown below, these flow demands range from 4,520 cfs in February to 235 cfs in October. This calculation is performed for each month. The analysis shows water is available at 80 percent exceedance year-round in the Willamette above Periwinkle Creek.

The net water available for appropriation ranges from 255 cfs in August to 7,020 cfs in January. Since water is also available year-round in all of the downstream WABs, water is available year-round from this location on the Willamette River. Willamette River is unique in that it still has water available year-round for future live flow water rights.

Table 4-2 Net Water Availability in the Willamette above Periwinkle Creek

Month	Estimated Natural Flow (80 percent exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	10,100.00	1,330.00	1,750.00	7,020.00
February	11,600.00	4,250.00	1,750.00	5,600.00
March	11,000.00	4,520.00	1,750.00	4,730.00
April	9,760.00	4,220.00	1,750.00	3,790.00
May	8,430.00	2,500.00	1,750.00	4,180.00
June	5,360.00	806.00	1,750.00	2,800.00
July	3,270.00	607.00	1,750.00	913.00
August	2,560.00	555.00	1,750.00	255.00
September	2,540.00	476.00	1,750.00	314.00
October	2,860.00	235.00	1,750.00	875.00
November	4,170.00	320.00	1,750.00	2,100.00
December	8,150.00	342.00	1,750.00	6,060.00

OWRD also calculates the natural streamflow at 50 percent exceedance. See **Table 4-3.** These values are used to determine whether water is available for water right applications for storage projects. Water availability analysis shows that water is available from the Willamette River upstream of Periwinkle Creek year-round at 50 percent exceedance. The agency estimates there is net 4,990,000 acre-feet available annually at 50 percent exceedance. This full amount of water may not necessarily be stored, since it includes water available during months outside of the storage season.

In reaching this determination, OWRD estimates the natural stream flow on the Willamette above Periwinkle Creek ranges from 19,100 cfs in December to 2,970 cfs in September at 50 percent exceedance. The consumptive portion of water rights is subtracted as well as the storage rights on this part of the river. OWRD calculates that the flow required to meet these needs ranges from 4,520 cfs in March to 235 cfs in October. OWRD then subtracts the flow for instream requirements to determine the net water available at 50 percent exceedance. In this case, the 1,750 cfs in-stream requirement reflects the minimum perennial stream flow (MF 184 - See **Section 3**).

Table 4-3 Net Water Availability in the Willamette above Periwinkle Creek

Month	Estimated Natural Flow (50 percent exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	17,300.00	1,330.00	1,750.00	14,200.00
February	17,400.00	4,250.00	1,750.00	11,400.00
March	15,800.00	4,520.00	1,750.00	9,530.00
April	13,800.00	4,220.00	1,750.00	7,830.00
May	11,400.00	2,500.00	1,750.00	7,150.00
June	7,370.00	806.00	1,750.00	4,810.00
July	4,130.00	607.00	1,750.00	1,770.00
August	2,980.00	555.00	1,750.00	675.00
September	2,970.00	476.00	1,750.00	744.00
October	3,550.00	235.00	1,750.00	1,570.00
November	8,170.00	320.00	1,750.00	6,100.00
December	19,100.00	342.00	1,750.00	17,000.00

Basin Program Classifications

OWRD generally issues new water rights only for uses that are identified as "classified uses" for the proposed source. OWRD's Willamette Basin Program governs the Willamette. The main stem Willamette River upstream from a location near Albany to its confluence with the McKenzie River (Lane County) is classified for the following purposes from September 1 through June 30: domestic, livestock, municipal, industrial, agricultural, commercial, pollution abatement, fish life, wildlife, recreation, power, mining, wetland enhancement, and public instream uses.

From July 1 through August 31, however, the mainstem Willamette in the above-described reach is classified for the following purposes: livestock, public instream uses, and domestic and commercial use for customarily domestic purposes not to exceed 0.01 cfs (use of water for such purposes as drinking, cooking and sanitation within a commercial establishment).

The Willamette Basin program classifies the surface water of the Willamette River and its tributaries for storage from November 1 to June 30, unless storage is expressly prohibited in a particular stream.

Although Willamette live flow is not classified for municipal purposes during July and August, OWRD could issue a water right that would allow the use of stored Willamette River water year-round, including July and August.

Summary

OWRD's administrative processes do not preclude the issuance of new, year-round water rights from the mainstem Willamette adjacent to Benton County for domestic, livestock, public instream uses, and some limited commercial uses, or for a water right to store water during the storage season and to use the stored water for any beneficial purpose during the year.

To obtain a new water right for other purposes, the applicant would need to obtain an exception to basin rules from the Oregon Water Resources Commission, or demonstrate that it could obtain water from an alternate source during July and August. On the other hand, water in the Willamette is both available and classified for storage during the storage season of November 1 through June 30.

Long Tom River -- Water Availability

OWRD calculates water availability at one location on the Long Tom River which is above its mouth. The flow estimates at 80 percent exceedance show that natural stream flows range from nearly 700 cfs in February to 32 cfs in September, **Table 4-4**. Required flows for consumption plus storage are subtracted from the estimated stream flow, netting water available. Since the Long Tom does not have an instream water right, the agency does not reduce the flow for instream requirements.

Water availability on the Long Tom shows net water available at an 80 percent exceedance for each month, except August. Since water is available year-round in the downstream WABs, water is available for further appropriation in every month except August. Consequently, a new live flow water right for a year-round use is not possible. Irrigation, however, is a possibility because it is a seasonal use.

Table 4-4 OWRD Water Availability above the Long Tom River Mouth

Month	Estimated Natural Flow (80 percent exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	568.00	149.00	0.00	419.00
February	697.00	388.00	0.00	309.00
March	596.00	555.00	0.00	40.90
April	373.00	249.00	0.00	124.00
May	215.00	63.80	0.00	151.00
June	105.00	29.60	0.00	75.40
July	50.60	47.90	0.00	2.67
August	35.40	38.70	0.00	-3.28
September	32.10	21.20	0.00	10.90
October	35.30	5.32	0.00	30.00
November	82.50	5.08	0.00	77.40
December	364.00	105.00	0.00	259.00

The Department's water availability analysis for the Long Tom River at 50 percent exceedance shows that water is available for storage during all months of the year (**Table 4-5**). The agency estimates that an annual average of 262,000 acre-feet would be available at 50 percent exceedance. However, this volume includes water available outside of the storage season.

Table 4-5 OWRD Water Availability above the Long Tom River Mouth

Month	Estimated Natural Flow (50 percent exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	1,220.00	149.00	0.00	1,070.00
February	1,330.00	388.00	0.00	942.00
March	984.00	555.00	0.00	429.00
April	590.00	249.00	0.00	341.00
May	301.00	63.80	0.00	237.00
June	146.00	29.60	0.00	116.00
July	68.80	47.90	0.00	20.90
August	42.40	38.70	0.00	3.72
September	40.00	21.20	0.00	18.80
October	48.40	5.32	0.00	43.10
November	211.00	5.08	0.00	206.00
December	1,050.00	105.00	0.00	945.00

Basin Program Classifications

Surface water in the Long Tom River Sub basin is classified in the Willamette Basin Program for livestock, wetland enhancement, public instream uses, domestic, and commercial use for customarily domestic purposes not to exceed 0.01 cfs (use of water for such purposes as drinking, cooking and sanitation within a commercial establishment). Up to 370 cfs of stored water released from Fern Ridge Reservoir into the Long Tom is classified for domestic and livestock use only. It remains unclear how, or if, this classification of stored water could be implemented by OWRD, because the water is stored exclusively for irrigation. The State cannot currently issue water rights from Fern Ridge Reservoir for domestic use - the current major water use for the City of Monroe.

Summary

The Long Tom provides minimal opportunities for future live flow water rights, due to the lack of available water year-round at 80 percent exceedance and the limited classified uses. On the other hand, water is currently available at 50 percent exceedance during the storage season and storage is a classified use.

<u>Luckiamute River</u> -- Water Availability

OWRD calculates water availability in the Luckiamute River at several locations, including two that are relevant to the use of water in Benton County. OWRD estimates stream flow above Kopplein Creek for water uses in the water availability basin upstream. Here, the river has a drainage area of slightly over 34 square miles and a length of approximately 51 miles.

For uses of Luckiamute water in Benton County downstream from Kopplein Creek, OWRD estimates stream flow at a point above McTimmonds Creek, after the river has flowed back into Polk County. At this point, the river has a drainage area of approximately 115 square miles and a length of 159 miles.

After subtracting consumptive use, storage and instream requirements from the estimated stream flow, net water is available for both stream reaches during the months of October through July, as shown below.

Table 4-6 Luckiamute River at 80 Percent Exceedance (WAB- Model)

Stream name	Nesting order	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Willamette at mouth	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Molalla R.	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Mill Cr.	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Luckiamute at mouth	4	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
Luckiamute above Soap Cr.	5	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
Luckiamute above McTimmonds Cr.	6	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
Luckiamute above Kopplein Cr.	7	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes

Water is only considered available for additional appropriation in this area from October through June because water is not available in July at the river's mouth. Water must be available at all downstream locations during July to be considered available at an upstream location. **Table 4-6** shows the nesting WABs considered in this analysis. Months for each river reach with a "no" indicate that water is not available that month; "yes" indicates availability.

OWRD's water availability calculations at 50 percent exceedance for the Luckiamute River above Kopplein Creek show that there is net water available year-round. Appendix D shows the water availability analysis at 50 percent exceedance above McTimmonds Creek shows that there is net water available from October through June.

Consequently, WARS reports water available at 50 percent exceedance for new storage rights only from October through July for both reaches, due to restricted water availability in the reach above McTimmonds Creek. **Table 4-7** shows the nesting WABs used to determine water availability at 50 percent exceedance. An estimated total annual average of 206,000 acre-feet would be available at 50 percent exceedance above McTimmonds Creek.

Table 4-7 Luckiamute River above Kopplein Creek at 50 Percent Exceedance (WAB-Model)

Stream name	Nesting order	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Willamette at mouth	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Molalla R.	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Mill Cr.	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Luckiamute at mouth	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Luckiamute above Soap Cr.	5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Luckiamute above McTimmonds Cr.	6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Luckiamute above Kopplein Cr.	7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes

Basin Program Classifications

The Willamette Basin program rules provide different classifications for the Luckiamute River mainstem than for its tributaries. Classifications for the mainstem depend on the time of year. From October 1 through July 31, the mainstem is classified for domestic, livestock, irrigation, municipal, agricultural, commercial, industrial, power, mining, fish life, wildlife, recreation, pollution abatement, wetland enhancement and public instream uses. For the period from August 1 through September 30, the Luckiamute mainstem is classified for domestic, livestock, public instream uses, and commercial use for customarily domestic purposes not to exceed 0.01 cfs.

The Luckiamute tributaries are classified separately from the mainstem. Several tributaries, including Maxfield Creek, are restrictively classified year-round for only domestic, livestock, public instream uses, and commercial use for customarily domestic purposes not to exceed 0.01 cfs. The remaining tributaries have the same restrictive classifications only from May 1 through October 31. During the remainder of the year (November 1 through April 30), the tributaries are classified for domestic, livestock, irrigation, municipal, agricultural, commercial, industrial, power, mining, fish life, wildlife, recreation, pollution abatement, wetland enhancement and public instream uses.

Summary

OWRD would generally not issue a new live flow water right from the Luckiamute for a year-round use, since water is not available from July through September. OWRD would not issue a water right for seasonal uses such as irrigation because water is not available during the entire irrigation season (March 1 through October 31) and because irrigation is not a classified use during August and September on the mainstem and from May through October for most of the tributaries.

Based on water availability and basin classifications, OWRD could issue new storage rights from the Luckiamute River because water is available at 50 percent exceedance during the November 1 to June 30 storage season and storage is a classified use.

Marys River -- Water Availability

Water availability is calculated at a number of locations on the Marys River. OWRD estimates availability for the greatest portion of the basin above Blakesley Creek. Blakesley Creek flows into the Marys River northeast of Wren. At this point, the river's drainage area is 92 square miles, and is 104 miles in length. OWRD calculates that water is available at 80 percent exceedance from December through April at this location.

For water uses downstream from Blakesley Creek, water availability is estimated above Muddy Creek and also at the mouth of the river. At the location above Muddy Creek, water is available at 80 percent exceedance from December through April. For uses in the lowest portion of the Marys River Basin, OWRD calculates water availability at the mouth, where water is available December through May at 80 percent exceedance. **Table 4-8** summarizes water availability in these WABs on the Marys River at 80 percent exceedance.

Table 4-8 Marys River at 80 Percent Exceedance (WAB- Model)

Stream name	Nesting order	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Willamette at mouth	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Molalla R.	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Mill Cr.	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Periwinkle Cr.	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marys at the mouth	5	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes
Marys above Muddy Cr.	6	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes
Marys above Blakesley Cr.	7	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes

For new storage rights, the analysis is the same for the reaches of the Marys River above Blakesley Creek and above Muddy Creek. In both cases, water is available from November through May, and in July. For the lowest water availability basin in the system, OWRD's water analysis shows that water is available for storage above the mouth from November through July. An average of 280,000 acre-feet would be available annually at 50 percent exceedance at the river's mouth. A storage right is not necessarily available for this amount of water, since this total includes quantities of water that are available outside of the November 1 to June 30 storage season. **Table 4-9** summarizes water availability at 50 percent exceedance.

Table 4-9 Marys River at 50 Percent Exceedance (WAB- Model)

Stream name	Nesting order	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Willamette at mouth	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Molalla R.	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Mill Cr.	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above PeriwinkleCr.	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marys at the mouth	5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes
Marys above Muddy Cr.	6	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes
Marys above Blakesley Cr.	7	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes

Basin Program Classifications

Similar to the Luckiamute, the Marys River mainstem and tributaries have different basin program classifications. The mainstem is classified year-round for domestic, livestock, irrigation, agricultural, commercial, municipal, industrial, power, mining, fish life, wildlife, recreation, pollution abatement, wetland enhancement and public instream uses.

The tributaries of the Marys River are classified for these purposes only from November 1 through May 31. For the period of June 1 through October 31, tributaries of the Marys River are classified only for domestic, livestock, public instream uses, and commercial use for customarily domestic purposes not to exceed 0.01 cfs.

The general provision for storage as a classified use applies to the Marys River.

Summary

OWRD would not generally issue a new live flow water right for a year-round use or a use during the irrigation season in the Marys River basin. OWRD might, however, issue new storage rights from the Marys River since water is available at 50 percent exceedance during the November 1 to June 30 storage season and storage is a classified use.

Muddy Creek -- Water Availability

OWRD calculates water availability at one location on Muddy Creek at a point above Evergreen Creek. Water availability for Muddy Creek above Evergreen Creek shows that water is not available at 80 percent exceedance in August. However, because water is not available from June through November at the mouth of the Marys River, this limitation applies to Muddy Creek as well. (**Table 4-10**)

Water is available in Muddy Creek at 50 percent exceedance only from November through July (**Tables 4-11**) due to limited water availability at the mouth of the Marys River. The agency's WARS system calculates that an annual average of 102,000 acre-feet would be available at 50 percent exceedance.

Table 4-10 Muddy Creek at 80 Percent Exceedance (WAB- Model)

Stream name	Nesting Order	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Willamette at mouth	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Molalla R.	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Mill Cr.	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Periwinkle Cr.	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marys at the mouth	5	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes
Muddy Cr. above Evergreen Cr.	6	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes

Table 4-11 Muddy Creek above Evergreen Creek at 50 Percent Exceedance (WAB- Model)

Stream name	Nesting order	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Willamette at mouth	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Molalla R.	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Mill Cr.	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Willamette above Periwinkle Cr.	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marys at the mouth	5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes
Muddy Cr. above Evergreen Cr.	6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes

Basin Program Classifications

Muddy Creek is a tributary of Marys River therefore the basin program classifications for the tributaries of the Marys apply to the Muddy.

Summary

OWRD would not generally issue new live flow water rights for year-round or irrigation uses from Muddy Creek since water is not available from June through November. OWRD could, however, issue new storage rights from Muddy Creek since water is available at 50 percent exceedance during the November 1 to June 30 storage season.

<u>Alsea River</u> -- Water Availability

OWRD calculates water availability on the Alsea River at a number of locations. The location closest to Benton County is above Five Rivers in Lincoln County. Water availability analysis for the Alsea River above Five Rivers shows that water is only available at 80 percent exceedance from December through June, as shown in **Table 4-12**.

OWRD's report for this location shows that water is available at 50 percent exceedance from November through July, as shown in **Table 4-13**. The WARS system calculates that an annual average of 308,000 acre-feet would be available for storage.

Table 4-12 Alsea River above Five Rivers at 80 Percent Exceedance (WAB- Model)

Stream name	Nesting order	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Alsea at mouth	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Alsea above Line Cr.	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes
Alsea above Hellion Can.	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes
Alsea above Five Rivers	4	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes

Table 4-13 Alsea River above Five Rivers at 50 Percent Exceedance (WAB- Model)

Stream name	Nesting order	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Alsea at mouth	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Alsea above Line Cr.	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Alsea above Hellion Can.	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Alsea above Five Rivers	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes

Basin Program Classifications

The Mid-Coast Basin Program rules do not classify the Alsea River specifically. As a result, the standard classification for this basin applies and water from the Alsea River is classified for domestic, livestock, municipal, irrigation, power development, industrial mining, recreation, wildlife and fish life uses, with preference give to human consumption and livestock consumption over any other beneficial uses. The basin program rules also provide that applications for storage of more than 3,000,000 gallons (9.2 acre-feet) must be reviewed by the Oregon Water Resources Commission and additional minimum stream flows may be established to protect aquatic life or minimize pollution.

Summary

Since water is not available at 80 percent exceedance from July through November of the year, OWRD would not generally issue a new water right on the Alsea River for year-round purpose or irrigation. OWRD might, however, issue new storage rights from the Alsea River since water is available at 50 percent exceedance. A storage application for storage projects larger than 9.2 acre-feet would require additional review.

Summary of Water Availability and Basin Program Classifications in Benton County

Generally, Oregon Water Resources Department will not issue new water rights from the described surface water sources in Benton County. Water is generally not available for appropriation year-round, or during the entire irrigation season, and the allowed uses are limited by basin classifications.

Surface water is available from these rivers and streams for storage during the November 1 through June 30 storage season (for the Willamette Basin), and all of the described waterways are classified for storage during some portion of the year. Once water is stored, that stored water can be used at any time during the year for any beneficial purpose.

4.1.2 Water Quality

Another potentially limiting factor for the use of water is water quality. Water quality can limit water use in two ways. First, poor water quality can limit the usefulness of water for certain uses (e.g., aquatic life, drinking water, recreation). Second, degraded quality can reduce or prevent additional use of water through the administrative review process for new water rights.

As part of its review to protect listed fish species, OWRD sends water right applications to the Department of Environmental Quality (DEQ), Oregon Department of Fish and Wildlife (ODFW), and the Oregon Department of Agriculture (ODA) for comment. If DEQ provides comments indicating that a proposed use of water would further degrade the water quality, OWRD may deny the application, reduce or otherwise impose conditions on the use to prevent further quality degradation.

A useful tool for identifying degraded water quality in the state's surface water bodies is DEQ's 303(d) list. DEQ is required to establish and submit this list to the US Environmental

Protection Agency (EPA) every two years. Once a water body is 303(d) listed, DEQ is responsible for developing Total Maximum Daily Loads (TMDLs) for each water quality limited parameter (e.g., temperature).

DEQ has completed the Willamette Basin TMDLs for temperature, bacteria, and mercury. The EPA approved these in September 2006. The Willamette TMDL includes a Water Quality Management Plan designed to identify strategies and approaches for implementing the TMDL reductions. The plan identifies local, state, and federal agencies or private entities with responsibility for addressing the implementation plans.

Development of the Alsea River TMDLs has been initiated based on the 303(d) listings.

DEQ's 303(d) list indicates that the Alsea, Luckiamute and Willamette Rivers and several Willamette tributaries within Benton County do not meet state water quality standards for several parameters:

- *E. coli* and fecal coliform, which can negatively affect people who participate in water contact recreation.
- Iron, manganese, and mercury, which are toxic substances that can affect aquatic and human health.
- Temperature, which may affect salmon and trout rearing and migration.
- Dissolved oxygen, where various levels are needed for aquatic life.

Table 4-14 Benton County 303d Listed Streams and associated Water Quality TMDLs

Waterbody Name	Listed River Mile	Parameter	Season	TMDL Written
Long Tom River	0 to 24.2	Fecal Coliform	Winter/Spring/Fall	Yes
Long Tom River	0 to 24.2	Temperature	Summer	Yes
Long Tom River	0 to 24.2	E. Coli.	Fall/Winter/Spring	Yes
Long Tom River	0 to 57.3	Manganese	Year round	No
Long Tom River	0 to 57.3	Iron	Year round	No
Marys River	0 to 13.9	Fecal Coliform	Winter/Spring/Fall	Yes
Marys River	0 to 13.9	Temperature	Summer	Yes
Marys River	0 to 13.9	Dissolved Oxygen	January to May	No
Marys River	0 to 41	Manganese	Year round	No
Marys River	0 to 41	Iron	Year round	No
Muddy Creek	0 to 33	Temperature	Summer	Yes
Soap Creek	0 to 16.8	Dissolved Oxygen	October - May	No
Soap Creek	0 to 16.8	Temperature	Year round	Yes
Willamette River Mainstem	110.5 to 149	Fecal Coliform	Winter/Spring/Fall	Yes
Willamette River Mainstem	110.5 to 158.6	Temperature	Summer	Yes
Willamette River Mainstem	110.5 to 158.6	Mercury	All Year	Yes
Alsea River	15.7 to 27	Dissolved Oxygen	September to June	No
Luckiamute River	0 to 60.1	Temperature	Year round	No

* **Source:** Oregon Department of Environmental Quality, Willamette Basin TMDLs

4.1.3 Fish Requirements

When processing an application for a water right, OWRD will conduct an additional public interest review to protect state or federally listed fish species. This review is conducted for both new surface and groundwater rights that will have the potential for substantial interference (PSI) with surface water. A number of criteria are considered. One criterion is whether a well will be within one-quarter mile of a surface water body if the groundwater is hydraulically connected to surface water. The remaining criteria are beyond the scope of this paper.

OWRD sends the applications to ODFW for comment. If there are comments, OWRD may deny a water right application, reduce the requested rate, or otherwise impose conditions on the water right to protect fish resources or water quality. Further, surface water rights will be conditioned to require fish screens to prevent fish from entering the diversion structure. For water right applications requesting the right to store water, OWRD may impose conditions to require passage of peak flows to protect fish and fish habitat, as well as to require fish passage around the dam.

All of the major waterways in the county, with the exception of Muddy Creek, have listed fish species.

Table 4-15 Listed Fish Species in Benton County Waterways

Waterway	Listed Species	State Listing	Federal Listing	Distinct Population Segment (DPS)
Willamette R.	Oregon chub	Sensitive, critical	Endangered	N/A
	Chinook salmon	N/A	Threatened	Upper Willamette R.
	Steelhead trout	Sensitive, critical	Threatened	Upper Willamette R.
Long Tom R.	Chinook salmon	N/A	Threatened	Upper Willamette R.
Luckiamute R.	Steelhead trout	Sensitive, critical	Threatened	Upper Willamette R.
Marys R.	Oregon chub	Sensitive, critical	Endangered	N/A
	Chinook salmon	N/A	Threatened	Upper Willamette R.
	Steelhead trout	Sensitive, critical	Threatened	Upper Willamette R.
Rock Cr.	Steelhead trout	Sensitive, critical	Threatened	Upper Willamette R.
Muddy Cr.	none			
Alsea R.	Coho salmon	N/A	Threatened	Oregon Coast
	Steelhead trout	Critical, vulnerable	N/A	

On July 11, 2008, the National Oceanic & Atmospheric Administration (NOAA) issued a biological opinion (BIOP) for the Willamette Basin, which includes minimum flow objectives for the Willamette River and its tributaries. **Table 4-16** identifies the BIOP's mainstem Willamette River flow objectives and also includes the deficit flows. This affects rivers within Benton County that carry released stored water from federal storage projects.

The mainstem Willamette flow objectives are a combination of the statutorily-authorized minimum flows measured at Albany and Salem (June through October) and the new mainstem "fish flow" objectives (April through June). The "biological minimum flow objectives," or "spring flows", refer to the minimum level of flow that the fisheries agencies have indicated are needed for migrating adult and juvenile salmon and steelhead during the spring (April through June) runoff period. The BIOP describes these spring flows as the minimum levels of flow recommended to sustain anadromous fish populations in the Willamette Basin on a long-term basis.

It remains to be seen how these flow objectives will impact new water right applications on affected waterways in the Willamette Basin.

Table 4-16 Flow Objectives and Deficit Flows for Willamette included in BIOP

Period	Albany	Salem	Salem	Salem
	Mainstem Willamette Flow Objective Minimum Flow (cfs)	Mainstem Willamette Flow Objective 7-Day Moving Average Minimum Flow (cfs)	Mainstem Willamette Flow Objective Minimum Instantaneous Flow (cfs)	Deficit Flows (based on 2001 water year) Weekly Average
April	Not defined	17,800	14,300	15,000
May	Not defined	15,000	12,000	15,000
June 1-15	4,500	13,000	10,500	11,000
June 16-30	4,500	8,700	7,000	5,500
July	4,500		6,000	5,000
Aug 1-15	5,000		6,000	5,000
Aug 16-31	5,000		6,500	5,000
September	5,000		7,000	5,000
October	5,000		7,000	5,000

4.2 Groundwater Reliability

Approximately 80-90 percent of the water demand (use) in Benton County is met by surface water withdrawals from the Willamette River and its tributaries. This is because of the historical availability of surface water in the county and the low aquifer yields in the underlying hydrogeologic formations. Consequently, the severe over-drafting of aquifers and long-term groundwater withdrawals observed in other regions of Oregon has been less frequently a problem in Benton County.

The abundance of rainfall in western Oregon provides plentiful recharge to groundwater. Based on hydrologic studies completed by the USGS (Frank, 1974), the quantity of groundwater available for use on a sustained basis far exceeds the quantity pumped. An evaluation of the reliability of future groundwater supplies identified four key factors:

- Over-development in areas prone to interference between pumping wells;
- Poor water quality and low yields in Marine Siltstone and Sandstone;
- Anthropogenic contamination of groundwater at various locations in the county; and
- Groundwater classifications in the Willamette Basin.

4.2.1 Groundwater Declines and Interference

One concern identified during this study was the localized interference between closely situated wells in rural subdivisions. Current OWRD rules do not require a minimum separation between wells. Consequently, well separation is a function of lot size and the number of wells on each lot. This potential problem is a particular concern in areas drawing water from the Siletz River Volcanics (**Section 2)**.

Figure 4-2 depicts the land that is currently available for development in relation to the principal hydrogeologic units. The areas most susceptible to well-to-well interference are those northwest of Corvallis and west of Philomath that have buildable lands underlain by Siletz River Volcanics. Other areas outside of the volcanics will be less prone to interference because of the lower permeability of the formations. **Section 5** discusses the potential for increased water demands under various land use scenarios.

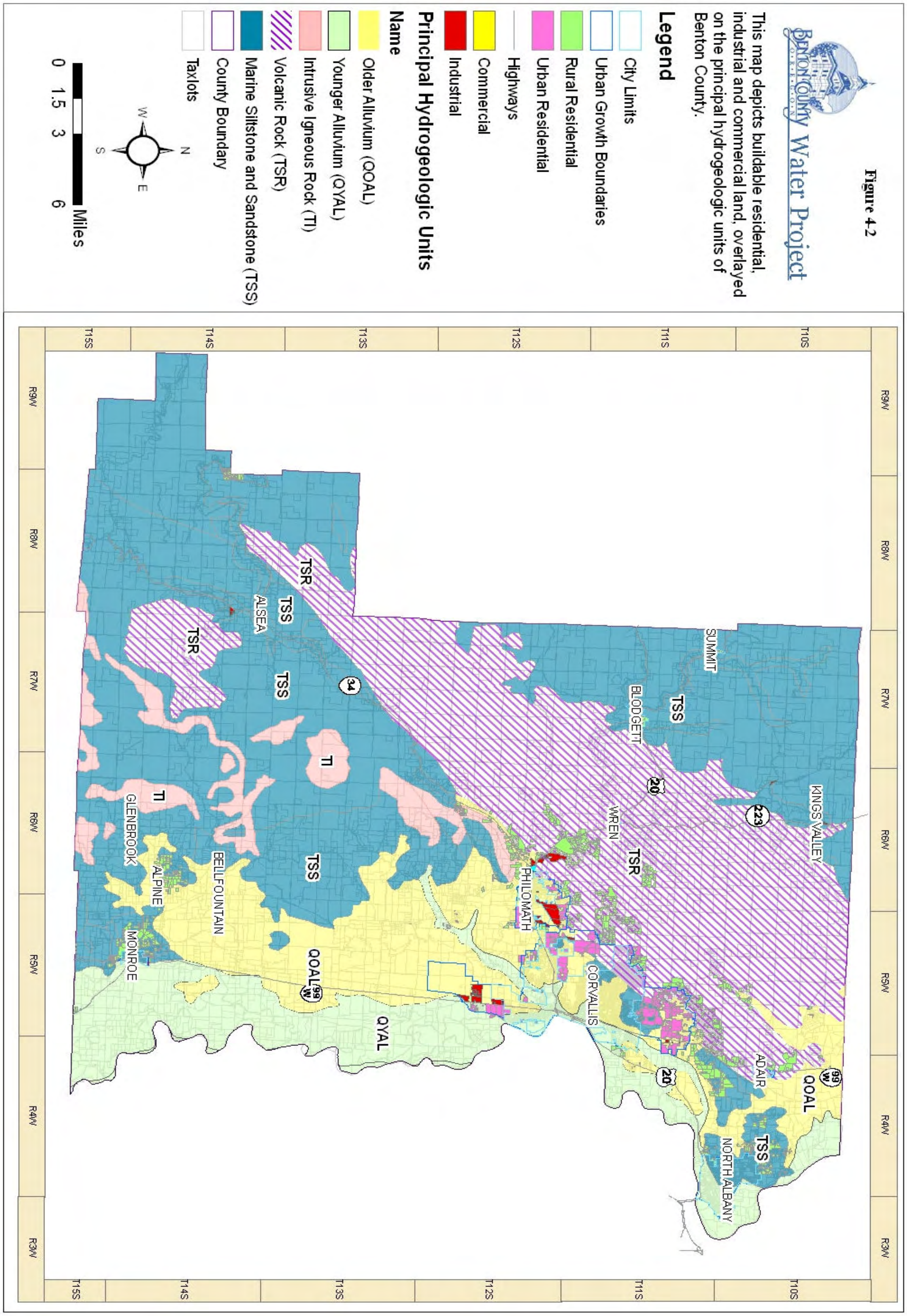


Figure 4-2
Benton County Water Project
This map depicts buildable residential, industrial and commercial land, overlayed on the principal hydrogeologic units of Benton County.
Legend
City Limits
Urban Growth Boundaries
Rural Residential
Urban Residential
Highways
Commercial
Industrial
Principal Hydrogeologic Units
Name
Older Alluvium (QOAL)
Younger Alluvium (QYAL)
Intrusive Igneous Rock (TI)
Volcanic Rock (TSR)
Marine Siltstone and Sandstone (TSS)
County Boundary
Taxlots
0 1.5 3 6 Miles
N
S
E
W
T10S
T11S
T12S
T13S
T14S
T15S
R9W
R8W
R7W
R6W
R5W
R4W
R3W
KINGS VALLEY
SUMMIT
BLODGETT
WREN
PHILOMATH
CORVALLIS
ADAIR
NORTH ALBANY
ALSEA
BELLFOUNTAIN
GLENBROOK
ALPINE
MONROE
TSS
TSR
TI
QOAL
QYAL
34
20
223
99W

4.2.2 Natural Water Quality Limitations

As discussed in **Section 2**, the quality of natural groundwater in Benton County is highly variable and there are areas where poor water quality may be encountered. The most common water quality problems are associated Marine Siltstones (**Figure 4-2**). Depending upon site specific conditions, groundwater in this unit may contain elevated concentrations of naturally occurring salts, sulfates, iron and arsenic due to the depositional nature of the formation. This problem is amplified in areas where the local geology is of low permeability or lacks fractures, such that the downward percolation of rainfall to provide groundwater recharge is restricted. Examples of this problem occur along Logsdon Ridge, Bellfountain Road, and areas west of Monroe. Water quality problems in this formation worsen with depth because of the natural low permeability of the formation. Due to the formation, once a well has encountered saline water, drilling deeper will not produce fresh water.

The best opportunity for good quality water in areas underlain by the Marine Siltstones is from relatively shallow wells (generally less than 100 feet) in locations where recharge from surface infiltration may occur. In general terms, the deeper water is older water and will contain higher concentrations of dissolved minerals that are present in this marine formation.

In most other formations discussed in **Section 2**, water quality is generally good and does not restrict water use. However, elevated concentrations of iron may be encountered in the older alluvium deposits within the valley floor and deeper portions of the Siletz River Volcanics.

In conclusion, the most significant natural groundwater quality restriction in Benton County occurs in areas of high salinity associated with the Marine Siltstones and in wells drilled too deep attempting to increase yields.

4.2.3 Anthropogenic Contamination

Both surface water and groundwater sources can have water quality issues, either naturally occurring or man-made. The parameters of water quality can fall into four types of contaminants: 1) microbial (viruses and bacteria), 2) inorganic (e.g. nitrate, arsenic, and other salts/metals), 3) organic chemicals (e.g. pesticides, fuels, solvents, and other volatile organic chemicals), and 4) radiologic (naturally occurring or resulting from oil production and mining).

Southern Willamette Valley Ground Water Management Area (GWMA)

Between 2000 and 2002, the Oregon Department of Environmental Quality (DEQ) undertook two studies to examine the magnitude and extent of nitrate in shallow groundwater. The 2000-2001 study sampled 476 wells in the study area. Over 20% (100 wells) had nitrate at or above 7 mg/L. In 2002, DEQ re-sampled the wells that had nitrate values greater than 7mg/L. This re-sampling found contamination levels consistent with previous levels. The result of the DEQ studies was that in 2004 Boards of Commissioners in Benton, Linn and Lane Counties agreed to establishment of the Ground Water Management Area (GWMA). The boundary of the GWMA shown in **Figure 4-3** encompasses and extends out from the distribution of the Younger Alluvium in Benton County. This designation was based upon areas with a 15 percent or greater frequency of nitrate values exceeding 7 mg/l.

The Federal Drinking Water Standard for nitrate is 10 mg/L. Some of the concentrations found in wells during the DEQ study were significantly greater (up to 27 mg/L) and are thought to be caused by human activities. Potential sources of pollution in the GWMA are found across land use sectors and include fertilizers, animal waste, septic systems, wastewater, and unused or poorly constructed wells.

Improperly Abandoned (unused) Water Wells

Unknown, inoperative, and often unseen groundwater wells can impact water quality. State statute (ORS 537.775 (3)) requires that when a landowner has a new well drilled and the old well is within the current required county set-back from a septic tank and drain field then it is the landowner's responsibility to have the old well permanently abandoned (sealed and/or collapsed). Historic wells provide a direct conduit to freshwater supplies, through which surface and subsurface contamination risks to local and regional drinking water can occur. Water quality impacts occur where septic tank drain fields and hazardous materials are located within the historic well capture zones, leading to pollution of water resources. The locations of improperly abandoned wells are unknown countywide.

Identified and Potential Chemical Contamination

As is the case with the high nitrate levels, other anthropogenic contamination can impair groundwater quality and restrict its uses. Because groundwater is derived from water infiltrating from the surface and percolating to the aquifer, land use activities located uphill from or within groundwater recharge zones, may have a significant impact to groundwater quality even if the source of the contaminant, e.g. petroleum contaminated soil, remains at or near the surface. As the downward infiltrating water passes through the contaminated soil, it dissolves some of the contaminant and carries it downward. To identify locations with groundwater impacted by human activities a search of EPA and DEQ databases was conducted.

EPA Superfund Sites

Benton County has one EPA-listed Superfund site - United Chrome Products, located near the Corvallis Airport. In 2005, after extensive groundwater and soil clean up activities, EPA and DEQ declared no further remedial action is needed at this site. Groundwater monitoring continues to ensure the effectiveness of the remedy.

DEQ Environmental Clean-up Sites

A search of the DEQ Environmental Cleanup Sites (ECS) listed fifty-six sites within Benton County in various stages of evaluation. These sites are associated with a variety of activities including industrial manufacturing, landfill operations, leaks from underground gasoline tanks, past leaks of solvent from dry cleaners, and auto salvage yards. DEQ lists only 13 of these 56 sites as requiring no further action.

Within the scope of this study, a site specific evaluation of the potential impacts to groundwater was not conducted. However the presence of these sites in areas not served by municipal water should be a consideration in developing future water supplies. A more detailed evaluation of potential groundwater contamination outside of city UGBs should be a consideration for subsequent phases of study.

Potential Sources of Contamination: Source Water Assessments of Public Water Systems

There are nearly 60 public water systems (PWSs) in Benton County, serving approximately 67,000 people. These PWSs vary in size from very small (e.g. Salmonberry County Park) to large (e.g. City of Corvallis). PWSs are regulated by the federal Safe Drinking Water Act and are required to monitor the water they serve for over 90 contaminants on a periodic basis. As is the case elsewhere in Oregon, the most commonly detected contaminants are coliform bacteria and nitrate.

In the Amendments to the Safe Drinking Water Act in 1996, states were required to conduct Source Water Assessments (SWAs) for all federally defined systems within their respective boundaries. The assessments were to include identification of the source of the drinking water, inventory of the potential contaminants that place the drinking water at risk, and the susceptibility (vulnerability) of the water supply to those contaminants. The respective drinking water programs of the Departments of Human Services and the Department of Environmental Quality collaborated to conduct the assessments in Oregon.

The Source Water Protection Areas (SWPAs) for the three PWSs that derive their drinking water from surface water are the respective watersheds or sub-watersheds from which the streams flow. The source water areas for the more than 50 groundwater based PWSs consist of the land area that overlies that part of the aquifer that supplies water to the well(s) or spring(s). A map showing the identified Source Water Protection Areas for Benton County is provided in **Figure 4-4** below.

Potential contaminant sources were surveyed to identify potential risk to drinking water. For surface water sources the primary concern is contaminated runoff, stormwater, waste water discharge, etc. that may reach the stream. For groundwater sources, the primary concern is contaminated water that has infiltrated from the surface into the aquifer.

For groundwater sources, the inventory indicated that the greatest potential risks in Benton County were:

- Above ground storage tanks: spills or leaks of fuel and other chemicals
- Underground storage tanks: leaks or spills of fuels or heating oil
- High density septic systems (>1 system per acre): microbes, nitrate, and other improperly discarded chemicals
- Transportation related spills, leaks, improper handling of chemicals
- Agricultural activities

Maps and Potential Contaminant Source lists produced by the Oregon Department of Human Services Drinking Water Program for individual community public water systems using groundwater as a primary drinking water source can be found in **Appendix G**.

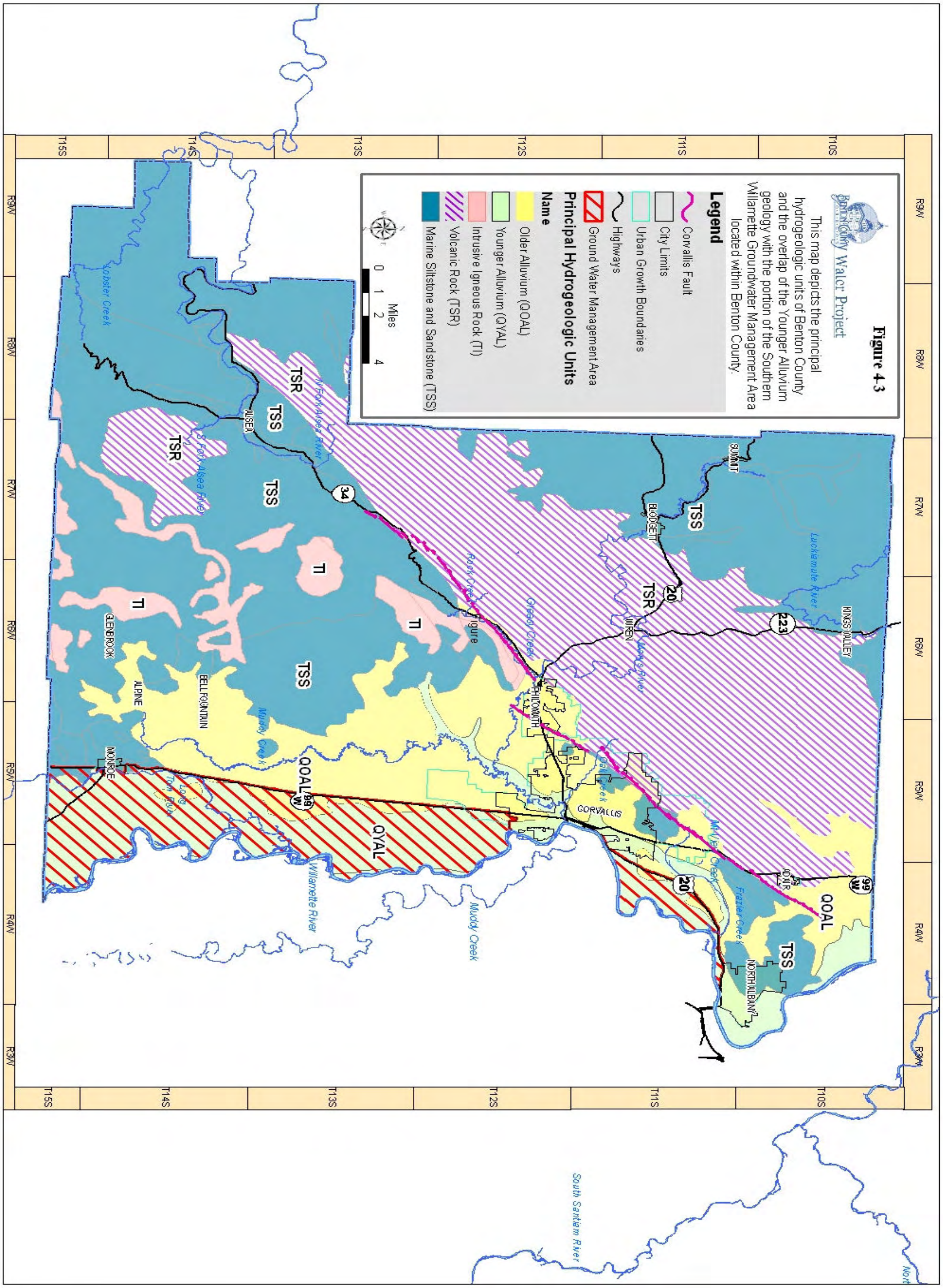


Figure 4.3
Benton County Water Project
This map depicts the principal hydrogeologic units of Benton County and the overlap of the Younger Alluvium geology with the portion of the Southern Willamette Groundwater Management Area located within Benton County.
Legend
Corvallis Fault
City Limits
Urban Growth Boundaries
Highways
Ground Water Management Area
Principal Hydrogeologic Units
Name
Older Alluvium (QOAL)
Younger Alluvium (QYAL)
Intrusive Igneous Rock (TI)
Volcanic Rock (TSR)
Marine Siltstone and Sandstone (TSS)
Miles
0 1 2 4
CORVALLIS
PHILOMATH
NORTH ALBANY
ALSEA
BLODGETT
SUMMIT
WREN
KINGS VALLEY
ADAIR
MONROE
ALPINE
BELLFOUNTAIN
GLENBROOK
Willamette River
Muddy Creek
South Santiam River
Luckiamute River
Lobster Creek
TSS
TSR
TI
QOAL
QYAL

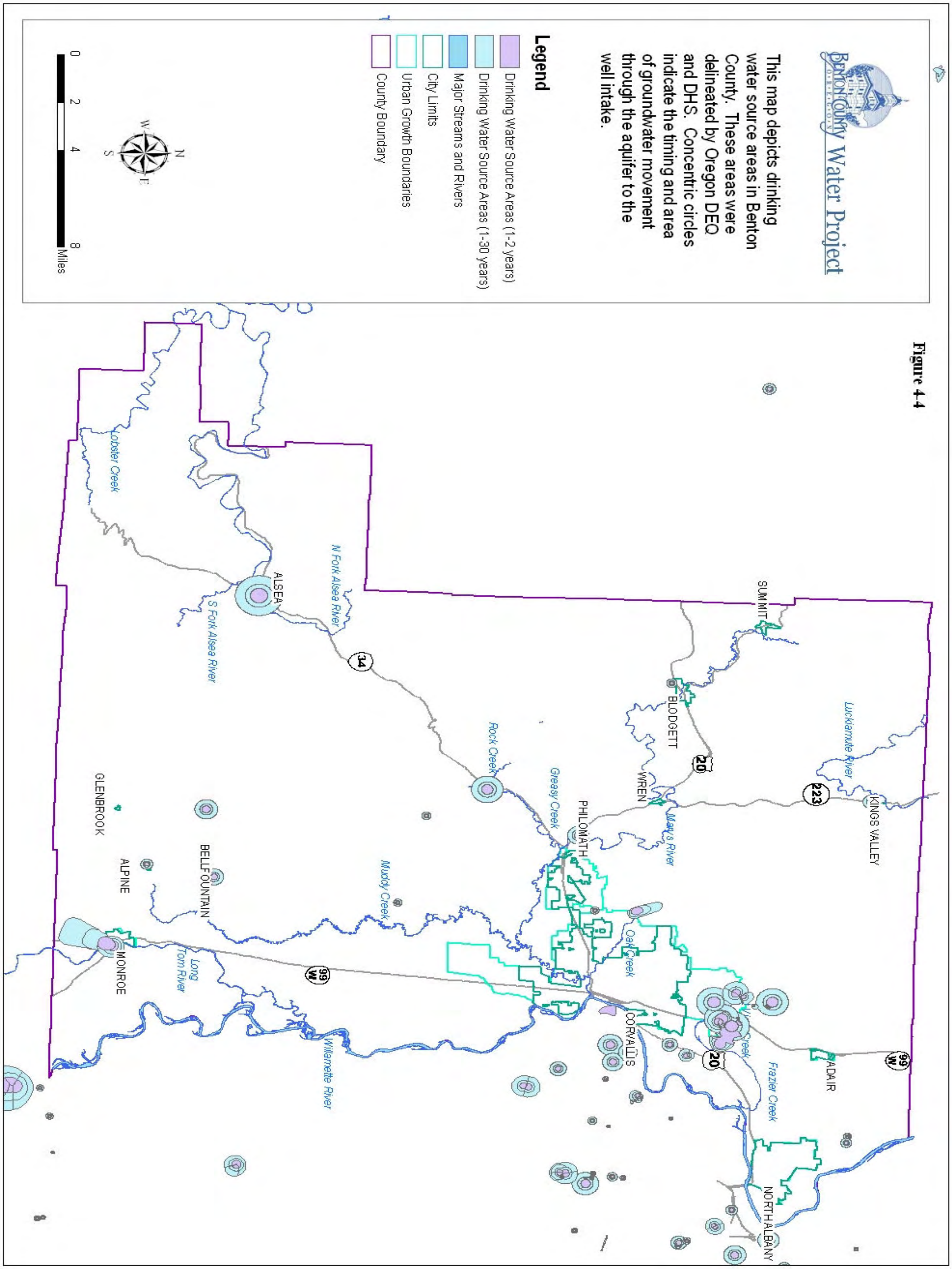

Benton County Water Project
This map depicts drinking water source areas in Benton County. These areas were delineated by Oregon DEQ and DHS. Concentric circles indicate the timing and area of groundwater movement through the aquifer to the well intake.
Legend
Drinking Water Source Areas (1-2 years)
Drinking Water Source Areas (1-30 years)
Major Streams and Rivers
City Limits
Urban Growth Boundaries
County Boundary
N
S
E
W
0
2
4
8
Miles
SUMMIT
BLODGETT
WREN
KINGS VALLEY
PHILOMATH
ALSEA
GLENBROOK
ALPINE
BELLFOUNTAIN
MONROE
CORVALLIS
ADAIR
NORTH ALBANY
Luckiamute River
N Fork Alsea River
S Fork Alsea River
Lobster Creek
Rock Creek
Greasy Creek
Marys River
Muddy Creek
Oak Creek
Long Tom River
Willamette River
Frazier Creek
34
20
223
99W

Figure 4-4

4.3 Groundwater Classifications

As previously discussed in the surface water section, OWRD's basin program rules "classify" water sources to identify the uses of water that are allowed from that source. These rules include classifications of the groundwater resource. While the Oregon Water Resources Commission may allow exceptions to these classifications in some limited circumstances, OWRD will generally not approve a water right application for a use that is not a classified use.

The Willamette Basin program classifies groundwater for domestic, livestock, irrigation, municipal, industrial, agricultural, commercial, power, mining, recreation, fish life, wildlife, pollution abatement, wetland enhancement and statutorily exempt groundwater uses except as described in other rules that establish groundwater limited areas. OWRD has not established any groundwater limited areas within Benton County to date.

4.4 Additional Considerations

A number of other considerations could affect the ability to obtain more water to meet future demands. These considerations include changing stream flows based either on natural conditions or operating changes at the federal storage projects that impact flow in several of the county's waterways. Additionally, changes in water resource or land use regulations could change the availability or the demand for water. Finally, changes in the nature of water demand in the county could affect its ability to obtain a reliable water source for its future needs. The following discussions provide a brief summary of a few of these considerations.

4.4.1 Climate Change

Scientists are certain that the Pacific Northwest is warming. Reports from EPA show that over the past century the average temperature in Corvallis has increased 2.5° F. Assessments suggest that the average warming will be approximately 2.7° F by 2030 and 5.4° F by 2050 (*Scientific Consensus Statement on Likely Impacts of Climate Change on the Pacific Northwest, June 2004*; **Appendix H**). The temperature impacts are expected to result in longer growing seasons and changes in vegetation types which could drive higher water use as irrigation demand increases.

Climate change will likely affect precipitation patterns, although the changes are uncertain. The literature suggests that Oregon will continue to have a winter-dominant precipitation regime with most of the precipitation falling in the mountains. Precipitation is estimated to increase slightly in the spring and fall, and decrease slightly in the summer. The temperature increase will cause lower snow packs in the Cascades which will result in lower summer stream flows and earlier reservoir drawdown during summer months.

In Benton County impacts on water resources will be observed although the magnitude is difficult to predict. It is likely that the demand for irrigation supply (including lawn watering) in the summer will increase due to lower precipitation, higher temperatures and longer growing seasons. Additionally it is expected that an earlier drawdown of tributary reservoirs to the main stem of the Willamette River could reduce late summer availability of water to meet human demand and in-stream flow targets.

4.4.2 Impacts of Recent Biological Opinion

The National Oceanic and Atmospheric Administration recently issued a Biological Opinion (BIOP) for the Willamette Basin, which includes minimum flow objectives for the Willamette River and its tributaries.

The BIOP specified a number of restrictions that will be placed on renewal of existing contracts as well as new contracts for use of stored water from the Willamette Project for irrigation. The following measures are intended to minimize the effects of diversions by the Bureau of Reclamation's contractors on listed fish species and their habitat. These measures include:

1. Limiting the total amount of stored water that can be provided under existing and new contracts to 95,000 acre-feet;
2. Requiring existing contract diverters to install screens and other fish passage devices within a specified timeframe;
3. Requiring screening of all new contract diversions;
4. Ensuring that the water released to serve contracts does not prevent meeting minimum flow objectives;
5. Reducing the volume of stored water diverted by contract holders in low water years to ensure minimum objectives are met; and
6. Prohibiting new contracts from being issued in the North and South Santiam Rivers.

The 11 federal storage projects store up to a total of 1,592,800 acre-feet of water for later beneficial use. Taking both existing contracts and pending irrigation contract applications into account, 14,569.33 acre-feet out of the 95,000 acre-feet cap would be available to meet future irrigation demand under the duration of the consultation.

In summary, the 2008 Willamette Basin BIOP will result in managed releases of water to meet the mainstem Willamette flow objectives, which will help ensure that there is a sufficient amount of water in the Willamette River for fish. The BIOP will also result in a number of changes to the Bureau of Reclamation's process for issuing contracts for release of stored water for irrigation and may reduce the amount of stored water available in the long-term for out-of-stream purposes.

Section 5

Future Water Demands (Use)

For the purposes of *Phase 1*, staff and project consultants developed a range of water demand (use) forecast scenarios for the cities and unincorporated areas in Benton County using selected past, current and future water demand (use) factors. These estimates are based on historic data which are inexact. The outcome is a range of projected demands that provide a basis for City, County, and community water and land use planning.

Summary

The forecasted total all-city Max Day Demand (MDD) is not projected to exceed the estimated total city water system capacity until year 2020. The total all-city Average Day Demand (ADD) within Benton County is projected to match total city water system capacity by year 2050. See **Section 5.2**.

Estimates of households served by non-municipal community water systems are at or exceeding household limits allowed by current water rights. See **Section 5.3**.

The aquifers in the county could provide sufficient supply of groundwater to meet self-supplied rural domestic and non-commercial irrigation needs, however, well yields will be relatively low and well-to-well interference may occur. See **Section 5.4**.

It is highly unlikely that aquifers in Benton County could provide sufficient supply of groundwater to meet the needs of industrial development outside of urban growth boundaries. However, groundwater could serve as a future water source for small commercial businesses that do not require volumes beyond typical household demands. See **Section 5.5**.

It is highly unlikely that aquifers in many parts of the Benton County could provide a sufficient supply of groundwater to meet new commercial irrigation requirements other than within the Younger Alluvial aquifer in areas near the Willamette River where the limiting factor is that much of the groundwater is directly connected with surface water resulting in restrictions on groundwater withdrawals to protect surface water flows. See **Section 5.6**.

5.1 Background Population and Land Use

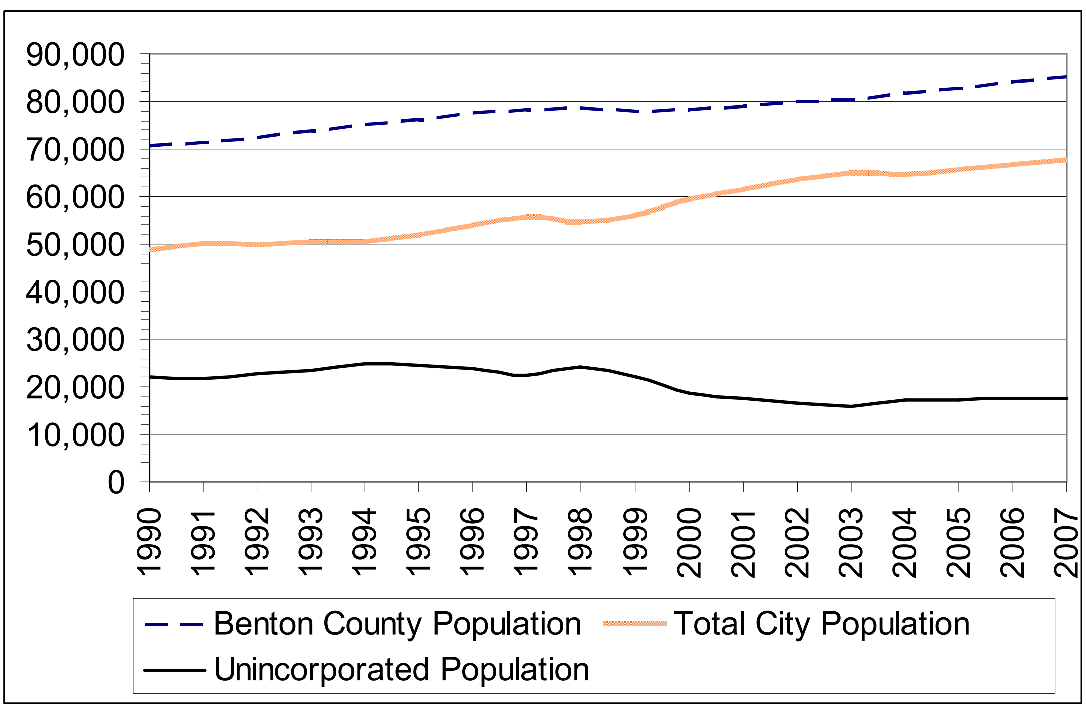
Many highly variable or unknown factors may affect future water demands, including:

- population size
- seasonal and long-term climate variability
- land use changes
- politics
- social and technological changes
- economics

The total county population has increased over the last two decades but the increase has been low to moderate depending upon the city. Annexations for health hazard or development of unincorporated rural areas in Benton County are the driving forces of population redistribution to cities. The largest change was the health annexation of rural north Albany by the City of Albany in 1991. Smaller annexations for development occurred in Philomath and Corvallis. The only urban growth boundary expansion has occurred at Adair Village in 2008 with the expectation that there will be measured annexation into the city as development opportunities ripen, with the potential for a large portion brought into the city limits in a short period of time.

Figure 5-1 shows an overall modest population growth trend over the last two decades of less than 2 percent. The leveling off and slight downward trend of unincorporated area populations is shown by the dark, solid line in the figure.

Figure 5-1 Population Changes (1990-2007)



*Data compiled from Portland State University and US Census Data

The trend of increasing city populations and decreasing rural populations is expected to continue, assuming current land use zoning does not significantly change. Future city annexations will depend upon the actions of the citizens in Corvallis, Albany and Philomath where annexations must be approved by the voters. Urban growth boundary expansions are more likely to occur in the smaller cities over the next decade than in the larger cities where there is ample buildable land within the urban growth boundary.

5.2 Future City Water Demands (Use)

5.2.1 City Population Forecasts

Each city's population forecast is based on a range of average annual growth rates (AAGR). AAGRs were gathered from city reports, Portland State University (PSU) Population Research Center historic population records and US Census data to form the 1950-2007 'Historic AAGR' for each city (**Table 5-1**). Three different population forecasts to year 2050 (**Tables 5-1 to 5-4**) were derived from the growth rates. This provides a range of future options.

Table 5-1 Average Annual Growth Rates (AAGR) used to Project City Population

Cities	AAGR	AAGR + 1%	Historic AAGR [6]	Period of Record for Determining Historic AAGR [6]
Adair Village	5.00% [1]	6.00%	1.7%	1980-2007
Corvallis	1.23% [2]	2.23%	2.2%	1950-2007
Monroe	3.4% [3]	4.4%	1.0%	1950-2007
North Albany	1.34% [4]	2.34%	3.6%	2000-2007
Philomath	0.06% [5]	1.06%	2.2%	1950-2007

1. Adair Village-Benton County Coordinated Population Growth Rate (2006)
2. City of Corvallis Water Distribution Facility Plan (1998); Corvallis Water Management and Conservation Plan (2005)
3. City of Monroe Water Management and Conservation Plan (2007)
4. City of Albany- Water System Hydraulic Modeling Update (2008)
5. City of Philomath Water Master Plan (2005)
6. Portland State University- Population Research Center; Historic 1850-2007 Population Data

See **Appendix E** for full population estimates.

Table 5-2 Population Forecst- Average Annual City Population Growth Rates plus 1 %

using AAGR + 1%	2000 [1]	2007 [1]	2020	2025	2030	2035	2040	2045	2050
Adair Village	536	905	1,611	2,094	2,722	3,539	4,601	5,981	7,776
Corvallis	49,322	54,890	70,803	78,697	87,472	97,225	108,066	120,115	133,508
Monroe	610	625	983	1,199	1,462	1,784	2,177	2,655	3,240
North Albany	5,104	6,599	8,606	9,613	10,738	11,994	13,398	14,965	16,716
Philomath	3,838	4,530	5,154	5,427	5,715	6,018	6,337	6,673	7,026

Table 5-3 Population Forecast- Average Annual City Population Growth Rates

using AAGR	2000 [1]	2007 [1]	2020	2025	2030	2035	2040	2045	2050
Adair Village	536	905	1,493	1,867	2,333	2,917	3,646	4,557	5,696
Corvallis	49,322	54,890	63,667	67,582	71,739	76,151	80,834	85,805	91,082
Monroe	610	625	901	1,054	1,059	1,063	1,067	1,071	1,076
North Albany	5,104	6,599	7,749	8,268	8,822	9,413	10,043	10,716	11,434
Philomath	3,838	4,530	4,565	4,579	4,593	4,607	4,620	4,634	4,648

Table 5-4 Population Forecast- Historic Average Annual City Population Growth Rates

using Historic AAGR	2000 [1]	2007 [1]	2020	2025	2030	2035	2040	2045	2050
Adair Village	536	905	1,106	1,200	1,302	1,412	1,532	1,663	1,804
Corvallis	49,322	54,890	70,589	78,353	86,972	96,539	107,158	118,946	132,030
Monroe	610	625	706	742	779	818	858	901	946
North Albany	5,104	6,599	9,687	11,431	13,489	15,917	18,782	22,162	26,151
Philomath	3,838	4,530	5,826	6,466	7,178	7,967	8,844	9,816	10,896

1. Portland State University- Population Research Center Population Estimates

5.2.2 City Water Demand (Use) Forecasts

A “high” maximum day demand (MDD) estimate and “low” average day demand (ADD) estimate was made for each projected city population using MDD and ADD multipliers developed from existing City water demands (**Section 3**). It is important to note that future water demand forecasts are for both the “Population” (residential only) and “Total” (e.g. residential, commercial, etc.) water demands (use) to year 2050 (**Appendix I** Forecasted Water Use to Year 2050).

Total water demands (use) for each city were estimated using a simple linear regression (excluding Monroe and North Albany) based on city water management and facility planning reports estimating 2050 demand (use) (**Appendix F**). The cities of Monroe and Albany (North) have estimated water demands (use) within the city service area for primarily residential demands, so an average of the three Population Demand scenarios for each city was used to form a “total water demand (use)” forecast for each.

Figure 5-2 is a comparison of the projected total population (residential demands) maximum day demands (MDD) and average day demands (ADD) for cities within Benton County to year 2050, based on:

- **Scenario 1:** Total City Population Water Demand (Use) assuming City Average Annual Growth Rate +1%
- **Scenario 2:** Total City Population Water Demand (Use) assuming City Average Annual Growth Rate
- **Scenario 3:** Total City Population Water Demand (Use) assuming Historic Average Annual Growth Rate for the period of record shown in **Table 5-1**.

Figure 5-2 Comparison of Projected Total City Population (residential only) Water Demands

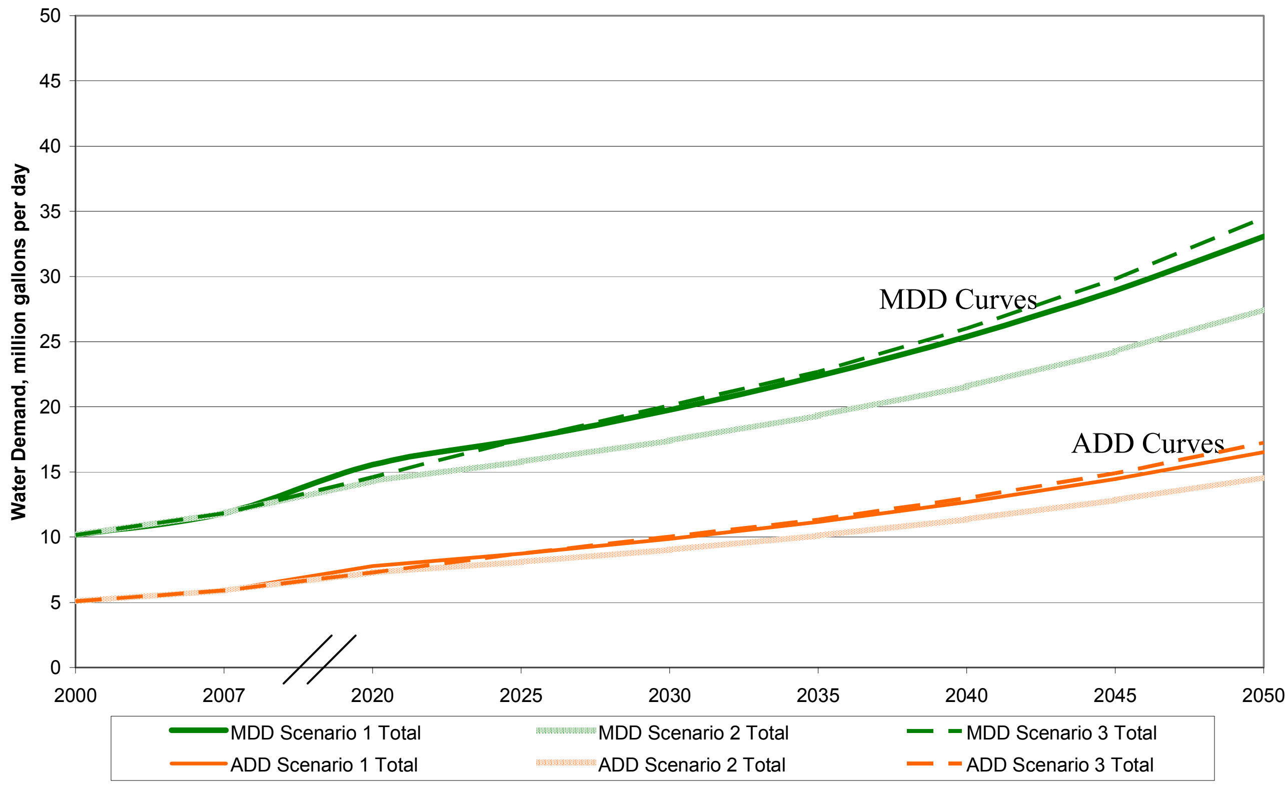
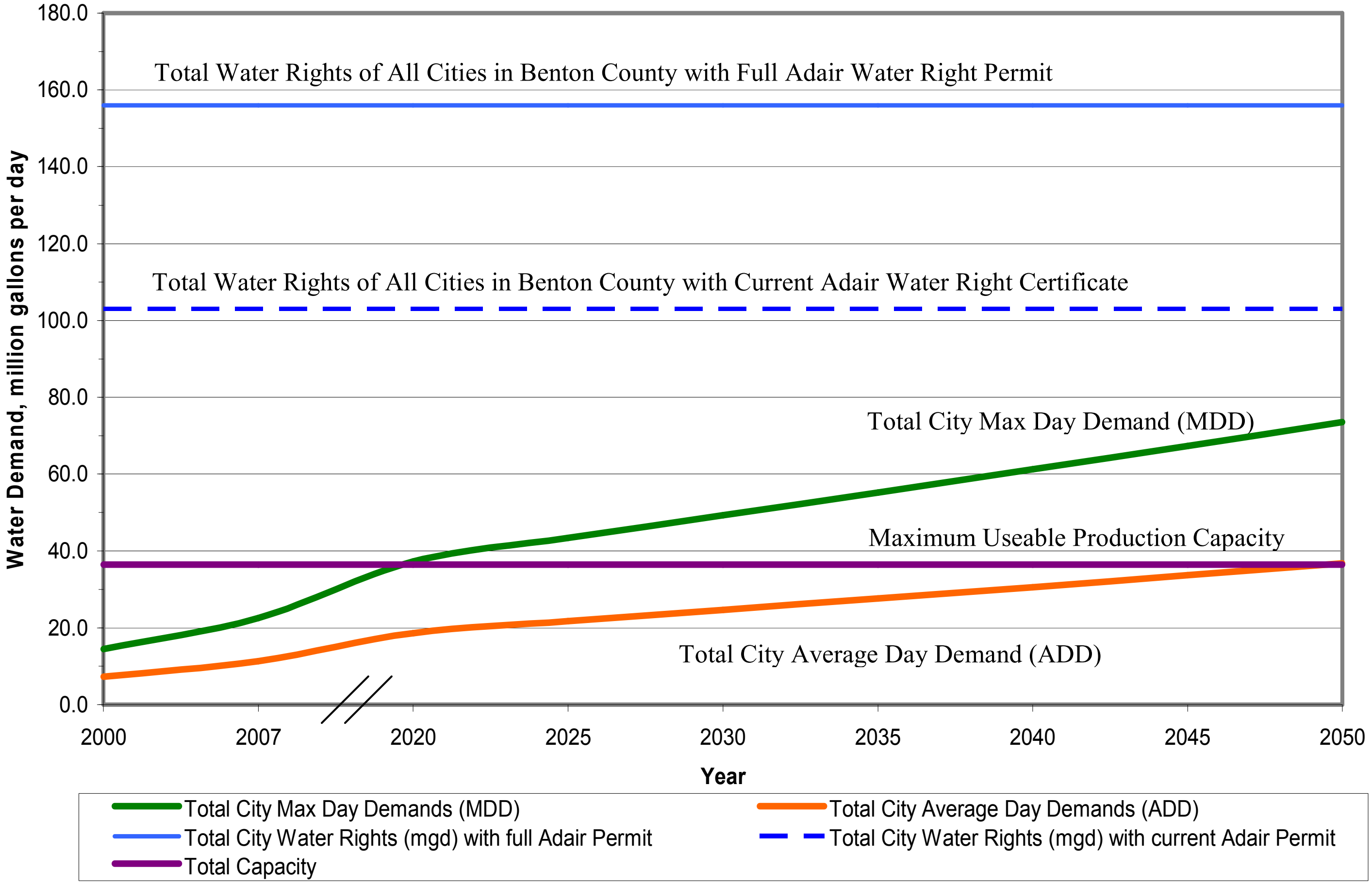


Figure 5-3 shows the projected water demands (use) for cities based on existing city demand forecast data and extrapolated to year 2050 using a simple linear regression (See **Appendix F** for regression analysis and city forecast data sources). It is important to note that the following items are also represented in these forecasted demand figures:

1. Total City Water Rights, with and without City of Adair Village full water right.
2. City Water System Capacity, as an estimate of the maximum amount of water that can be delivered to the city's service area using the current water system (estimates provided by staff from each of the cities. See **Section 5.2.3**).

Figure 5-3

Comparison of Projected Total City Water Demands to City Water System Capacity and Benton County City Water Rights



5.2.3 City Water System Capacity Estimates

All-city maximum useable water system capacity is an estimate of the maximum amount of water that a city's current water transmission system can supply in a single day. These capacity estimates were provided by City employees and/or city-contracted water managers, and are the most current water production information available. Depending on infrastructure (e.g. reservoirs, storage tanks) and individual service connection lines, the actual amount of water delivered is highly variable. Storage and other existing infrastructure or future infrastructure changes can obviously increase the system capacity.

Maximum day demands (MDD) drove system capacity estimates which assume that peak demands need to be met instantaneously. A city and/or water provider may need to implement curtailment actions to reduce demands (uses) during peak periods, but non-peak conditions may have adequate source capacity. A shortfall under the average day demand (ADD) estimate is an indicator of a more critical water production shortage. However, a shortfall under MDD conditions does not necessarily mean that average day demands cannot be met.

During the period that system capacities were collected, the Monroe water treatment plant and associated system was a month away from functioning (November 2008). For the purposes of this report, the maximum plant production (350 gpm) was assumed to be the maximum city water system capacity estimate (0.17 mgd). The Philomath water system capacity estimate includes 0.5 mgd supplied by Corvallis through a water supply pipeline inter-tie (**Section 2**). Additionally, the Albany water system capacity was estimated using the current MDD (1.8 mgd). Due to the current single transmission line, storage system, and various pressure zones that supply North Albany, this estimate is used to demonstrate that the current treatment and distribution system can meet current maximum day demand. Note: Albany is separated by the Willamette River from the North Albany area in Benton County.

The forecast all-city Max Day Demand (MDD) is not projected to exceed the estimated total city water system capacity until year 2020, given the stated assumptions. Additionally, the total all-city Average Day Demand (ADD) within Benton County is projected to match total city water system capacity by year 2050 under the given assumptions (**Figure 5-3**).

5.3 Community Water System Demand (Use) Forecast

The Oregon Water Resources Department (OWRD) Water Rights Information System supplied the total dwelling units allowed under current non-municipal community water right permits and certificates (**Table 5-5**). Each state-defined community water system in the county has an allowed number of households that can be supplied under their system water right(s). Using existing population estimates from the Oregon Drinking Water Program (Oregon Department of Human Resources), a comparison between the current estimated number of households and the total number of households that are allowed under the current State water rights system was completed (**Table 5-5).** See **Table 3-21** for water rights and population estimates.

The US Census report for 2006 showed that the estimated average household size in Benton County was 2.24 people. Using the Oregon Drinking Water Program population estimates and US Census Data, an estimate of current total households for each community water system was developed using the same methodology described in **Section 3.2.2** Estimate of Domestic and Non-Commercial (Exempt) Uses of Groundwater. For community water systems that have no stipulation for the maximum number of households under the water right(s), estimated future households were kept consistent with current household estimates.

As shown in **Table 5-5,** the estimates of households served by non-municipal community water systems are at or exceeding household limits allowed by water rights, under the given assumptions. Future water demands for non-municipal community water systems with exempt groundwater use were not projected, as there are no regulations on the size of future populations. For these exempt groundwater use communities, the limiting factor on water use in the future is the ability of the service population to stay within the exempt groundwater use limit of 15,000 gallons per day and up to one half-acre of non-commercial irrigation.

Table 5-5 Projected Non-Municipal Community Water Demands

Community	Estimated Current Number of Households [1]	Maximum Number of Households allowed under Existing Water Rights [2]	Projected Future Number of Households Possible
Alsea County Service District	89	"domestic water services not to exceed 1 cfs" (current Pop. of 89)	89
Cascade View Estates County Service District	71	60	71
Fir View Water Company	80	63	80
Jackson Creek Water Association	20	20	20
Knoll Terrace Manufactured Home Community	223	212	223
North Corvallis-MHP	45	45	45
Pioneer Village Water Co.	51	51	51
Raintree Estates	22	22	22
Ridgewood District Improvement Company	49	41	49
Vineyard Mountain Water and Improvement District	145	130	145
TOTALS	**795**	**733**	**795**

1. Oregon Department of Human Services (ODHS)- Drinking Water Program Database (2008)
2. Oregon Water Resources Department (OWRD)- Water Rights Information System (2008)

As shown in **Table 5-5** five of the community water systems have household connections exceeding the number stated in the water right. It was assumed for both community systems with a water right and without a water right that future system connections would remain at the current connection rate into the future. Tracking the amount of connections (households) allowed to occur over time would provide a valuable baseline for projecting more accurate future water use within the community water service area.

5.4 Self-Supplied Domestic and Non-Commercial Irrigation Water Needs

Not all domestic water use is supplied by municipal water systems or community water service districts. Some domestic water use is self-supplied almost exclusively outside of the municipalities' service areas. Of those self-supplied users, some of this water has a water right for surface water or groundwater, but more commonly the users have an exempt use of groundwater from a well.

Estimates of current self-supplied water use in rural Benton County were provided in **Section 3 (Table 3-17**). The estimates indicate that the current average daily use of water by residents (non-municipal and non-community systems) is approximately 2.0 million gallons per day (MGD), and the peak daily use is projected to be up to 3.8 MGD. The water supply is primarily from domestic wells pumping groundwater as an exempt use. Since domestic wells are not metered, water use estimates were made by interpolating empirical data from metered community systems across the estimated total number of wells. A similar approach was taken to estimate future water needs for self-supplied residents in the county. It is important to note that these estimates include all water required by rural residences, including household use and irrigation of less than one-half acre of lawn and noncommercial garden.

5.4.1 Approach

As illustrated in **Figure 5-1**, while the total population in the county has grown since 1990, the population in rural Benton County is stable or slightly declining, primarily due to redistribution caused by annexation. Population trends in rural Benton County indicate that self-supplied water use in rural areas will not increase significantly and, in fact, may decrease. However, rural population trends are difficult to predict and are influenced to a large degree by changes in land use zoning and annexations.

To estimate the future self-supplied water use by rural residences, an approach was taken that relies on current land use designations and potential future annexations. **Figure 5-4** shows the locations of existing buildable lots in the county based on current zoning. According to information from Benton County Community Development Department there are 3,018 buildable residential lots outside of all city limits in the county. This was estimated using current Geographic Information Systems (GIS) databases and a method of estimating buildable lots (**Appendix J** for Estimate Methodology). The number of buildable lots outside of all city limits is assumed to establish the maximum number of residences that would require water from a self-supplied system. Water use estimates for current conditions from **Section 3** were then applied to the number of possible future residences to develop estimates of future water use. Several key assumptions underlie this approach:

1. One residence would be placed on each buildable lot,
2. Future water use will be generally consistent with the current use estimates (**Section 3)**, and
3. There will be no changes in zoning that would significantly increase or decrease the number of buildable lots in the county.

Two scenarios were considered in determining the number of buildable lots that would require self-supplied water:

Scenario 1 assumes that all buildable lots outside of all city limits require self-supplied groundwater systems (wells or springs). Assuming that a minimum of 10 percent of the 3,018 lots could not be developed for housing, due to slope, septic set-backs and other limitations, there would be **2,716 buildable lots** in the county outside of all city limits.

Scenario 2 assumes that rural lots within current urban growth boundaries but outside of city limits will eventually be supplied by municipal water as annexations occur. Under this scenario, 2,331 buildable lots would self-supply their domestic water. If 90 percent of these lots were ultimately developed, **2,098 buildable lots** would require self-supplied domestic water.

5.4.2 Results

Estimates of future water use under the two rural build out scenarios are presented in **Table 5-6**. Adding the results in **Table 5-6** to the current water uses in rural Benton County, results in an estimated range of total future water use under the two scenarios as presented in **Table 5-7**.

Table 5-7 shows both future growth scenarios resulting in an increase of water use of approximately 30 to 38 percent. The rate or time period over which the new rural residential lots and water use could be expected to develop was not estimated. For the purposes of this study, a simplifying assumption of 100 percent build out by the year 2050 could be made. This estimate would be highly dependant upon many factors including population trends, annexations, expansion of existing service districts, and other changes in land use that may impact how rural Benton County will develop (**Section 5.7** Summary of Other Future Water Use Factors). Refining the rural growth rate is a task that is more appropriately addressed in subsequent project phases.

Table 5-6 Future Water Use for New Rural Residents

Scenario	New Rural Residences	Average Daily Use (gallons)[1]	Maximum Daily Use (gallons)[2]
1. Area Outside of City Limits	2,716	752,000	1,450,000
2. Area Outside of UGBs	2,098	581,000	1,120,000

1. Average daily use of 277 gallons/residence
2. Maximum daily use of 533 gallons/residence

Table 5-7 Future Water Self-Supplied Water Use in Rural Benton County (existing and new residences)

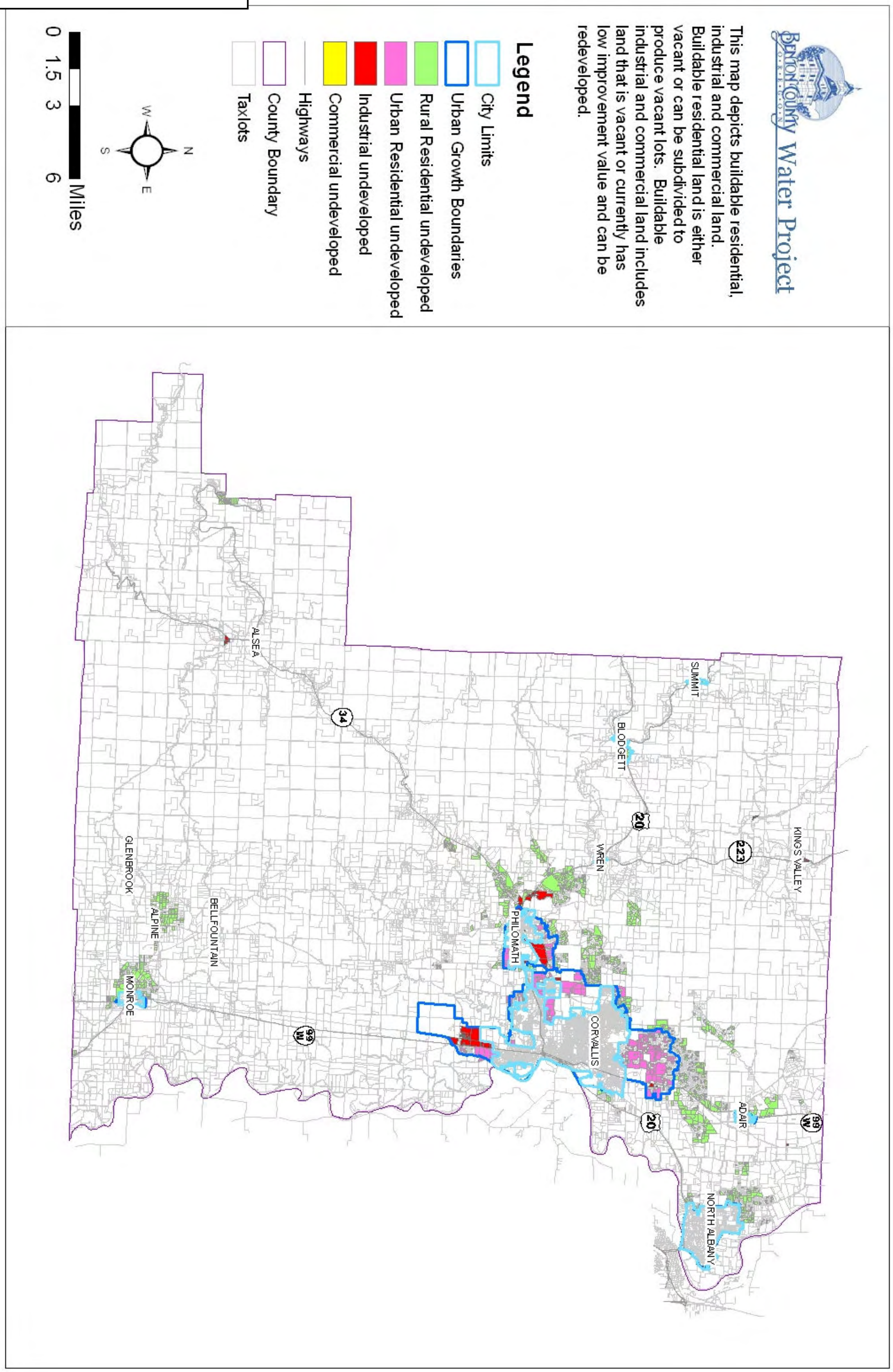
Daily Use Estimate	Current	Future Scenario 1: No Annexation	Future Scenario 2: Annexation within UGB
Average (MGD)	2.0	2.8	2.6
Maximum (MGD)	3.8	5.3	4.9

Conclusions

Self-supplied domestic and non-commercial irrigation needs in Benton County will be met largely from groundwater resources. The aquifers in the county could provide sufficient supply of groundwater to meet these needs under both scenarios described in **Table 5-7**. The well yields in most areas of the county will, however, be relatively low. Further, rural residential urban-type developments (see **Figure 5-4**) result in a number of wells in close proximity and "well-to-well interference" will likely occur. Well-to-well interference is already occurring in the county and further rural residential development could exacerbate the problem. Interference can lower the water level in domestic wells, but does not deplete the aquifer. Consequently, the water levels in these wells will recover over time when pumping is reduced.

The scenarios of rural groundwater use also assume that irrigation would only occur on a half-acre or less, however it is likely that rural groundwater is used for irrigation over this legal water use limit. Future phases of project work should analyze the conflict of competing uses (irrigation versus municipal and domestic drinking water)

Figure 5-4


Benton County Water Project
This map depicts buildable residential, industrial and commercial land. Buildable residential land is either vacant or can be subdivided to produce vacant lots. Buildable industrial and commercial land includes land that is vacant or currently has low improvement value and can be redeveloped.
Legend
City Limits
Urban Growth Boundaries
Rural Residential undeveloped
Urban Residential undeveloped
Industrial undeveloped
Commercial undeveloped
Highways
County Boundary
Taxlots
N
E
S
W
0 1.5 3 6
Miles
SUMMIT
BLODGETT
KINGS VALLEY
WREN
PHILOMATH
CORVALLIS
ADAIR
NORTH ALBANY
ALSEA
GLENBROOK
ALPINE
BELLFOUNTAIN
MONROE
34
20
223
99W

5.5 Industrial and Commercial Water Needs

Industrial and commercial water use forecasts are based on the current zoning. Any industrial and commercial land within the city limits of the municipalities in the county would presumably receive water through the municipalities' water supply systems. As shown in **Figure 5-4**, there is a limited amount of land outside of the municipal city limits that is zoned for commercial and industrial purposes. There are an estimated total of 85 such parcels, covering 1,082 acres, according to information from Benton County Community Development Department and Geographic Information Systems work group estimates (**Appendix J** for methodology).

Much of the industrial land that is outside of the city limits is within the cities' urban growth boundaries. We have assumed that in order for an industrial water user to locate on this land, it would require annexation and access to municipal water supply. Consequently, we have assumed that only the industrial lands outside of the existing urban growth boundaries will require non-municipal water sources. The provided information indicates that property zoned for industrial and commercial purposes outside of the urban growth boundaries is comprised of only 38 parcels covering 331 acres.

Approach

In order to develop an estimated average rate of water use for future commercial or industrial purposes, we calculated the average rate for existing commercial and industrial water rights. It is understood that this approach likely reflects an overestimate of actual use; however, it provides a simplified basis for conservatively estimating future rates of industrial water use.

The combined average rate for surface water and groundwater rights determination is 1.1 cfs (0.7 MGD). Applying this average rate to the 38 industrial parcels outside the urban growth boundaries yields an estimated maximum future use of 41.8 cfs (27 MGD) for self-supplied industrial and commercial purposes, under the current zoning. Future industrial and commercial water use is expected to grow in 'step-increases' as facilities are built. Depending upon the individual industry type, the facility use could either be relatively high (e.g. a paper mill) or relatively low (e.g. commercial buildings).

As described in **Section 4**, it is unlikely that future industrial and commercial demands could be met by a new surface water right because the use would likely require a year-round water supply. No surface water sources in Benton County have water available year-round for new water rights, except the Willamette River. While the mainstem Willamette has water available year-round in Benton County, the basin program rules do not classify that reach of the river for industrial or general commercial uses from July 1 through August 31. The river is, however, classified for customarily domestic purposes within a commercial facility.

The future need for water for commercial and industrial purposes could possibly be met by the release of stored water for locations downstream from an existing (or future) storage facility, although water from federal storage projects is not presently available for industrial purposes.

Conclusions

It is highly unlikely that aquifers in Benton County could provide sufficient supply of groundwater to meet industrial requirements, except in locations near the Willamette River underlain by the Younger Alluvium. The problem in these areas is that much of the groundwater is in direct connection with surface water, and restrictions on groundwater withdrawals would apply to protect surface water flows. Groundwater could serve as a future water source to small commercial businesses that do not require volumes beyond typical household demands.

5.6 Irrigation Water Needs

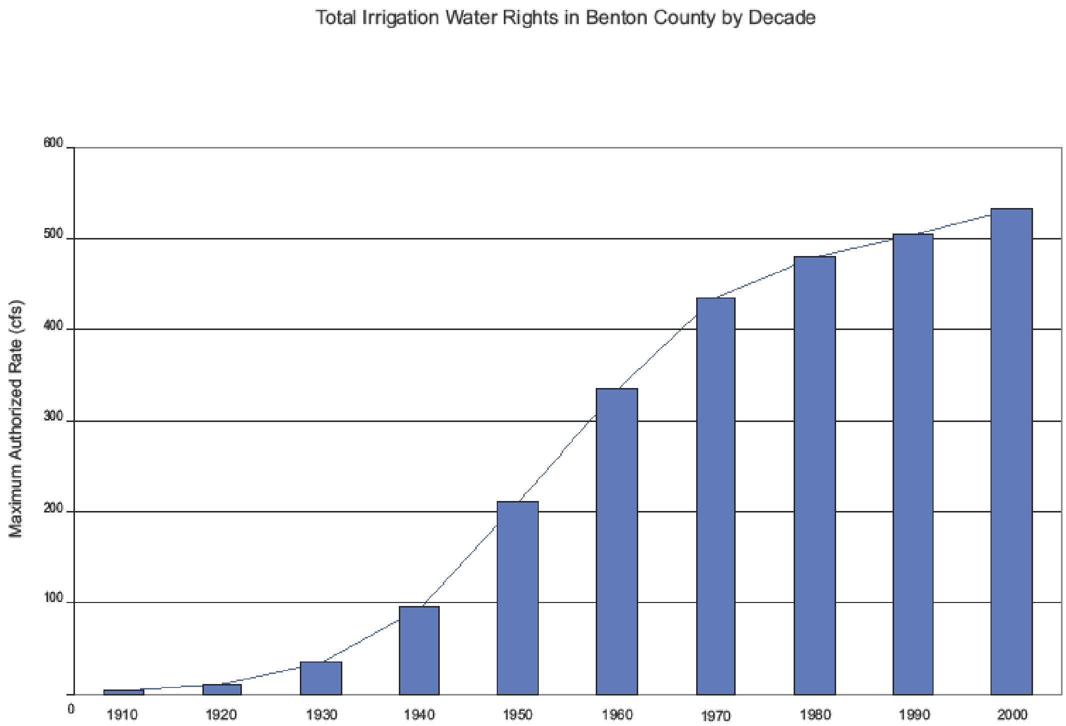
As previously described, irrigation is a major water use in Benton County. This section discusses future irrigation water needs focusing on larger commercial-scale operations because they represent the vast majority of irrigation demand. Future water needs for residential irrigation (lawns and gardens) are much smaller and are incorporated in the domestic forecasts in **Sections 5.2, 5.3 and 5.4.**

According to OWRD's point of diversion summary report, the amount of new authorized groundwater and surface water use for irrigation purposes in Benton County has slowed over the last few decades (**Figure 5-5**). This is consistent with data from the U.S. Department of Agriculture which show essentially no increase (approximately 90 acres) in irrigated acres for farms in Benton County from 1997 to 2002 (**Figure 5-6)**.

With the exception of the Greenberry Irrigation District, there has been limited expansion of irrigation use. Since January 1, 2000, the agency has issued new primary irrigation water use permits that authorize up to approximately 27.18 cfs (17.6 mgd) from points of diversion in the county. The majority of this use is associated with a new five-year water right issued to the Greenberry Irrigation District.

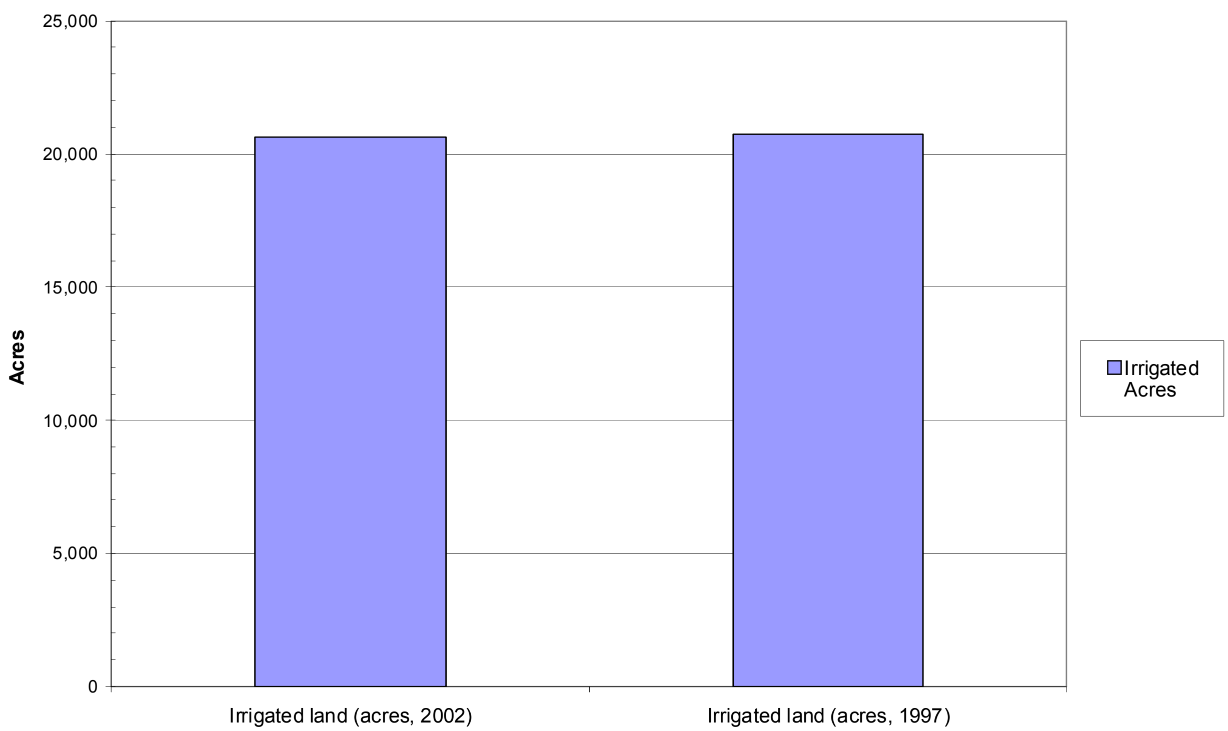
Non-commercial irrigation of lawns and gardens can also be supplied by an exempt use of groundwater. To estimate the maximum anticipated amount of such use, we multiplied the largest number of anticipated additional households from Scenario **1** for self-supplied domestic water in **Section 5.4.1** (3,018 residences), by the daily average water use for non-commercial irrigation of 380 gallons (**Section 3**). The resulting maximum estimated additional exempt use of groundwater for noncommercial lawns and gardens is 1.15 million gallons per day (mgd). If we instead assume that the City of Corvallis will provide water to all of the new households within its urban growth boundary, this additional water demand is reduced. Under that scenario only 2,331 new households would require water for their lawns and gardens, resulting in an additional daily water use of approximately 886,000 gallons per day. This additional use would occur primarily during the peak demand summer months.

Figure 5-5 Growth in Maximum Rate of Irrigation Water Use Authorized by Water Rights



* Current number of water rights estimated through October 2008

Figure 5-6 Comparison of Irrigated Farmland Acres in Benton County (1997-2002) (Source: Natural Resources Conservation Service, National Agricultural Statistics Service database)



The amount of water used for irrigation in Benton County could change over time either through issuance of new water rights or increased use of water under existing water rights (up to the maximum amount authorized).

A number of factors could influence such a change in water use; for example, climate change could increase the need for irrigation. Market forces, such as a demand for locally-grown produce, could also increase the need for water for irrigation purposes. On the other hand, increased efficiency and more water re-use projects could decrease the irrigation need. Finally, changes in farming practices and land use could impact the amount of water used for irrigation.

As described in **Section 4 Water Reliability**, it is unlikely that any future demand for water for irrigation purposes could be met by surface water. As previously discussed, the surface water sources in Benton County, except the Willamette River, are over-appropriated during at least a portion of the irrigation season. The mainstem Willamette in this area has water available during the irrigation season, but the basin program rules do not classify that reach of the river for irrigation use from July1 through August 31. Any future need for water could be met by the release of stored water for locations downstream from existing (or future) storage facilities. As previously noted, however, the recently-issued biological opinion has set a limit of 95,000 acre-feet on the total amount of irrigation contracts to be issued from the federal Willamette Basin storage projects. Consequently, these federal projects may become a less reliable option for obtaining stored water.

Conclusions

It is highly unlikely that aquifers in many parts of the Benton County could provide a sufficient supply of groundwater to meet new commercial irrigation requirements. The broad exception is the Younger Alluvial aquifer in areas near the Willamette River. As discussed in **Section 2**, the geologic materials in this deposit are highly permeable and can supply large quantities of groundwater. The limiting factor is that much of the groundwater is directly connected with surface water resulting in restrictions on groundwater withdrawals to protect surface water flows.

5.7 Summary of Other Future Water Demand Factors

Projected water demands for the cities and unincorporated areas within Benton County were based on set assumptions driven by past population and water demand projections extrapolated to year 2050. It is important to note that the future demands were based on existing reports and are conservative estimates based on past population growth rates and non-residential water demands. Many of the factors affecting future water demand could not be taken into account for future demand forecasting, due to the difficulty in quantifying when the water demand factor would occur and how the water demand factor would develop over a specific period of time. The following descriptions were identified by project stakeholders, as leading water demand scenario possibilities to highlight the need for taking these often unknown water demand factors into account in future project phases and work:

- **Economic-** Current industrial/commercial business can potentially reduce a given work force, decreasing the population and associated water demands of the business and possibly relocating the work force. For instance, Hewlett Packard is likely to reduce employees and operations and thus to likely decrease the total water demands for the City of Corvallis. Furthermore, historic industries such as timber mills throughout Benton County have decreased. Conversely, the economy of Benton County could encourage increased populations and higher demands for water depending on the type of industry and population that could occur. For instance, the industrial land located outside of the City of Adair Village has the potential to be a water intensive industry.
- **Seasonality and Climate Change -** The specific future impacts of seasonal and longer climate change on the regional water supply and water quality of the Pacific Northwest and specifically Benton County are unknown. There is consensus that there will be markedly different water resource issues requiring mitigation in the future than in past years. According to the Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest (see **Appendix H**):
    - Precipitation changes are very uncertain; however, there will be"likely impact on water resources due to low summer precipitation".
    - Earlier peak stream flow will likely include decreased summer water availability.
    - Changes in our ability to manage flood damage
    - Shifts in hydropower production from summer to winter
    - Decreased water quality due to higher temperatures, increased salinity and pollutant concentrations (**Appendix H** Executive Summary- p.1-2).

  Understanding and planning for impacts is important, and could greatly change the future demands of Benton County. For example, 'climate refugees' relocating to Benton County from more arid areas of Oregon and the United States could potentially increase the population and associated increase in demand for water throughout the county.

- **Annexation and Other Policy Decisions -** Depending on a diversity of land designations, actions, and uses over the forecasting period, water demands within city and unincorporated areas across Benton County are subject to change at unknown times in the future. For example, depending on the timing and location that Benton County and a given city approve an annexation and/or new water supply service line installations and connections, the water demand on rural groundwater resources and given city water source(s) may be subject to a wide range of future demands.
- **Agriculture –** Perhaps most important to land use and associated water demands within is the type of agriculture within Benton County. Depending on the type of agriculture within the county (crop, nursery, livestock, etc.), greatly differing water demands will be required to meet agricultural and irrigation needs into the future. For example, a shift to more locally grown food is a trend that would require increased water use for irrigation and agriculture. Water conservation and efficiency potential exist to offset future water demands for agriculture. Shifting of watering practices to enhance production (i.e. the trend of irrigating grass seed fields shortly after planting in late September during the high water demand season, to increase yields).
- **Technology/Infrastructure –** Cities and rural water utilities will require new or retrofit existing water collection and distribution technology and infrastructure to improve water use efficiency and support increased water demands. Such water system improvements will require capital and operating costs that may or may not limit which communities and landowners have the ability to meet their future demand. Population and cost are drivers in the ability of each community water system to update water infrastructure. Incorporating new 'soft' infrastructure that uses the landscape (e.g. wetlands and agriculture for wastewater reuse) could assist in water and wastewater issues in the future.

Section 6
Outreach and Education

6.1 Objectives

Involving the highest number and diversity of residents and organizations in the *Phase 1* Benton County Water Analysis and Demand Forecast was an important component of the project. The ongoing outreach and education objectives are to engage community groups and residents in identifying important water issues and values and to inform residents and organizations throughout Benton County of the *Phase 1* water project goals.

6.1.1 Water Project Outreach and Education Strategy

Benton County Water Project staff with assistance from outreach and education team members (see **Section 1.6**) set out to foster community engagement across the county. This was accomplished through direct postcard mailings, Water Project email updates, community meetings, project website, local newspapers, and newsletters. The Outreach and Education Team completed the following to identify water issues, concerns, and values of the community:

- The formation of a Benton County Water Project Questionnaire (**Appendix K**) made available through interactive community meetings and online through the project website (www.co.benton.or.us/boc/water/questionnaire).
- Facilitation of Community Water Project Meetings held in five communities throughout Benton County (**Table 6-1**). Presentations given by the project coordinator covered the technical findings of the water project to date. Questionnaires and open discussion captured water quantity and quality concerns from meeting participants.

Table 6-1 Community Meetings held during the *Phase 1* Water Project Period

Community Areas of Focus	Locations	Dates and Times
Philomath, Corvallis, surrounding unincorporated areas	Philomath Historical Museum	9/9/08; 6:00-7:15 P.M.
Monroe, Alpine, Bell Fountain	Monroe High School	9/17/08; 6:30-8:30 P.M.
Alsea, Lobster Valley areas	Alsea Public Library	9/22/08; 7:00-9:00 P.M.
Wren, Kings Valley, Hoskins, Summit and Blodgett areas	Wren Community Hall	9/30/08; 7:00-9:00 P.M.
Lewisburg area, North Corvallis area residents	Mountain View High School	10/1/08; 7:00-9:00 P.M.
North and South Corvallis	Corvallis-Benton County Public Library	12/10/08; 7:00-9:00 P.M.

6.2 Water Project Outreach and Education Metrics

6.2.1 Community Meeting Outreach

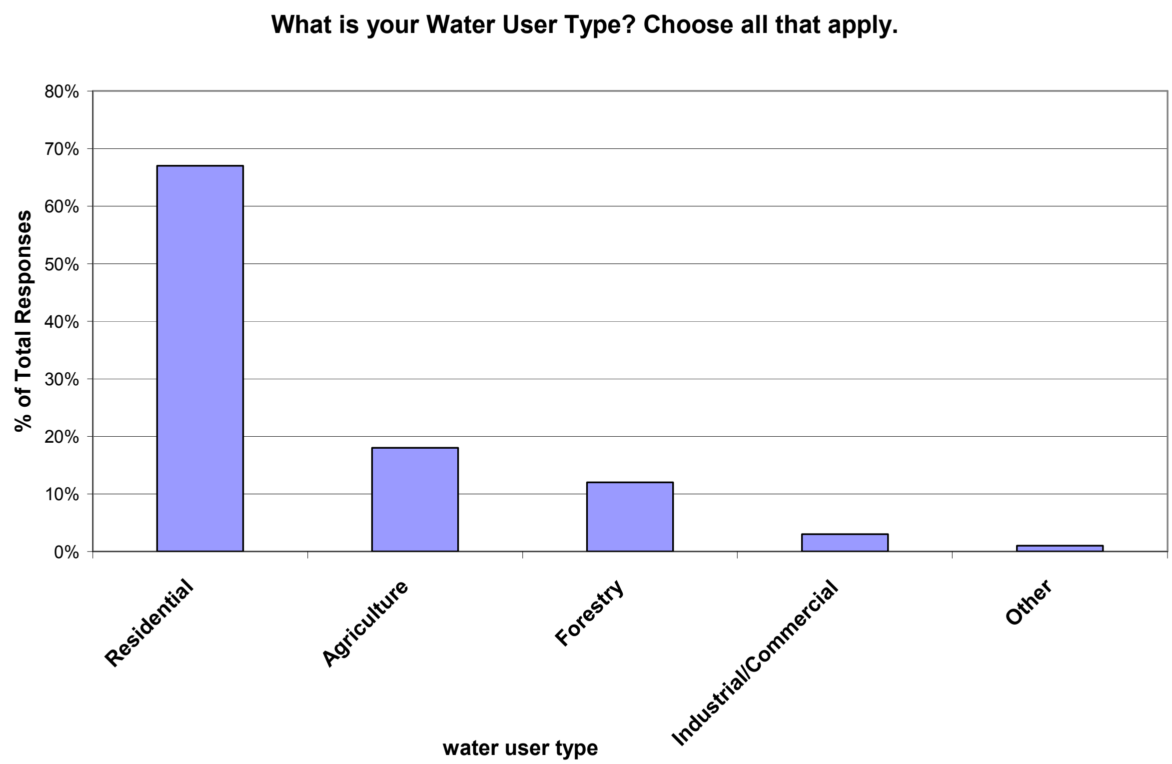
Table 6-2 below shows the community meeting attendance and percentage of meeting participants who completed multiple choice questionnaires. Attendance at community meetings is likely linked to the methods of advertising. A range of advertising methods were used to engage attendance and input throughout the *Phase 1* project period. However, limited budget and staff resources did not allow for all community events to be advertised in the same way.

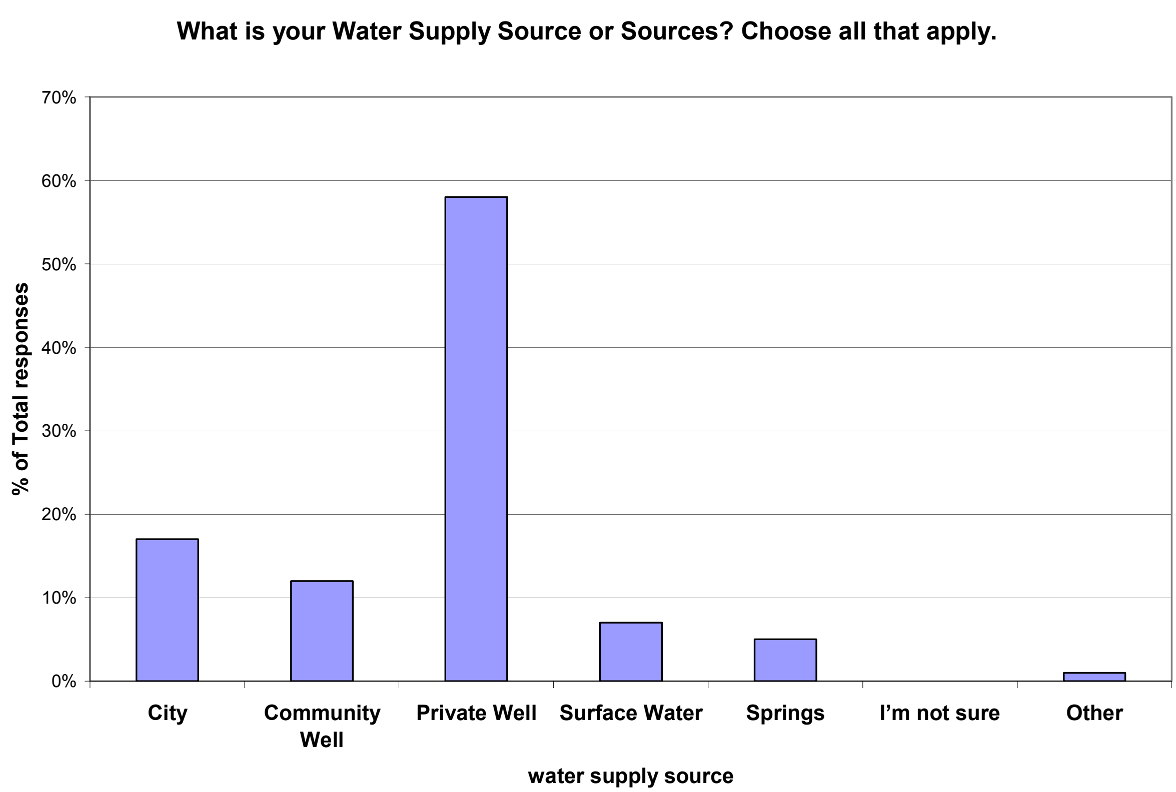
Table 6-2 Community Meeting Attendance and Questionnaire Response Total

Meeting Location	Total Attendance	Attendees Completing the *Phase 1* Questionnaire (%)
Philomath Historical Museum	34	97 %
Monroe High School	25	100 %
Alsea Public Library	16	92%
Wren Community Hall	16	100%
Mountain View High School, Lewisburg	20	100%
Corvallis-Benton County Public Library	12	75%
TOTAL	123	*
AVERAGE	21	98 %

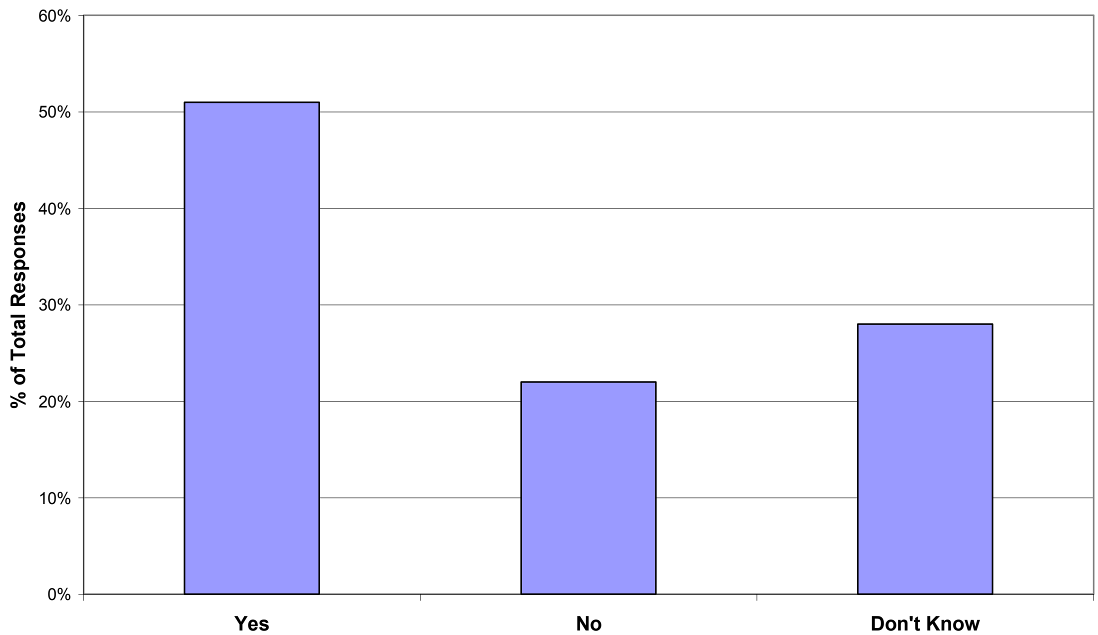
6.2.2 Responses- Multiple Choice Questions from Community Meetings

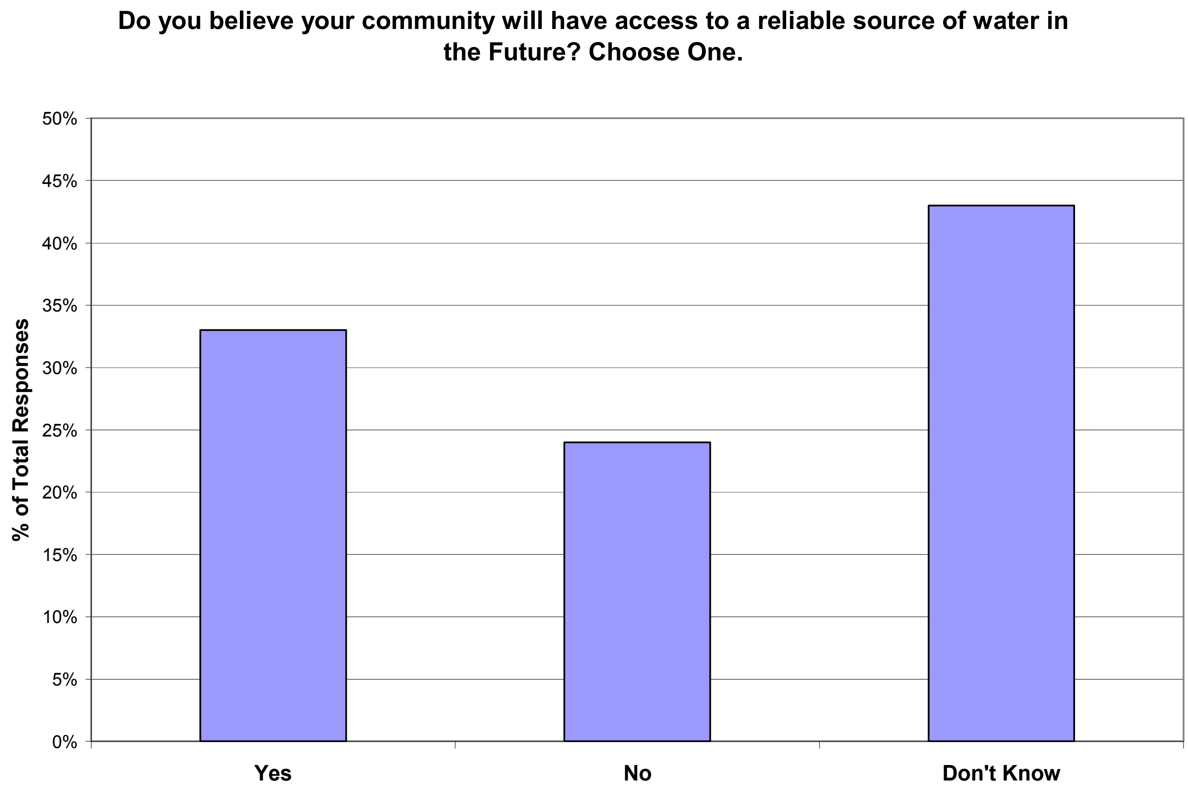
The following graphs show responses to the multiple choice questions that capture the range of water quantity and quality concerns, issues, and values expressed by meeting participants. **Table 6-3** provides responses to the open-ended questions.


What is your Water User Type? Choose all that apply.
% of Total Responses
80%
70%
60%
50%
40%
30%
20%
10%
0%
Residential
Agriculture
Forestry
Industrial/Commercial
Other
water user type


What is your Water Supply Source or Sources? Choose all that apply.
% of Total responses
70%
60%
50%
40%
30%
20%
10%
0%
City
Community Well
Private Well
Surface Water
Springs
I'm not sure
Other
water supply source

Does your community have access to a reliable source of water now in year 2008? Choose One.




Do you believe your community will have access to a reliable source of water in the Future? Choose One.
% of Total Responses
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Yes
No
Don't Know

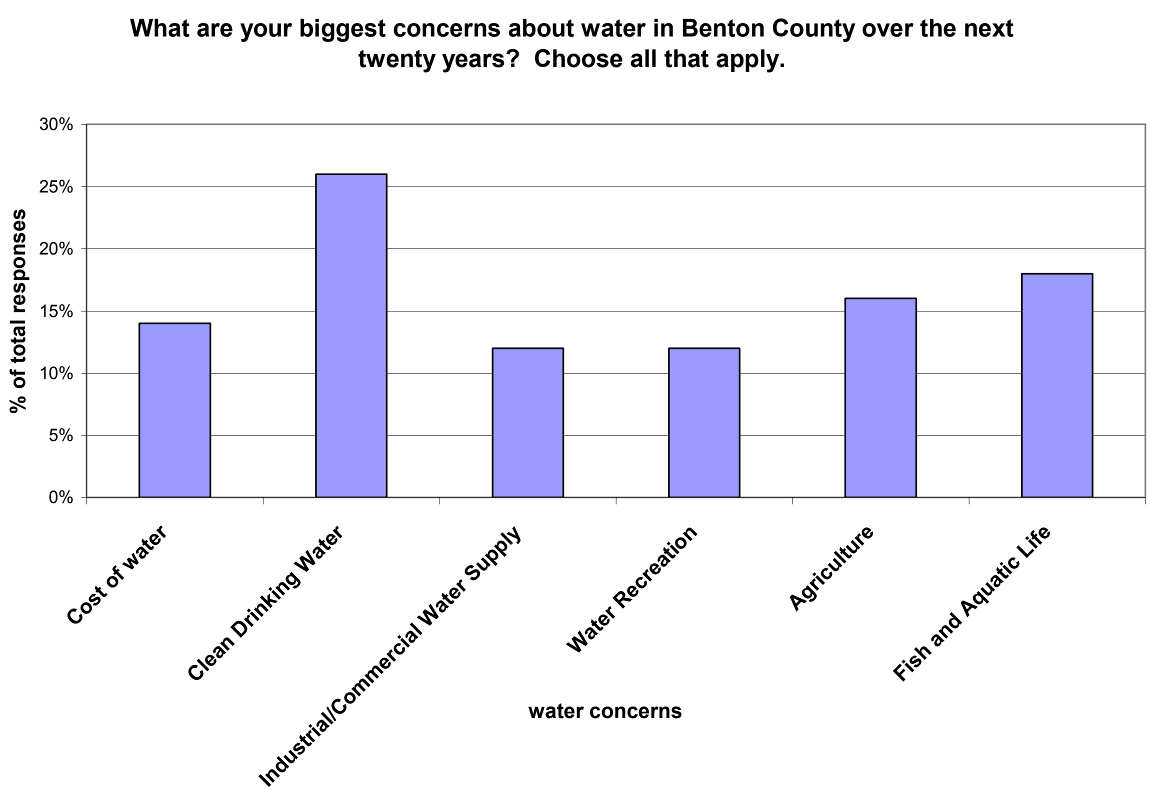

What are your biggest concerns about water in Benton County over the next twenty years? Choose all that apply.
% of total responses
30%
25%
20%
15%
10%
5%
0%
Cost of water
Clean Drinking Water
Industrial/Commercial Water Supply
Water Recreation
Agriculture
Fish and Aquatic Life
water concerns

Table 6-3 Selected Responses to Open-Ended Questions from Community Meetings

Open Ended Question #1: Is there anything else you would like to tell us about your water related concerns?

Water Quantity Focused Responses

Don't allow a home to be built unless the lot has required water and storage and keep statistics of all well and septic failures.
Concern that most people don't perceive that water issues will become increasingly important.
The County and the State will use the water issues as a reason to limit development.
Rivers running dry in the summer.
Droughts have occurred in the past and we need to have an ongoing water plan.
Government needs to write laws that are meaningful, useful and take responsibility.
Will the County match supply with use (ex. Fish and domestic use?) and restrict growth if needed?
Development may top the water table and negatively affect domestic wells.
Salmon runs compared to human life.
Fish and wildlife concerns seem to come before agricultural needs.
Will resource land like forest and agricultural be considered low /slow growth areas?
Determine carrying capacity - start with definition of quality of life.
Show and use examples of areas conserving groundwater (i.e. Highland Dell).
Data assessment may lead to regulation of private wells.
Unknown groundwater supply and future growth.
Need to plan for future growth and begin to educate the public now.
Climate change, growth, costs.
Low production of wells and lack of knowledge of options for assistance.
Management of water supply uncertain.
Not enough is being done to protect and replenish underground water tables.
Concerned about restricting growth and foothill water quantity problems.

Water Quality Focused Responses

Over several years there have been elevated contaminant levels of nitrates.
There is too much chlorine in City water.
Not enough is being done by the County to protect and improve the quality of water in our rivers.
Concerns included the use of chemicals on neighboring properties contaminating groundwater.
Quality concerns that are merely aesthetic vs. actual legally defined health concerns.
Hardness, sulfates, solids, chemicals, and the connection with supply consistency.
Excessive rural development will seriously impact water quality.

<u>Open Ended Question #2:</u> How might we make this Benton County Water Project beneficial to your community?

Make all results from the Water Project available to public.
Promote low impact development for all permits.
Provide demonstration projects for grey water reuse, rainwater collection, etc.
In the future a water plan should be made to help with rural development plans to limit the environmental impacts.
The water project needs to include a plan to maintain or improve fish and ecosystems health.
Get an idea of Benton County's aquifer capacity.
Have guidance for cities to manage future development.
Fund a county wide detailed professional groundwater study to give future planners much needed and currently unavailable data.
The primary goal of the Benton County Water Project now and in the future should be to create more awareness and understanding of the issues facing our communities.
Collect data from Benton County residents on wells that have gone dry to aid in overall report data.
Evaluate alternative water supplies for domestic/private users.
Be sure to factor in all water uses when assigning allocations in the future.
Possibly meetings every 4 to 6 months.
Predict emergency needs, examine local geology and impacts of usage over time, and examine using cisterns.
Communication about on-going progress.
Coordinate with other counties, survey wells for development planning, know supply to aquifer.

Gather data to make long-term decisions.
Interference studies for new development in low water supply areas.

6.3 Online and Other Outreach

Online questionnaire responses were completed by 40 residents within Benton County. The online version of the *Phase 1* questionnaire was made available for completion from 9/30-11/1/08. The online *Phase 1* questionnaire was sent to approximately 220 Benton County Water Project email list subscribers. The project mailing list includes the "The Oregon Water List" (TOWL) maintained by the Institute for Water and Watersheds at Oregon State University (OSU), which has approximately 715 subscribers ranging from OSU students and faculty, to local/state/federal politicians, and many other persons interested in water resources issues in Oregon.

There was limited response to the open-ended questions via the web-based questionnaire, compared to the responses gained through the community meetings. This may be due to the facilitation and personal contact provided at the meetings. It is likely that without more explanation of the Benton County Water Project, an online respondent may not have enough background to suggest how the project could aid their community. Lacking personal interaction, on-line respondents may have felt less vested in the project process, leading to low response rates. Additionally, online respondents were less diverse in water user type and water use with an overwhelming majority being from the City of Corvallis. Online responses are included in **Appendix L**.

A presentation of project work was given to the United States Department of Agriculture-Farm Service Agency (FSA) Committee during the project period. FSA commissioners composed of farmers from Benton, Lincoln, and Linn counties provided their comments and concerns. The consensus was little concern for supply now and in the future due to groundwater and surface water supply rights, and the general lack of using water efficient/conservation technology that is available now and in the future. Farmers/commissioners were receptive and thankful for the presentation.

Final meetings were held with city council and staff members from all cities involved during the *Phase 1* report. These meetings allowed for city specific comments to be collected and changes made to the collected information.

6.4 Summary

The *Phase 1* project questionnaire and associated open ended question responses were completed by 150 county residents during the project period. The results of the *Phase 1* Benton County Water Project questionnaire and community discussions are useful in beginning to comprehend the county-wide water values, concerns, and specific water quantity and quality issues. Responses and comments came from a range of water users on past, current, and future water issues within Benton County. Residents utilizing water from private wells, community wells, cities, and springs provided input.

The water quantity and quality issues that meeting participants (residents of Benton County) are facing when it comes to their individual communities water supplies include:

- Throughout the county, residents expressed strong values associated with clean water, fish and wildlife, and agriculture now and into the future.
- Residents experiencing groundwater quantity and quality issues are concerned about these impacts - specifically as new development occur within their water use area.
- A majority of outreach participants expressed a desire to plan ahead and develop strategies that are fair and equitable, when dealing with water quantity and quality issues.
- The majority (58%) of participants use a private well as their water source.
- Groundwater quantity and quality issues were most commonly identified.

Shared groundwater resources and impacts to these resources is a current and growing issue within location specific areas of Benton County- It is important to introduce the issues associated with shared groundwater quantity and quality. This idea, which was continually stated at the public meetings, refers to neighbors implicating other neighbors that are "taking their water". Typically, it is expressed as an implication that the new development next door is reducing the "flow of my well". This assumes groundwater commons from which new and existing users take from the others in the same groundwater basin or shared aquifer (groundwater supply). This can occur across land use from agriculture-irrigation use, to rural-domestic use.

The collected *Phase* 1 citizen input provided here is a first step to build on through future project phases. The information gathered provides ideas for future project outreach and education efforts focused on expressed concerns, issues, and values. How this citizen input aligns with the technical findings of Sections 1-5 should be reviewed further by project staff and committees.

Sustained and ongoing communications and meetings with specific organizations (e.g. districts, councils, State representatives) and Benton County residents and communities will aid in addressing water management, policy, and planning issues over time. Future project phases should continue to focus on gathering broader citizen input on a community/site specific basis to determine the political, financial, and technical methods to solve current and projected future water issues over time.

Section 7
Future Work

7.1 Looking Forward to Phase II

This report is based on the best available information from federal and state agencies, water districts and cities, as well as input from community members, published reports, and members of the technical and outreach teams.

The information collected and produced for *Phase 1* is often historic and incomplete. Therefore, the Steering Committee, in conjunction with the Technical Team, produced a conservative range of data estimates.

The Steering Committee identified two general areas in which it recommends further work to expand and refine available knowledge and information:

1. Scientific knowledge about the surface and ground water systems in Benton County and the factors that affect water quantity and quality.
2. Social mechanisms to address water supply and quality issues that exist and will arise over time.

The Steering Committee reviewed community input and outlined the following concerns, values and related objectives that will frame future phases of project work.

- Maintain and improve water quality. County residents value clean water.
- Provide water to fish, wildlife, and agriculture. Residents expressed concern for adequate water for fish and wildlife and support for agriculture and irrigation.
- A majority of county residents use surface water supplies provided by cities and are more concerned with water quality than water quantity issues.
- Determine the basis of groundwater use conflicts between domestic well users; the conflict has the potential to increase over time.
- Better understand surface and groundwater sources and approaches to protection.
- Collect more data on groundwater quantity.
- Review guidelines for new wells. County requirements call for 5 gallons per minute production on new wells for developments, however many county residents who have used and/or installed wells with less water production have attained sufficient water supplies through conservation and storage.
- Provide education to landowners on site-specific groundwater issues.
- Evaluate and prioritize areas where alternative water supplies will be needed.
- Work with stakeholders to develop approaches to water conservation and water quality protection.
- Continue to raise awareness of project findings and share County and regional data on water quality and quantity issues.
- Develop a plan to address known and projected water issues.

7.2 *Phase 2* Plan Development

The following focus areas are central to the development of a countywide comprehensive management plan that addresses the significance of watershed-based planning that crosses political jurisdictions.

1. Continue to promote collaboration with adjacent counties, municipalities, water providers, and other stakeholders to develop the capacity to work collaboratively to address regional water quantity and quality issues. These include but are not limited to: data collection, information sharing, and policy/planning collaboration.
2. Provide the template methods of the *Phase 1* assessment and demand forecast methodology and findings to neighboring counties and interested stakeholders to encourage similar holistic evaluation of water resource issues and elicit responses.
3. Develop scenarios of future water demands for the range of surface water and groundwater users including but not necessarily limited to: land use changes, irrigation, climate change, conservation, and infrastructure scenarios.
4. Evaluate priorities and potential feasibility for water quantity and quality mitigation where groundwater and surface water supplies affect county residents' use of these water resources. It should be noted that any decision to alter natural flows (e.g. storage) can have the impact of affecting other water users and natural processes.

7.3 Surface Water Information Gaps

To further inform a broadly defined basis for plan development, the beginning of a comprehensive list of information gaps related to surface water systems, quantity, and quality follows.

Surface Water System

- Linkages between ground and surface water systems need to be better elaborated and understood.
- The extent of groundwater basins and interaction of groundwater users need to be delineated
- The origin and relative contribution of pollutants need to be identified.

Surface Water Quantity

- *Phase 1* data was based on historical, estimated, and/or limited stream flow data (Federal and State databases). Estimates for 80 and 50 percent exceedance stream flows and monthly discharge data is needed for current and projected future stream flows under various scenarios.
- 47 percent of surface water rights are for irrigation. No estimate of actual water use occurred during the *Phase 1* project period, due to the complexity and lack of reporting. Determine the need and ability to estimate irrigation water use.

- Possible development of a useful ‘water budget’ (An accounting of the inflow to, outflow from, and storage changes of water in a watershed) that is consistent for all water users with primary sources of surface water, to determine stream flow supply once these estimated water demands are met.

Surface Water Quality

- Total Maximum Daily Load (TMDL), storm water, and wastewater discharge management was not addressed in *Phase I*. County work with regional partners should be considered to maximize limited funding for improving water quality.

7.4 Groundwater Information Gaps

To further inform a broadly defined basis for plan development, the beginning of a comprehensive list of information gaps related to groundwater quantity and quality follows. The “groundwater commons” issues described in Section 6 is both a scientific and social question of immediate and future concern. The scientific question from the existence of common groundwater sources that are shared by several users are:

- How to determine/refine groundwater boundaries and impacts upon the resource?

The social question of the groundwater (aquifers) is:

- How to deal with the conflict issues that arise from shared groundwater resources over time?

Groundwater Quantity

- Data on estimated water use from domestic and community wells was developed and should continue and expanded to better understand groundwater demand.
- Determine the amount of water used across parcel sizes, property ownership, and microclimates within the county. This could occur through collaboration with community utilities, well-level monitoring and reporting by volunteers.
- Identify the specific location of domestic, deepened, and abandoned wells within the county.
- Well-to-well interference issues were identified throughout the county within Marine Sediment and Sandstone and the Siltez River Volcanics Principal Hydrogeologic Areas. Develop a method to determine aquifer and well yields and the social methods for dealing with current and potential conflicts (e.g. incentive, regulatory, etc.).
- Inventory the storage and management methods used by private and community groundwater users to better understand the range of existing best management practices and possible water supply solutions for groundwater users.
- Compile well-level data from federal, state, and local sources with increased state and federal monitoring being promoted by Benton County through observation wells and voluntary groundwater monitoring/reporting.

- Refine estimates of current and future populations in community groundwater use areas.

Groundwater Quality

- Community (defined by State drinking water program) groundwater systems were the focus of *Phase 1*- however many schools, and transient/non-community groundwater uses exist within Benton County. Develop and promote prevention of groundwater contamination as a cost effective method, rather than remediation after pollution occurs, in areas that are prioritized as sensitive based on State Drinking Water Source Assessments and other existing source water protection reports.
- The Southern Willamette Valley Groundwater Management Area (GWMA) findings were overviewed in the project including boundaries of the management area and water quality monitoring. The GWMA spans Linn, Benton, and Lane counties and provides an area of focus to study water quality and engage in regional cooperation to solve water quantity/quality issues across political boundaries.
- Compile and review well water quality monitoring records at the county level from state, university, and federal records. This could include residents directly reporting water quality from private wells.

7.5 Institutional Functions and Relationships

To further inform a broadly defined basis for plan development, the beginning of a comprehensive list of issues related to institutional functions and relationships follows.

- Benton County gets water from Linn, Lane, and Polk counties. Water from Benton County flows to Polk and Linn Counties. What are possible social arrangements between the counties, cities, and water districts with major state and federal agencies in the regional area?
- Willamette Basin reservoirs have storage capacity for water that is designated for particular uses. Would it be desirable to review these water allocations?
- What relationship will state agencies have with local water providers regarding water supply, quality, conservation, and allocation?
- Does Oregon water law need to be revised to enable achieving the highest and best use of water. What is the definition of highest and best use? What is the relative value placed on domestic water supply, fishing, industrial water supply, boating, irrigation, water contact recreation, livestock watering, aesthetic quality, fish and aquatic life, hydropower, wildlife and hunting, commercial navigation and transportation.
- People have a strong distrust of government. They are concerned about regulations limiting their activities. What processes can be used to increase trust, participation, and achievement of community goals.

- City and county land use planning has a significant impact on water quality and quantity. What changes need to be made to land use planning and other procedures to adjust to future water quality and quantity needs?

7.6 Community Participation

- Water conservation has been identified as an important goal. Who will have responsibility for setting water conservation goals and design approaches to meet them? What types of incentives work best in achieving water conservation goals?
- Many people mentioned concern for how the actions of others affected the quantity and quality of water available to them. What are the mechanisms that can be used to successfully resolve disputes that may arise regarding water quality and quantity?
- Residents have a wide range of experience with water quality and quantity. How can this experience be effectively collected? How can people be mobilized to collect additional data?
- Community meetings were very useful. What other processes might be used? Can more meetings be held? What resources are needed to increase community involvement? How can these resources be obtained?

Glossary

The following Phase 1 Project definitions were compiled from published reports from State and Federal Agencies, namely the Oregon Water Resources Department and the United States Geological Survey.

Abandonment: The act of voluntarily giving up a water right

Abandoned Well: As defined in ORS 537.775 (3); A well that is sealed according to state law.

Adjudication: The determination made by a Circuit Court, based on information provided by the Water Resources Department, regarding a claim of pre-1909 surface water use or pre-1955 groundwater use. The determination is set out in a court decree recording the amount, type, and location of water uses existing before the adoption of Oregon Water Code.

Alluvial: soil or sediments deposited by a river or other running water.

Aquifer: "A water-bearing body of naturally occurring earth materials that is sufficiently permeable to yield usable quantities of water to wells and/or springs" [OAR 690-08-001]

Basin: The source area for rivers and streams.

Beneficial Use: "The basis, the measure, and the limit of all rights to use of water in the state" [ORS 540.610]. The term is not defined in law but examples of beneficial uses include: irrigation, municipal, fish and wildlife, hydropower, and navigation.

Community Water System: A public water system with 15-plus connections; or 25-plus people, used year-round (e.g. cities, water districts, rural subdivisions) (source: ODHS).

Consumptive Use: term usually reserved for uses characterized by significant consumption such as irrigation and municipal uses, where the quantity of water returned to the original source after utilization is diminished.

Domestic Use: Household water demands (drinking, non-commercial irrigation)

Exempt Use: Any water use explicitly listed in statute as not being subject to the water right or any other approval process. Allowed uses of water, not requiring a water right include: The beneficial use of groundwater up to 15,000 gallons per day for each well or water system and irrigation of up to one-half acre of non-commercial lawn and garden; The limited use of surface water for emergency fire fighting, some non-emergency fire fighting training, fish screens, fish ways and fish bypass structures, certain land management practices, some livestock watering operations and limited forest management activities.

Groundwater: (1) water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturate zone is called the water table. (2) Water stored underground in rock crevices and in the pores of geologic materials that make up the Earth's crust.

Groundwater Commons: shared groundwater (see above) resource commonly referred to as a 'common pool resource', where several users are dependent on a shared aquifer (see aquifer).

Groundwater Management Area: An area established by the Environmental Quality Commission, in response to groundwater contamination problems. Designation is triggered by specific contaminant levels and results in a plan to prevent additional, and reduce existing, pollution.

Hydrogeology: the geologic characteristics that influence the underground flow or movement of water

Instream Water Right: a special type of water right that can only be applied for by three state agencies, which are the Oregon Department of Environmental Quality, the Oregon Department of Fish and Wildlife, and Oregon Parks and Recreation Department. These water rights protect water in the stream for fish and wildlife, recreation, navigation or pollution abatement purposes. Once approved, the water right is held by OWRD in trust for the people of the state of Oregon.

Recharge Area: Surface areas through which water percolates down into underground groundwater storage areas (see **aquifers**).

Sediment: any particulate matter that can be transported by fluid flow and which eventually is deposited as a layer of solid particles on the bed or bottom of a body of water or other liquid.

Surface Water: water that is on the Earth's surface, such as in a stream, river, lake, or reservoir.

Water Demand: maximum water use under a specified condition.

Water Quality: a term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Water Use: the amount of water needed for a variety of purposes including drinking, irrigation, processing of goods, power generation, etc.

Wastewater: water that has been used in homes, industries, and businesses that is not for reuse unless it is treated.

Well: An opening in the surface of the earth for the purpose of removing fresh water.

Appendix

Appendix A

Benton County Comprehensive Plan Policies regarding Water Quantity and Quality

Benton County Comprehensive Plan- Goal 6 Air, Water and Land Quality

6.2.1 Benton County shall encourage collaborative efforts involving state agencies, municipalities, users of surface waters and environmental interests, to preserve and enhance surface water quantity during low-water periods.

6.2.2 Benton County shall incorporate vulnerability assessments and source protection for the public's water supply as part of the land use process. The source of such assessments and information shall be state agencies and other qualified entities.

6.2.3 Benton County shall assure that public water systems and private wells meet minimum water quality standards.

6.2.4 Benton County shall place a high priority on maintaining natural systems and processes as a biological method for maintaining and protecting clean water.

6.2.5 Benton County shall collaborate with others to promote watershed management practices that protect and enhance water quality and quantity.

6.2.6 Benton County shall require development to be designed or located in a manner that will result in no net degradation of water quality and quantity.

6.2.7 Benton County shall cooperate with and request state and federal agencies to undertake hydrological studies to determine the location, quantity, quality, and estimated consumption of groundwater within the county.

6.2.8 Benton County shall encourage protection of water quality by developing a septic management system to monitor existing systems and by working with DEQ, municipalities, and others to identify point and non-point sources of pollution and encourage effective abatement.

6.2.9 Benton County shall achieve efficient use of water and water conservation through the land use permitting process, operation of County-managed water systems, and a public information program.

6.2.10 Water resources shall be managed wherever possible on a watershed or landscape scale to assure continuity and integrity of practices to the waterway."

Appendix B

Statistical Summaries of Stream Flow Data

Water-Data Report 2007

14170000 LONG TOM RIVER AT MONROE, OR

Willamette Basin
Upper Willamette Subbasin

LOCATION.--Lat 44°18′47″, long 123°17′43″ referenced to North American Datum of 1927, in NE ¼ sec.33, T.14 S., R.5 W., Benton County, OR, Hydrologic Unit 17090003, on left bank, at Monroe, 110 ft upstream from bridge on State Highway 99W, 0.1 mi downstream from Shafer Creek and at mile 6.8.

DRAINAGE AREA.--391 mi^2.

SURFACE-WATER RECORDS

PERIOD OF RECORD.--November 1920 to July 1921, October 1921 to April 1926, November 1926 to May 1927, October 1927 to current year. Prior to October 1930, published as "near Monroe."

REVISED RECORDS.--WSP 654: Drainage area. WSP 1248: 1923, 1927, 1928(M). WSP 1288: 1952.

GAGE.--Water-stage recorder and concrete control. Datum of gage is 270.57 ft above NGVD of 1929. Prior to Nov. 24, 1944, nonrecording gage at various sites ranging from present site to 1.5 mi downstream at different datums.

REMARKS.--No estimated daily discharges. Records good. Flow regulated since November 1941 by Fern Ridge Lake, (active capacity, 93,350 acre-ft). Several small diversions upstream from station. Periodic suspended sediment data are available for the period October 1991 to September 1994.

AVERAGE DISCHARGE FOR PERIOD OF RECORD.--18 years (water years 1922-25, 1928-1941), 689 ft^3/s, 499,200 acre-ft/yr. 66 years (water years 1942-2007), 767 ft^3/s, 555,900 acre-ft/yr, regulated period.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 19,300 ft^3/s Jan. 2, 1943, gage height, 17.14 ft, site and datum then in use, from graph based on gage readings, includes some overflow from Willamette River near Junction City; no flow Oct. 20-22, 1944 (water filling pool at gage); minimum discharge observed prior to regulation, 7 ft^3/s Sept. 29, Oct. 1, 1939.

EXTREMES FOR CURRENT YEAR.–Maximum discharge, 5,970 ft^3/s Jan. 3, gage height, 8.64 ft; minimum discharge, 29 ft^3/s Aug. 16, 17, 29-31, Sept. 5.

Water-Data Report 2007

14174000 WILLAMETTE RIVER AT ALBANY, OR

Willamette Basin
Upper Willamette Subbasin

LOCATION.--Lat 44°38′20″, long 123°06′20″ referenced to North American Datum of 1927, in SW ¼ sec.6, T.11 S., R.3 W., Linn County, OR, Hydrologic Unit 17090003, on right bank, 5 ft upstream from bridge on U.S. Highway 20 (Ellsworth Street) in Albany, 0.2 mi downstream from Calapooia River and at mile 119.31.

DRAINAGE AREA.--4,840 mi^2, approximately.

SURFACE-WATER RECORDS

PERIOD OF RECORD.--November 1878 to April 1888 (fragmentary), January to June 1892, November 1892 to September 1894, December 1894 to current year. Monthly discharge only for some periods, published in WSP 1318.

REVISED RECORDS.--WSP 694: Drainage area. WSP 904: 1939. WSP 964: 1881, 1890, 1894, 1897, 1901, 1903, 1908, 1910, 1916, 1923, 1927, 1932(M). WSP 984: 1916. WSP 1248: 1895, 1902, 1907, 1915(M), 1917(M), 1918-19, 1934(M). WSP 1318 (monthly and annual figures only): 1894, 1897, 1901-3, 1907-8, 1910, 1916, 1918-19, 1923, 1927.

GAGE.--Water-stage recorder. Datum of gage is 167.18 ft above NGVD of 1929. Prior to Sept. 27, 1906, nonrecording gage at site 0.2 mi upstream at datum 5.00 ft higher. Sept. 27, 1906 to Nov. 12, 1934, nonrecording gage at site 300 ft upstream at datum 5.00 ft higher. Nov. 14, 1934 to Sept. 30, 1962, at datum 5.00 ft higher.

REMARKS.--No estimated daily discharges. Records good. Flow regulated by nine reservoirs upstream from station. Albany power canal diverts water from South Santiam River at Lebanon and discharges into Calapooia River near mouth; small diversions for irrigation and municipal water supply.

AVERAGE DISCHARGE FOR PERIOD OF RECORD.--47 years (water years 1894, 1896-1941), 13,760 ft^3/s, 38.63 in/yr, 9,969,000 acre-ft/yr. 66 years (water years 1942-2007), 14,570 ft^3/s, 40.91 in/yr, 10,560,000 acre-ft/yr, regulated period.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 266,000 ft^3/s Jan. 14, 1881, gage height, 37.8 ft, present datum; minimum discharge, 1,840 ft^3/s Sept. 1, 2, 1940.

EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of Dec. 4, 1861, reached a stage of 41.0 ft, discharge, 340,000 ft^3/s, from rating curve extended above 220,000 ft^3/s. Flood of Feb. 4, 1890, reached a stage of 38.9 ft, discharge, 291,000 ft^3/s.

EXTREMES FOR CURRENT YEAR.–Maximum discharge, 65,800 ft^3/s Dec. 27, gage height, 21.40 ft; minimum discharge, 4,270 ft^3/s July 12.

Water-Data Report 2007

14171000 MARYS RIVER NEAR PHILOMATH, OR

Willamette Basin
Upper Willamette Subbasin

LOCATION.--Lat 44°31′35″, long 123°20′00″ referenced to North American Datum of 1927, in NE ¼ SE ¼ sec.18, T.12 S., R.5 W., Benton County, OR, Hydrologic Unit 17090003, on right bank, 15 ft downstream from bridge on Bellfountain Road, 0.6 mi downstream from Newton Creek, 2.0 mi southeast of Philomath and at mile 9.4.

DRAINAGE AREA.--159 mi², including drainage area of Evergreen Creek, upstream from Bellfountain Road, 1.4 mi south of station.

SURFACE-WATER RECORDS

PERIOD OF RECORD.--October 1940 to September 1985, October 2000 to current year.

REVISED RECORDS.--WSP 1218: Drainage area. WSP 1935: 1956(M).

GAGE.--Water-stage recorder. Datum of gage is 224.01 ft above NGVD of 1929 (levels by U.S. Army Corps of Engineers). Prior to Oct. 1, 1961, nonrecording gage at bridge 50 ft upstream at same datum. October 1, 1961 to Sept. 30, 1985, gage on left bank, 35 ft downstream at same datum.

REMARKS.--Records fair except for estimated daily discharges, which are poor. Records include flow of Evergreen Creek at Bellfountain Road crossing, 1.4 mi south of station, with which overflow from Marys River may at times be mingled. Slight regulation by small storage reservoir on Rock Creek from which municipal supply is diverted for city of Corvallis. Other small diversions upstream from station for irrigation.

AVERAGE DISCHARGE FOR PERIOD OF RECORD.--52 years (water years 1941-85, 2001-07), 448 ft³/s, 38.24 in/yr, 324,200 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 13,600 ft³/s Dec. 22, 1964, gage height, 20.72 ft; maximum gage height, 21.07 ft Dec. 30, 2005; minimum discharge, 0.60 ft³/s Aug. 23, 1967.

EXTREMES FOR CURRENT YEAR.--Peak discharges greater than base discharge of 3,200 ft³/s and (or) maximum (*):

Date	Time	Discharge (ft³/s)	Gage height (ft)
Dec 15	0030	*6,320	*20.38
Dec 26	1800	4,620	19.40

Minimum discharge, 9.9 ft³/s, Oct. 1, 6, Nov. 1, gage height, 2.24 ft.

Water-Data Report 2007

14306500 ALSEA RIVER NEAR TIDEWATER, OR

Northern Oregon Coastal Basin
Alsea Subbasin

LOCATION.--Lat 44°23′10″, long 123°49′50″ referenced to North American Datum of 1927, in NW ¼ NW ¼ sec.6, T.14 S., R.9 W., Lincoln County, OR, Hydrologic Unit 17100205, on right bank, 0.9 mi downstream from Grass Creek, 2.5 mi upstream from Scott Creek, 3.8 mi southeast of Tidewater and at mile 21.0.

DRAINAGE AREA.--334 mi².

SURFACE-WATER RECORDS

PERIOD OF RECORD.--October 1939 to current year.

GAGE.--Water-stage recorder. Datum of gage is 48.16 ft above NGVD of 1929. Prior to Nov. 16, 1939, nonrecording gage at present site and datum.

REMARKS.--Records good except for estimated daily discharges, which are fair. No regulation. Diversion for irrigation upstream from station. Continuous water-quality records for period October 1979 to September 1981 have been collected at this location.

AVERAGE DISCHARGE FOR PERIOD OF RECORD.--68 years (water years 1940-2007), 1,463 ft³/s, 59.51 in/yr, 1,060,000 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 41,800 ft³/s Dec. 22, 1964, gage height, 27.44 ft; minimum discharge, 45 ft³/s Sept. 26, 27, 1965.

EXTREMES OUTSIDE PERIOD OF RECORD.--Flood on or about Feb. 3, 1890, reached a stage of 29.5 ft, from floodmark (discharge not determined).

EXTREMES FOR CURRENT YEAR.–Peak discharges greater than base discharge of 13,000 ft³/s and (or) maximum (*):

Date	Time	Discharge (ft³/s)	Gage height (ft)
Nov 7	1300	16,700	16.54
Dec 15	0000	*17,400	*16.89

Minimum discharge, 58 ft³/s, Oct. 12-14, gage height, 1.04 ft.

Appendix C

Oregon Department of Human Services Database- Community Drinking Water Systems in Benton County

Oregon Department of Human Services

Drinking Water Program

Introduction :: Data Search Options :: WS Name Look Up :: WS ID Look Up :: DWP Home

Back

County/Region:	Benton
Activity Status:	Active systems

Water System	ID	Address	System Type	Connections	Pop	Primary Source	County	Reg. Agency	Contact	Phone
ALSEA COUNTY SERVICE DISTRICT	00978	360 SW AVERY AVE CORVALLIS, OR 97330	C	79	200	GW	Benton	County	BOB MILLER	541-766-6821
CASCADE VIEW ESTATES	01456	360 SW AVERY AVE CORVALLIS, OR 97330	C	51	160	GW	Benton	County	BOB MILLER	541-766-6821
CORVALLIS MOBILE HOME PARK	01376	200 NW FIFTY-THIRD #70 CORVALLIS, OR 97330	C	90	90	SWP	Benton	State - Reg 2	NONAME NONAME8	541-752-2334
FIR VIEW WATER COMPANY	00023	4175 NW RIDGECREST ALBANY, OR 97321	C	61	180	GW	Benton	County	STEVE PILKERTON	541-926-6792
KNOLL TERRACE PARK	00174	5055 NE ELLIOT CIRCLE CORVALLIS, OR 97330	C	212	500	GW	Benton	County	KEN/CATHY STEPHENS	541-752-2225
NORTH CORVALLIS MHP-WELL #1	01158	5140 NW HWY 99 W SP 0 CORVALLIS, OR 97330	C	70	100	GW	Benton	County	MANFRED/PATRICIA DOERNER	541-754-1033
NORTH CORVALLIS MHP-WELL #2	01342	5140 NW HWY 99 W SP 0 CORVALLIS, OR 97330	NP	6	12	GW	Benton	County	MANFRED/PATRICIA DOERNER	541-754-1033
PIONEER VILLAGE WATER COMPANY	01296	31689 Whitman Way PHILOMATH, OR 97370	C	36	115	GW	Benton	County	WARNER BUTLER	541-929-7275
RAINTREE ESTATES	05548	903 NW RAINTREE DR CORVALLIS, OR 97330	C	19	50	GW	Benton	County	DEBBIE CASSIDY	541-745-4415
RIDGEWOOD DIST IMPROV CO	00229	7970 RIDGEWOOD CORVALLIS, OR 97330	C	40	110	GW	Benton	County	ANN BATTEN	541-752-0439
VINEYARD MOUNTAIN WATER	00231	1615 NW WORDEN CIRCLE CORVALLIS, OR 97330	C	122	325	GW	Benton	County	HANS NEUKOMM	541-745-5483

Appendix D

Tables further describing the protected flows (Instream Water Rights for Marys and Alsea Rivers) and Estimated 80 and 50 Percent Exceedance Stream Flows

OWRD Water Availability in Luckiamute River at Kopplein Creek

Month	Stream Flow (80 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	161.00	0.41	10.00	151.00
February	176.00	0.41	10.00	166.00
March	152.00	0.41	10.00	142.00
April	104.00	0.43	10.00	93.60
May	56.50	0.54	10.00	46.00
June	31.00	0.66	10.00	20.30
July	16.70	0.86	10.00	5.84
August	10.30	0.76	10.00	-0.46
September	9.70	0.58	10.00	-0.88
October	13.20	0.41	10.00	2.79
November	63.30	0.41	10.00	52.90
December	168.00	0.41	10.00	158.00

OWRD Calculated Water Availability in Luckiamute River at McTimmonds Creek

Month	Stream Flow (80 percent Exceedcance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	371.00	3.27	20.00	348.00
February	400.00	3.22	20.00	377.00
March	326.00	2.91	20.00	303.00
April	214.00	2.24	20.00	192.00
May	122.00	4.01	20.00	98.00
June	62.80	6.10	20.00	36.70
July	30.80	9.19	20.00	1.61
August	19.10	7.68	20.00	-8.58
September	16.60	4.72	20.00	-8.12
October	22.60	1.98	20.00	0.62
November	92.00	2.40	20.00	69.60
December	335.00	3.25	20.00	312.00

OWRD Water Availability in Luckiamute River at Kopplein Creek

Month	Stream Flow (50 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	326.00	0.41	10.00	316.00
February	316.00	0.41	10.00	306.00
March	256.00	0.41	10.00	246.00
April	159.00	0.43	10.00	149.00
May	84.20	0.54	10.00	73.70
June	41.60	0.66	10.00	30.90
July	22.70	0.86	10.00	11.80
August	13.40	0.76	10.00	2.64
September	13.30	0.58	10.00	2.72
October	24.40	0.41	10.00	14.00
November	174.00	0.41	10.00	164.00
December	331.00	0.41	10.00	321.00

OWRD Water Availability in Luckiamute River at McTimmonds Creek

Month	Stream Flow (50 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	740.00	3.27	20.00	717.00
February	713.00	3.22	20.00	690.00
March	545.00	2.91	20.00	522.00
April	317.00	2.24	20.00	295.00
May	181.00	4.01	20.00	157.00
June	88.80	6.10	20.00	62.70
July	42.90	9.19	20.00	13.70
August	25.00	7.68	20.00	-2.68
September	24.40	4.72	20.00	-0.32
October	38.40	1.98	20.00	16.40
November	269.00	2.40	20.00	247.00
December	731.00	3.25	20.00	708.00

OWRD Water Availability in Marys River at Blakesley Creek

Month	Stream Flow (80 percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	214.00	0.56	75.00	138.00
February	250.00	0.55	75.00	174.00
March	214.00	0.54	75.00	138.00
April	142.00	0.65	75.00	66.40
May	74.30	1.39	75.00	-2.09
June	37.80	2.29	40.00	-4.49
July	16.20	3.64	10.00	2.56
August	9.74	2.99	6.00	0.75
September	8.35	1.72	6.00	0.63
October	10.70	0.51	18.70	-8.51
November	35.00	0.51	75.00	-40.50
December	169.00	0.55	75.00	93.50

OWRD Water Availability Marys River at Muddy Creek

Month	Stream Flow (80 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	353.00	5.37	135.00	213.00
February	410.00	5.36	135.00	270.00
March	350.00	5.37	135.00	210.00
April	229.00	5.52	135.00	88.50
May	119.00	6.91	135.00	-22.90
June	57.40	11.10	70.00	-23.70
July	23.30	13.60	20.00	-10.30
August	13.80	12.40	15.00	-13.60
September	11.80	10.10	15.00	-13.30
October	15.00	5.40	38.70	-29.10
November	49.70	5.29	135.00	-90.60
December	271.00	5.36	135.00	131.00

OWRD Water Availability at Marys River Mouth

Month	Stream Flow (80 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	579.00	13.20	135.00	431.00
February	661.00	12.90	135.00	513.00
March	567.00	12.40	135.00	420.00
April	350.00	11.40	135.00	204.00
May	188.00	17.80	135.00	35.20
June	90.60	27.70	70.00	-7.12
July	40.00	34.50	20.00	-14.50
August	24.10	29.40	15.00	-20.30
September	19.60	22.20	15.00	-17.60
October	23.60	10.00	38.70	-25.10
November	71.00	10.50	135.00	-74.50
December	424.00	12.90	135.00	276.00

OWRD Water Availability in Marys River at Blakesley Creek

Month	Stream Flow (50 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	483.00	0.56	75.00	407.00
February	447.00	0.55	75.00	371.00
March	368.00	0.54	75.00	292.00
April	223.00	0.65	75.00	147.00
May	109.00	1.39	75.00	32.60
June	52.20	2.29	40.00	9.91
July	23.80	3.64	10.00	10.20
August	13.30	2.99	6.00	4.31
September	13.30	1.72	6.00	5.58
October	18.70	0.51	18.70	-0.51
November	113.00	0.51	75.00	37.50
December	420.00	0.55	75.00	344.00

OWRD Water Availability in Marys River at Muddy Creek

Month	Stream Flow (50 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	794.00	5.37	135.00	654.00
February	735.00	5.36	135.00	595.00
March	600.00	5.37	135.00	460.00
April	361.00	5.52	135.00	220.00
May	174.00	6.91	135.00	32.10
June	81.00	11.10	70.00	-0.11
July	35.30	13.60	20.00	1.75
August	19.30	12.40	15.00	-8.08
September	18.50	10.10	15.00	-6.55
October	25.80	5.40	38.70	-18.30
November	168.00	5.29	135.00	27.70
December	689.00	5.36	135.00	549.00

OWRD Water Availability at Marys River Mouth

Month	Stream Flow (50 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	1,300.00	13.20	135.00	1,150.00
February	1,180.00	12.90	135.00	1,030.00
March	964.00	12.40	135.00	817.00
April	579.00	11.40	135.00	433.00
May	264.00	17.80	135.00	111.00
June	124.00	27.70	70.00	26.30
July	60.50	34.50	20.00	5.96
August	31.30	29.40	15.00	-13.10
September	28.00	22.20	15.00	-9.18
October	38.70	10.00	38.70	-10.00
November	237.00	10.50	135.00	91.50
December	1,150.00	12.90	135.00	1,000.00

OWRD Water Availability in Muddy Creek at Evergreen Creek

Month	Stream Flow (80 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	168.00	2.74	0.00	165.00
February	191.00	2.49	0.00	189.00
March	166.00	2.24	0.00	164.00
April	88.50	1.66	0.00	86.80
May	51.00	4.69	0.00	46.30
June	27.00	8.25	0.00	18.80
July	13.90	13.80	0.00	0.09
August	8.30	11.10	0.00	-2.80
September	6.10	5.77	0.00	0.34
October	7.10	0.95	0.00	6.15
November	19.20	1.01	0.00	18.20
December	118.00	2.55	0.00	115.00

OWRD Water Availability in Muddy Creek at Evergreen Creek

Month	Stream Flow (50 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	388.00	2.74	0.00	385.00
February	340.00	2.49	0.00	338.00
March	286.00	2.24	0.00	284.00
April	170.00	1.66	0.00	168.00
May	69.60	4.69	0.00	64.90
June	34.50	8.25	0.00	26.30
July	21.20	13.80	0.00	7.39
August	9.70	11.10	0.00	-1.40
September	7.90	5.77	0.00	2.13
October	11.70	0.95	0.00	10.80
November	59.30	1.01	0.00	58.30
December	352.00	2.55	0.00	349.00

OWRD Water Availability in Alsea River at Five Rivers

Month	Stream Flow (80 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	710.00	0.29	277.00	433.00
February	814.00	0.29	277.00	537.00
March	672.00	0.26	277.00	395.00
April	454.00	0.48	277.00	177.00
May	261.00	1.13	127.00	133.00
June	148.00	3.31	127.00	17.70
July	81.60	8.35	85.00	-11.70
August	52.60	6.48	63.90	-17.80
September	43.90	1.09	56.50	-13.70
October	53.90	0.38	100.00	-46.50
November	196.00	0.27	277.00	-81.30
December	634.00	0.29	277.00	357.00

OWRD Calculated Water Availability in Alsea River at Five Rivers

Month	Stream Flow (50 Percent Exceedance) (cfs)	Consumptive Use & Storage (cfs)	Instream Requirement (cfs)	Net Water Available (cfs)
January	1,390.00	0.29	277.00	1,110.00
February	1,390.00	0.29	277.00	1,110.00
March	1,090.00	0.26	277.00	813.00
April	702.00	0.48	277.00	425.00
May	385.00	1.13	127.00	257.00
June	198.00	3.31	127.00	67.70
July	105.00	8.35	85.00	11.70
August	64.50	6.48	63.90	-5.88
September	59.80	1.09	56.50	2.21
October	85.10	0.38	100.00	-15.30
November	580.00	0.27	277.00	303.00
December	1,310.00	0.29	277.00	1,030.00

Marys River

Certificate #		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
59713		5	5	5	5	5	5	5	5	5	5	5	5
59714		10	10	10	10	10	10	10	10	10	10	10	10
72589	1st half	75	75	75	75	75	40	10	6	6	8	40	75
	2nd half	75	75	75	75	75	15	6	6	6	18.7	75	75
72588	1st half	135	135	135	135	135	70	20	15	15	20	70	135
	2nd half	135	135	135	135	135	40	15	15	15	38.7	135	135

Alsea River

Certificate #		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
73139	1st half	277	277	277	277	127	127	85	63.9	56.5	75.8	277	277
	2nd half	277	277	277	277	127	85	85	63.9	56.5	75.8	277	277
59574	1st half	130	130	130	130	85	50	25	25	25	50	140	140
	2nd half	130	130	130	130	85	50	25	25	25	100	140	140

Appendix E

Projected Benton County City Populations to Year 2050 (see Appendix I for Future Water Demands Table)

Table 5-2 Population Forecst- Average Annual City Population Growth Rates plus 1 %

using AAGR + 1%	2000 [1]	2007 [1]	2020	2025	2030	2035	2040	2045	2050
Adair Village	536	905	1,611	2,094	2,722	3,539	4,601	5,981	7,776
Corvallis	49,322	54,890	70,803	78,697	87,472	97,225	108,066	120,115	133,508
Monroe	610	625	983	1,199	1,462	1,784	2,177	2,655	3,240
North Albany	5,104	6,599	8,606	9,613	10,738	11,994	13,398	14,965	16,716
Philomath	3,838	4,530	5,154	5,427	5,715	6,018	6,337	6,673	7,026

Table 5-3 Population Forecast- Average Annual City Population Growth Rates

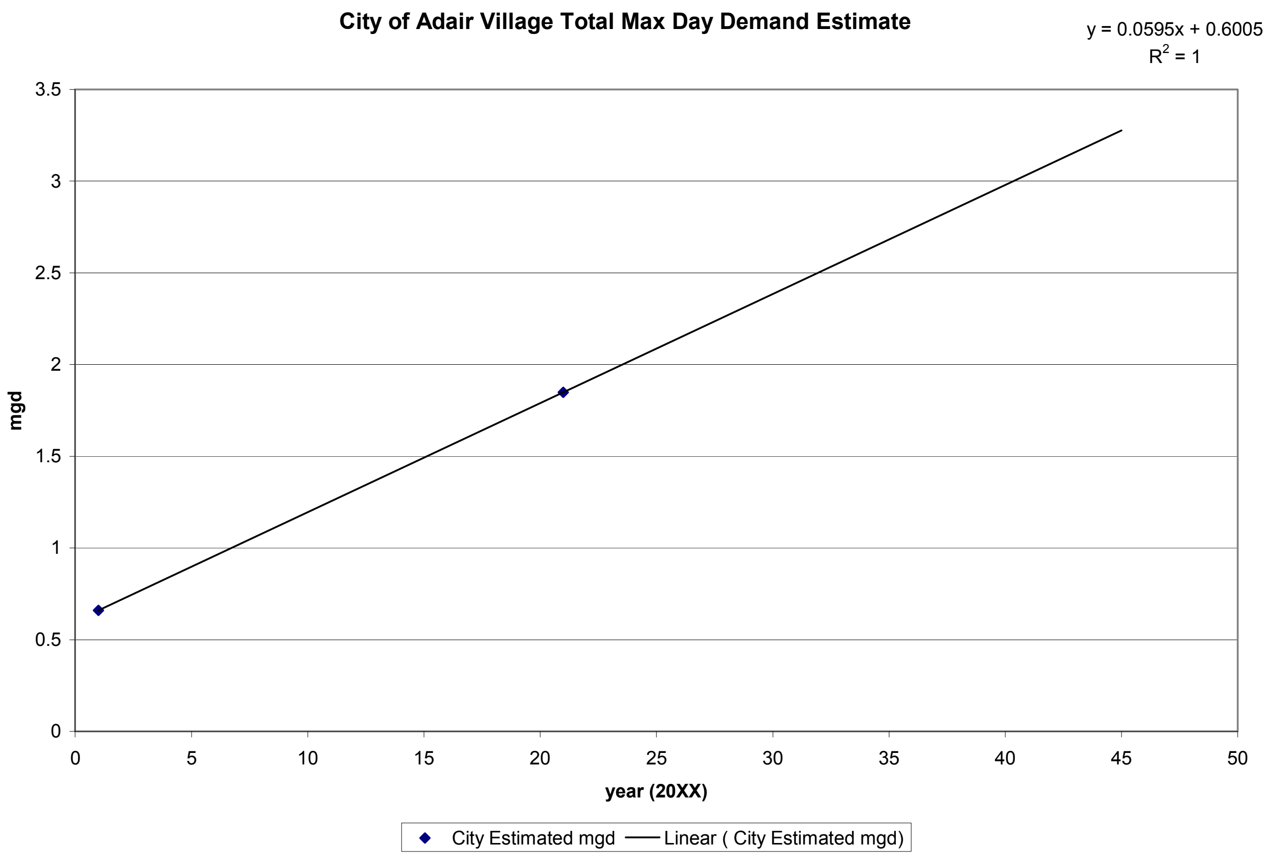
using AAGR	2000 [1]	2007 [1]	2020	2025	2030	2035	2040	2045	2050
Adair Village	536	905	1,493	1,867	2,333	2,917	3,646	4,557	5,696
Corvallis	49,322	54,890	63,667	67,582	71,739	76,151	80,834	85,805	91,082
Monroe	610	625	901	1,054	1,059	1,063	1,067	1,071	1,076
North Albany	5,104	6,599	7,749	8,268	8,822	9,413	10,043	10,716	11,434
Philomath	3,838	4,530	4,565	4,579	4,593	4,607	4,620	4,634	4,648

Table 5-4 Population Forecast- Historic Average Annual City Population Growth Rates

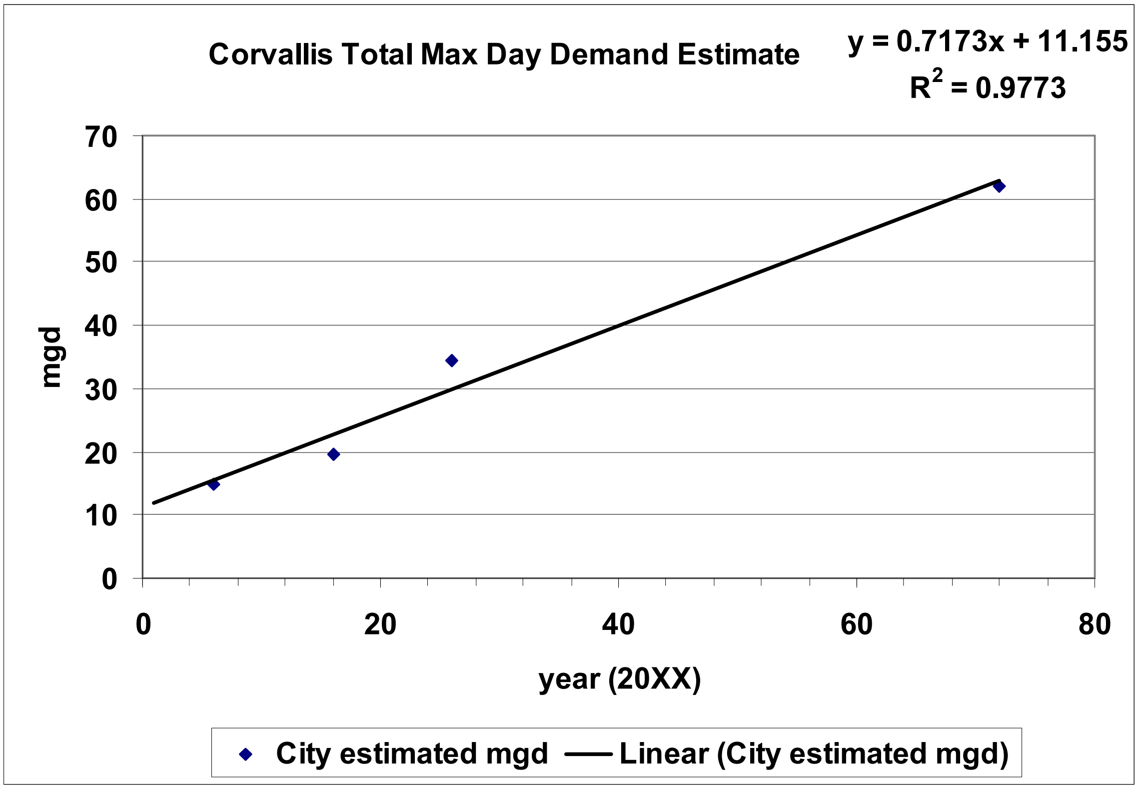
using Historic AAGR	2000 [1]	2007 [1]	2020	2025	2030	2035	2040	2045	2050
Adair Village	536	905	1,106	1,200	1,302	1,412	1,532	1,663	1,804
Corvallis	49,322	54,890	70,589	78,353	86,972	96,539	107,158	118,946	132,030
Monroe	610	625	706	742	779	818	858	901	946
North Albany	5,104	6,599	9,687	11,431	13,489	15,917	18,782	22,162	26,151
Philomath	3,838	4,530	5,826	6,466	7,178	7,967	8,844	9,816	10,896

Appendix F

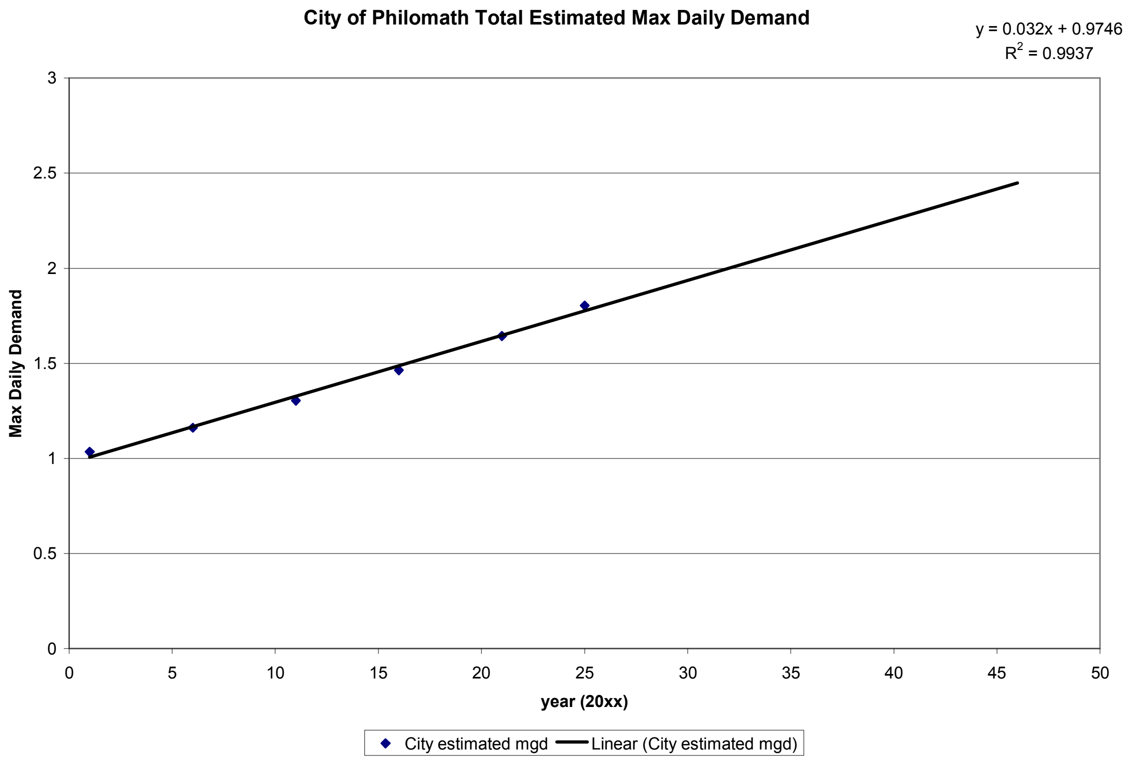
Linear Regression Analyses for Estimating Total City Water Demands to year 2050 based on existing City Water Demand Reports



Source of City Estimated mgd: **City of Adair Village, Water System Master Plan Update**, 2008



Source: **City of Corvallis Water Management and Conservation Plan**, 2005



Source: **City of Philomath Water System Master Plan**, 2005

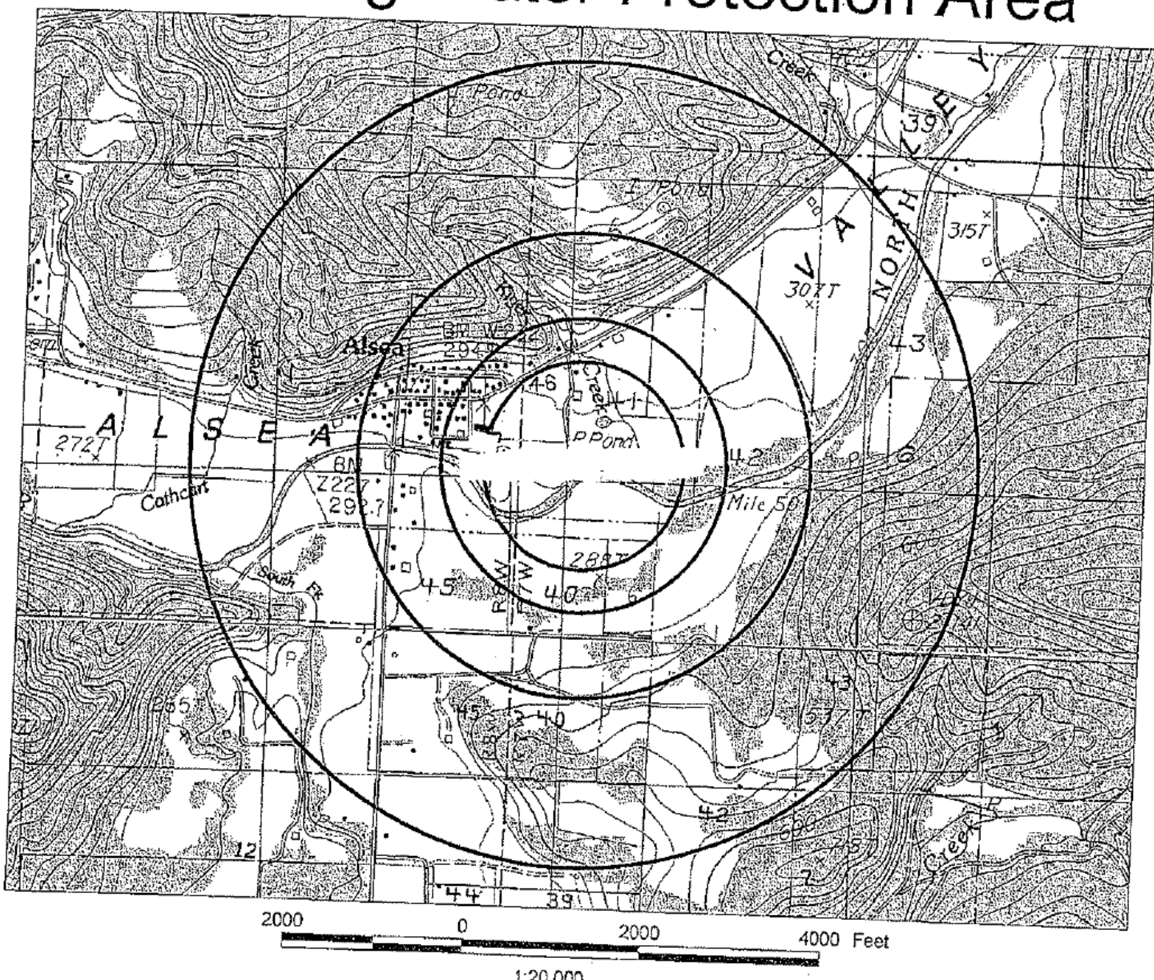
* **Please Note-** Averages of the three population growth rates of the cities of North Albany and Monroe population (residential only demands) were used to estimate Total Demands, based on the lack of commercial, industrial, or other water demands within the current city water service area. See Section 5.2 of Report for more details.

Appendix G

Oregon Department of Human Services (ODHS)- Drinking Water Program

Compiled Drinking Water Source Assessments and Potential Contaminant Lists for each community water system within Benton County using groundwater as a primary source (**exact wellhead locations have been omitted at the request of ODHS staff**).

Alsea County Service District
Drinking Water Protection Area



Drinking Water Protection Area
Circular zones from center outward
represent the 1, 2, 5 and 15 year
Time-of-Travel for groundwater to the well
Dellineation Method: Calculated Fixed Radius
Model Parameters:
Water Use (gal/day): 33,888.89
Effective Porosity: 0.1
Aquifer Character: shallow confined fractured sandstone
(Tyee Formation)
Thickness of Producing Zone (ft): 4.1
Total Area of Delineation (mi2): 0.2895

USGS Alsea 7.5- Minute
Quadrangle (topographic)
Benton County

Prepared by Kim Swanson
Drinking Water Program, Oregon Health
Division, Dept. of Human Services
Date: 4/17/01
PWS# 4100978

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100978 ALSEA COUNTY SERVICE DISTRICT

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (2)	Potential Impacts	Comments
1	UST - Upgraded/Registered - Active	Alsea Garage/General Store	Northwest of wells	Alsea	Database (2) Field-Observation Interview	Between 2-yr and 5-yr TOT	Lower	Spills or improper handling during tank filling or product distribution may impact the drinking water supply.	Three upgraded tanks.
	Automobiles - Gas Stations						Higher	Spills, leaks, or improper handling of fuels and other materials during transportation, transfer, and storage may impact the drinking water supply.	Three upgraded tanks.
2	Transportation - Freeways/State Highways/Other Heavy Use Roads	State Highway 34	Runs east and west through DWPA	Alsea	Field-Observation	Within the 2-yr TOT.	Moderate	Vehicle use increases the risk for leaks or spills of fuel & other haz. materials. Road building, maintenance & use can increase erosion/slope failure causing turbidity. Over-application or improper handling of pesticides/fertilizers may impact water.	
3	Other --School Maintenance Building	Alsea School Maintenance Facility	Northwest of wells	Alsea	Database (2) Field-Observation	Within the 2-yr TOT.	Moderate	Spills, leaks, or improper handling of chemicals and other materials during transportation, use, storage, and disposal may impact the drinking water supply.	
	Above Ground Storage Tanks - Excluding Water						Moderate	Spills, leaks, or improper handling of stored materials may impact the drinking water supply.	
	UST - Upgraded/Registered - Active						Lower	Spills or improper handling during tank filling or product distribution may impact the drinking water supply.	
4	Schools	Alsea School	Northwest of wells	Alsea	Field-Observation	Within the 2-yr TOT.	Lower	Over-application or improper handling of cleaning products, pesticides or fertilizers used on the school grounds may impact drinking water. Vehicle maintenance wastes may contribute contaminants.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

7/24/2001

Page 1 of 3

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100978 ALSEA COUNTY SERVICE DISTRICT

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (2)	Potential Impacts	Comments
5	Fire Station	Fire Station	Northwest of wells	Alsea	Field-Observation	Between 2-yr and 5-yr TOT	Lower	Spills, leaks, or improper handling of chemicals and other materials during transportation, use, storage and disposal may impact the drinking water supply.	
6	Sewer Lines - Close Proximity to PWS	Sewer Lines	Northwest of wells	Alsea	Field-Observation Interview	Within the 2-yr TOT.	Higher	If not properly designed, installed, and maintained, sewer lines can impact drinking water, especially adjacent to a waterbody or within the 2-year time-of-travel zone for drinking water wells.	
7	Large Capacity Septic Systems (serves > 20 people) - Class V UICs	Large Capacity Septic System	West of wells	Alsea	Field-Observation Interview	Within the 2-yr TOT.	Higher	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water.	System appears to be within 100 feet of wells.
8	Utility Stations - Maintenance Transformer Storage	Alsea Substation	Northwest of well	Alsea	Field-Observation	Between 2-yr and 5-yr TOT	Higher	Spills, leaks, or improper handling of chemicals and other materials including PCBs during transportation, use, storage and disposal may impact the drinking water supply.	
9	Other -ODOT Maintenance Facility	ODOT Maintenance Shop	Southwest of well	Alsea	Database (2) Field-Observation	Between 5-yr and 15-yr TOT	Moderate	Spills, leaks, or improper handling of chemicals and other materials during transportation, use, storage, and disposal may impact the drinking water supply.	
	UST - Status Unknown						Higher	Spills, leaks, or improper handling of stored materials may impact the drinking water supply.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

7/24/2001

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100978 ALSEA COUNTY SERVICE DISTRICT

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (2)	Potential Impacts	Comments
10	Other --Merchantile	John Boys Alsea Merchantile	Northwest of wells	Alsea	Database (2) Field-Observation	Between 2-yr and 5-yr TOT	Lower	Spills, leaks, or improper handling of chemicals and other materials during transportation, use, storage, and disposal may impact the drinking water supply.	
	UST - Not Upgraded and/or Registered Tanks						Higher	Spills, leaks, or improper handling of stored materials may impact the drinking water supply.	
11	Managed Forest Land - Clearcut Harvest (< 35 yrs.)	Clear cuts	Southeast of wells	Alsea	Field-Observation	Between 2-yr and 5-yr TOT	Moderate	Cutting and yarding of trees may contribute to increased erosion, resulting in turbidity and chemical changes in drinking water supply. Over-application or improper handling of pesticides or fertilizers may impact drinking water source.	
12	Grazing Animals (> 5 large animals or equivalent/acre)	Grazing Animals	Southwest of wells	Alsea	Field-Observation	Between 2-yr and 5-yr TOT	Moderate	Improper storage and management of animal wastes may impact drinking water supply. Concentrated livestock may contribute to erosion and sedimentation of surface water bodies.	
13	Crops - Nonirrigated (inc. Christmas trees, grains, grass seed, pasture)	Non-irrigated crops	Northeast of wells	Alsea	Field-Observation	Between 2-yr and 5-yr TOT	Lower	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Some agricultural practices may result in excess sediments discharging to surface waters, but non-irrigated crops are generally considered to be a low risk.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

7/24/2001

Page 3 of 3

Appendix F: Sensitivity Summary: Alsea County Service District Public Water System
East Well

Highly Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☒	☐	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☒	☐	Organic Chemical Detection . Xylenes . 0.0039 mg/L . ethylbenzene . 0.0007 mg/L on 11/98
☐	☒	Inorganic Chemical Detection (>50% MCL) ....
☐	☒	Source-related Coliform: total .... fecal .... Date ....
☐	☒	Nitrate-N≥ 5mg/L: Concentration .... Date ....
☒	☐	Well Construction/Setback or Monitoring Deficiencies from Site Visit: no concrete slab around casing, sanitary seal not watertight ......
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☐	☒	Casing Seal Not Constructed Properly:. ....
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☐	☒	Inorganic Chemical Detection (<50% of MCL) ....
☒	☐	Well Construction Deficiencies from Site Visit. inadequate protective housing
☐	☒	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☒	☐	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☒	☐	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments no soil data available - assumed to be highly ... permeable ....

Sensitivity Analysis Completed by: Kim Swanson .... **Date:** 7/22/02

Sensitivity Summary: Alsea County Service District Public Water System West Well

Highly Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☒	☐	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☒	☐	Organic Chemical Detection .xylenes . 0.0039 mg/L. ethylbenzene. 0.0007 mg/L on 11/98
☐	☒	Inorganic Chemical Detection (>50% MCL) ....
☐	☒	Source-related Coliform: total .... fecal .... Date ....
☐	☒	Nitrate-N≥ 5mg/L: Concentration .... Date ....
☒	☐	Well Construction/Setback or Monitoring Deficiencies from Site Visit: .no.. concrete. slab around casing, .sanitary. seal .not. watertight
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☐	☒	Casing Seal Not Constructed Properly:..........................
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☐	☒	Inorganic Chemical Detection (<50% of MCL) ....
☒	☐	Well Construction Deficiencies from Site Visit. . inadequate protective housing
☐	☒	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☒	☐	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☒	☐	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

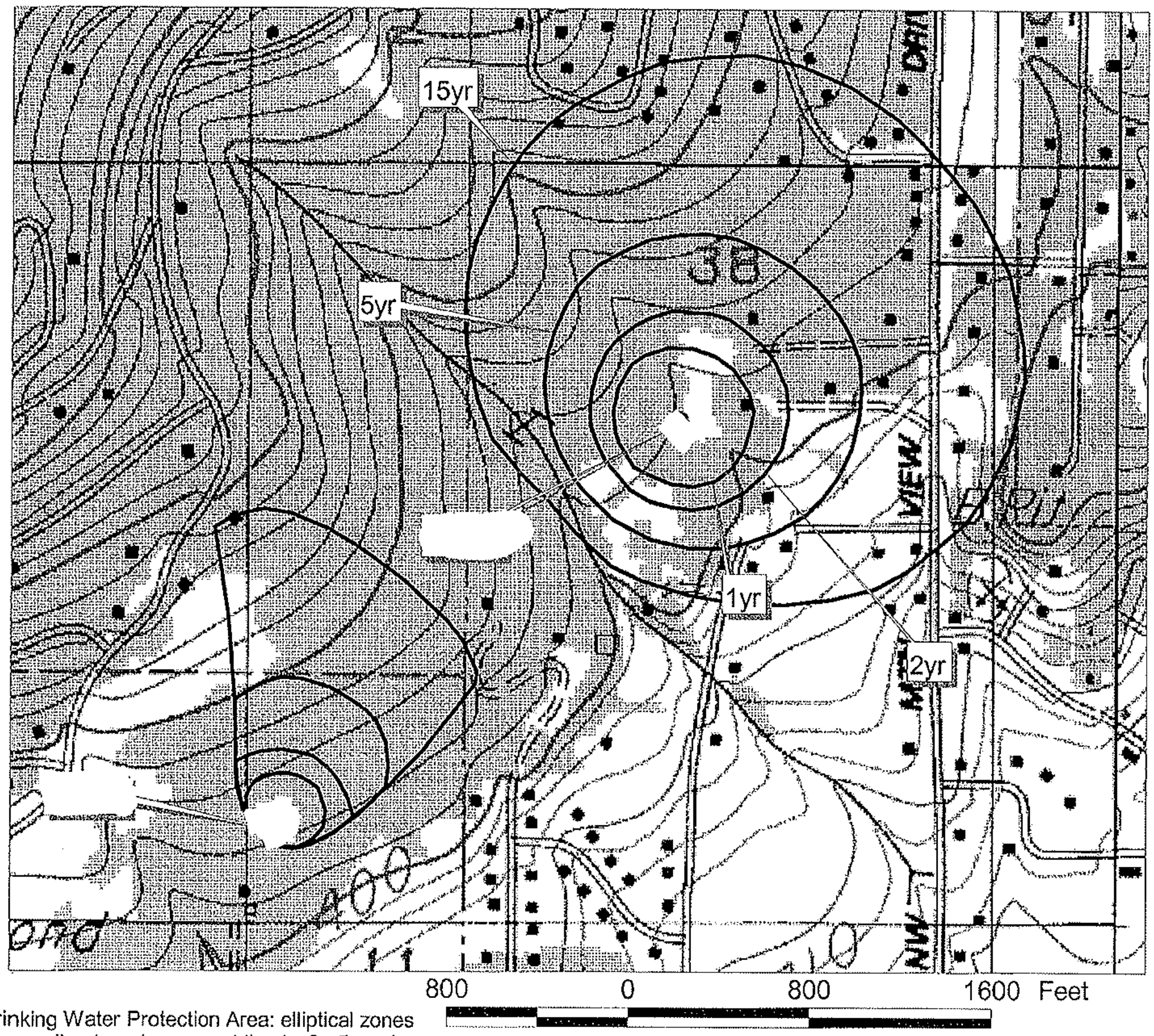
Additional Comments ..no soil data available - assumed to be highly ..permeable.......................................

Sensitivity Analysis Completed by: . Kim Swanson .... **Date:** 7/22/02

37

Figure 1

Cascade View Estates
Drinking Water Protection Areas

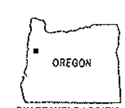


Drinking Water Protection Area: elliptical zones from well outward represent the 1-, 2-, 5- and 15-year time-of-travel for groundwater to move through the aquifer to the well.
Delineation Method: Enhanced
Calculated fixed radius
Model parameters:
- Water use (ft3/day): Well 1: 2500; Well 4: 620
- Thickness of water-bearing zone: 12 feet
- Effective porosity: 0.25

Aquifer character: Confined fractured volcanic (Siletz River Volcanics)

USGS Arlie South 7.5-minute topographic map
Benton County

N



Prepared by Kim Swanson and
Dennis Nelson RG 1224
Drinking Water Program
Oregon Department of Human Services
July 27, 2001
PWS# 4101456

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4101456 CASCADE VIEW ESTATES

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
1	Wells/Abandoned Wells	Rural Homesteads on septic	Throughout DWPA	Corvallis	Field-Observation	Within the 2-yr TOT.	Higher	Improperly installed or maintained wells and abandoned wells may provide a direct conduit for contamination to groundwater and drinking water source.	
	Homesteads - Rural - Septic Systems (< 1/acre)						Lower	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water. Use of drain cleaners and dumping household hazardous wastes can result in groundwater contamination.	
2	Wells/Abandoned Wells	Abandoned Well	North of well 1	Corvallis	Field-Observation	Outside DWPA	Higher	Improperly installed or maintained wells and abandoned wells may provide a direct conduit for contamination to groundwater and drinking water source.	Contact from Vineyard Mtn. Water indicated well had not been capped. Underground reservoir located next to well. Well reported capped/abandoned-should verify closure meets state standards.
3	Grazing Animals (> 5 large animals or equivalent/acre)	Grazing Animals	East of well 4	Corvallis	Field-Observation	Between 2-yr and 5-yr TOT	Moderate	Improper storage and management of animal wastes may impact drinking water supply. Concentrated livestock may contribute to erosion and sedimentation of surface water bodies.	
4	Crops - Nonirrigated (inc. Christmas trees, grains, grass seed, pasture)	Non-irrigated crops	East of well 4	Corvallis	Field-Observation	Between 5-yr and 15-yr TOT	Lower	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Some agricultural practices may result in excess sediments discharging to surface waters, but non-irrigated crops are generally considered to be a low risk.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

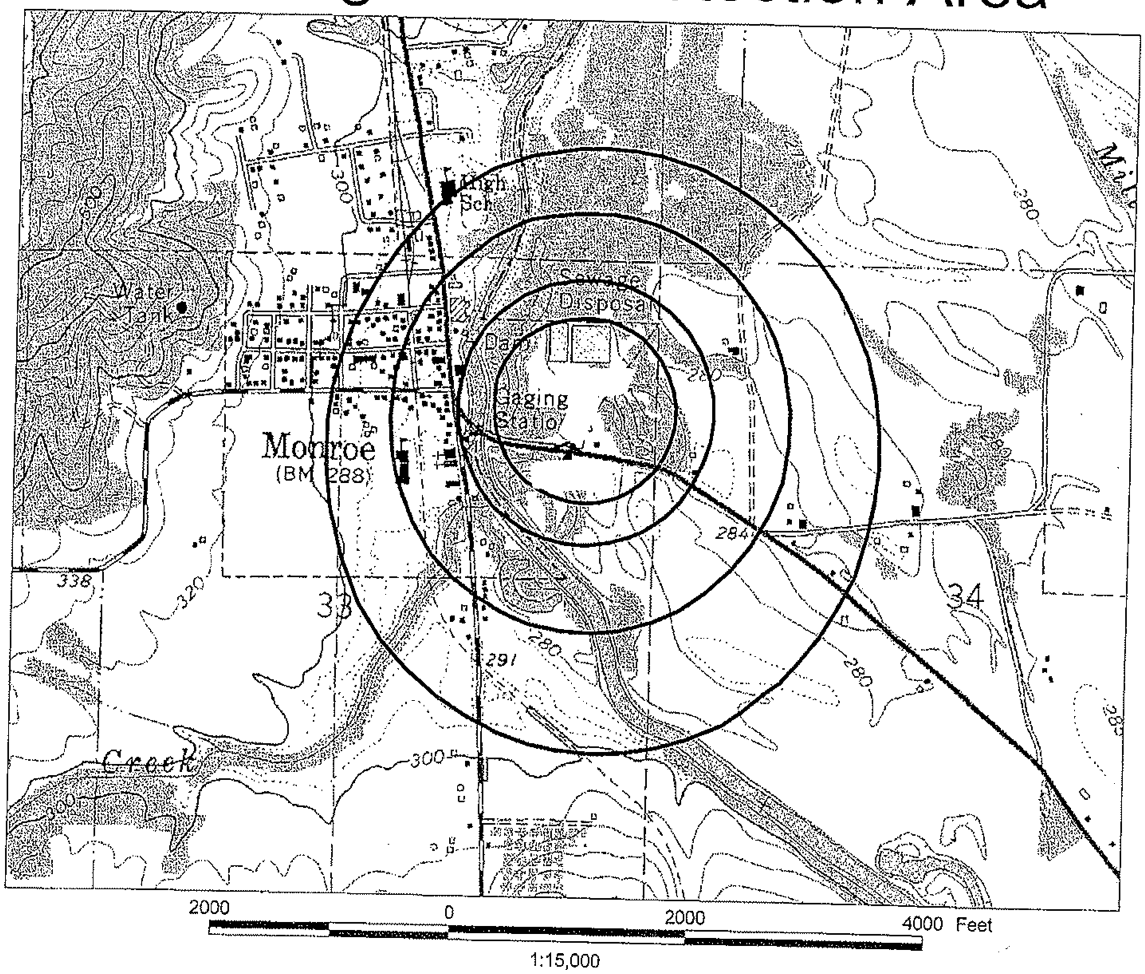
(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

10/30/2001

Page 1 of 1

City of Monroe: Well 1
Drinking Water Protection Area

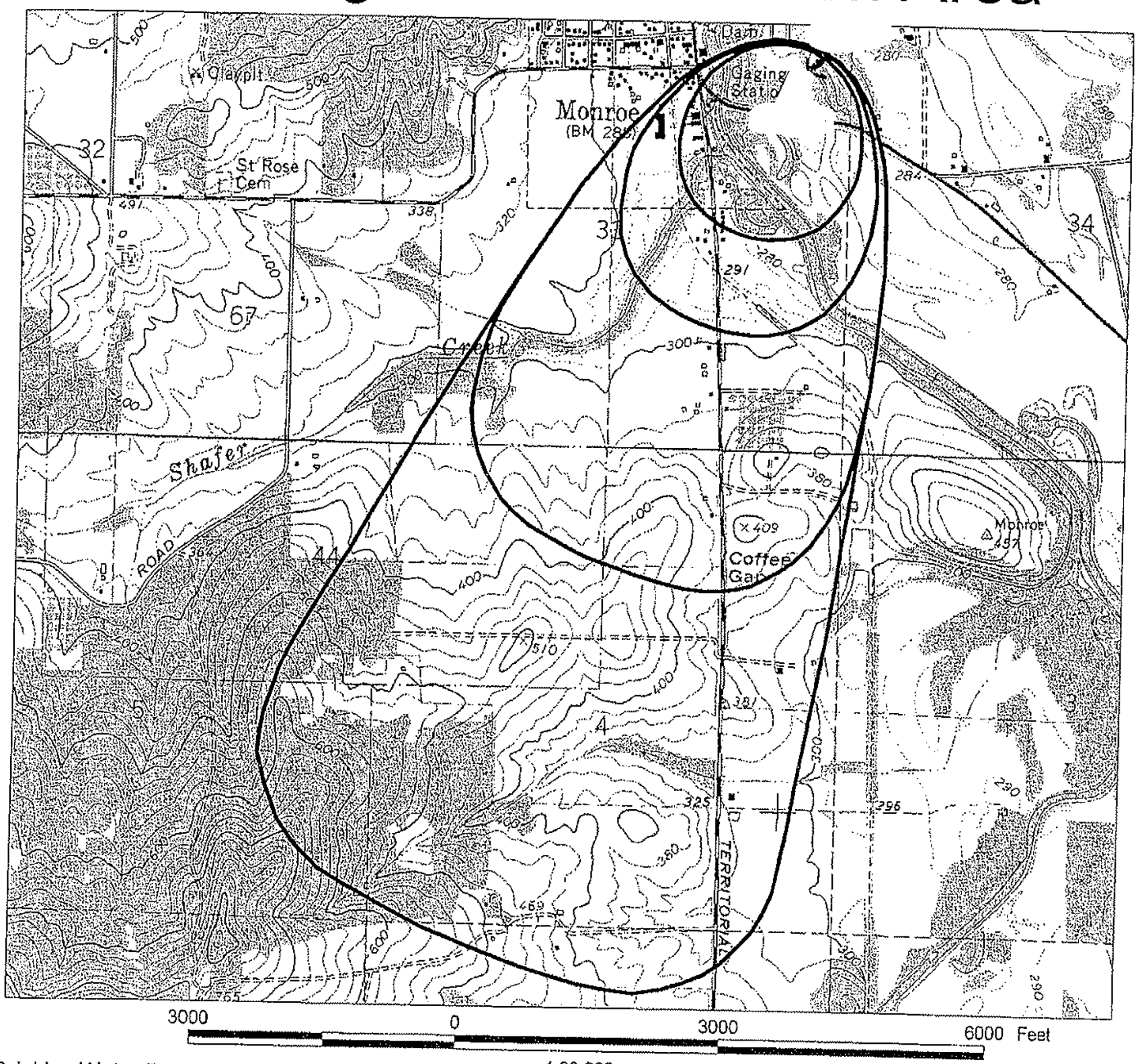


Drinking Water Protection Area
Circular zones from center outward
represent the 1, 2, 5 and 10 year
Time-of-Travel for groundwater to the well
Delineation Method: MWCAP Analytical Model
Aquifer Character: shallow unconfined sand/gravel
(Older Alluvium)
Model Parameters:
Water Use (gal/day): 76,830.60
Effective Porosity: 0.25
Transmissivity (ft^2/day): 162
Hydraulic Gradient: 0.00175
Thickness of Producing Zone (ft): 8
Groundwater flow direction: 73°
Total Area of Delineation (mi2): 0.6552

USGS Monroe 7.5- Minute
Quadrangle (topographic)
Benton County

Prepared by Kim Swanson
Drinking Water Program, Oregon Health
Division, Dept. of Human Services
Date: 8/28/01
PWS# 4100540

City of Monroe: Well 2
Drinking Water Protection Area



Drinking Water Protection Area
Capture zones represent the 1, 2, 5 and 10 year Time-of-Travel for groundwater to the well
Delineation Method: MWCAP Analytical Model
Aquifer Character: deep confined fractured sandstone (Tyee Formation)
Model Parameters:
- Water Use (gal/day): 31,844.46
- Effective Porosity: 0.25
- Transmissivity (ft^2/day): 85.15
- Hydraulic Gradient: 0.0135
- Thickness of Producing Zone (ft): 2
- Groundwater Flow Direction: 70°
- (note: capture zones include an error of +- 10° flow direction)
- Total Area of Delineation (mi2): 1.713

USGS Monroe 7.5- Minute
Quadrangle (topographic)
Benton County

Prepared by Kim Swanson
Drinking Water Program,
Oregon Health Division,
Dept. of Human Services
Date: 8/28/01
PWS# 4100540

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100540 **MONROE, CITY OF**

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
1	Transportation - Freeways/State Highways/Other Heavy Use Roads	State Highway 99	Runs through DWPA for well 1 and 2	Monroe	Field-Observation	Within the 2-yr TOT.	Moderate	Vehicle use increases the risk for leaks or spills of fuel & other haz. materials. Road building, maintenance & use can increase erosion/slope failure causing turbidity. Over-application or improper handling of pesticides/fertilizers may impact water.	
2	Lagoons/Liquid Wastes	Sewage Treatment Plant	North of well 1 and 2	Monroe	Database (2) Field-Observation Interview	Within the 2-yr TOT.	Higher	Improper seepage or overflows of liquid wastes may impact the drinking water supply.	
	Wastewater Treatment Plants/Collection Stations						Moderate	Improper management of wastewater, treatment chemicals, or equipment maintenance materials may impact drinking water supply.	
3	Sewer Lines - Close Proximity to PWS	Sewer Lines	Northwest of well 2	Monroe	Interview	Within the 2-yr TOT.	Higher	If not properly designed, installed, and maintained, sewer lines can impact drinking water, especially adjacent to a waterbody or within the 2-year time-of-travel zone for drinking water wells.	Sewer lines found within city limits.
4	Waste Transfer/Recycling Stations	Monroe Transfer Station	East of well 1 and 2	Monroe	Field-Observation Interview	Within the 2-yr TOT.	Moderate	Improper management of water contacting waste material may impact the drinking water supply.	The transfer station may be just outside DWPA for well 1. PWS should verify.

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

2/8/2002

Page 1 of 6

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100540 MONROE, CITY OF

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
5	Homesteads - Rural - Septic Systems (< 1/acre)	Rural Homestead	Throughout DWPA for well 1 and 2	Monroe	Field-Observation	Within the 2-yr TOT..	Lower	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water. Use of drain cleaners and dumping household hazardous wastes can result in groundwater contamination.	
	Wells/Abandoned Wells						Higher	Improperly installed or maintained wells and abandoned wells may provide a direct conduit for contamination to groundwater and drinking water source.	
6	Automobiles - Gas Stations	Terry's Repair and Gas	Northwest of well 2	Monroe	Database (2) Field-Observation	Between 2-yr and 5-yr TOT	Higher	Spills, leaks, or improper handling of fuels and other materials during transportation, transfer, and storage may impact the drinking water supply.	
	Automobiles - Repair Shops						Higher	Spills, leaks, or improper handling of automotive fluids, solvents, and repair materials during transportation, use, storage and disposal may impact the drinking water supply.	
	Above Ground Storage Tanks - Excluding Water						Moderate	Spills, leaks, or improper handling of stored materials may impact the drinking water supply.	
	UST - Upgraded/Registered - Active						Lower	Spills or improper handling during tank filling or product distribution may impact the drinking water supply.	
7	Fire Station	Monroe Fire Station	Northwest of well 2	Monroe	Database (2) Field-Observation	Between 5-yr and 10-yr TOT	Lower	Spills, leaks, or improper handling of chemicals and other materials during transportation, use, storage and disposal may impact the drinking water supply.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

2/8/2002

Page 2 of 6

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100540 MONROE, CITY OF

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
8	Housing - High Density (> 1 House/0.5 acres)	High Density Housing	Northwest portion of DWPA for well 2	Monroe	Field-Observation	Between 2-yr and 5-yr TOT	Moderate	Improper use, storage, and disposal of household chemicals may impact the drinking water supply. Stormwater run-off or infiltration may carry contaminants to drinking water supply.	
9	UST - Status Unknown	Butlers Hardware-Historic Gas Station	Northwest of well 2. Off Main St	Monroe	Database (2) Field-Observation Interview	Between 2-yr and 5-yr TOT	Higher	Spills, leaks, or improper handling of stored materials may impact the drinking water supply.	Potential risk should be verified during enhanced inventory. Two other sites were identified by contact as historic gas stations. One at the site where the Bank is located and one at Vineyard Restaurant.
	Furniture/Lumber/Parts Stores						Moderate	Spills, leaks, or improper handling of hazardous chemical products and other materials in inventory during transportation, use, storage and disposal may impact the drinking water supply.	Potential risk should be verified during enhanced inventory. Two other sites were identified by contact as historic gas stations. One at the site where the Bank is located and one at Vineyard Restaurant.
	Historic Gas Stations						Higher	Historic spills, leaks, or improper handling of solvents and petroleum products may impact the drinking water supply. Abandoned underground storage tanks may be present.	Potential risk should be verified during enhanced inventory. Two other sites were identified by contact as historic gas stations. One at the site where the Bank is located and one at Vineyard Restaurant.

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

2/8/2002

Page 3 of 6

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100540 MONROE, CITY OF

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
10	Automobiles - Gas Stations	Monroe Keylock	Northwest of well 2	Monroe	Database (2) Field-Observation	Between 2-yr and 5-yr TOT	Higher	Spills, leaks, or improper handling of fuels and other materials during transportation, transfer, and storage may impact the drinking water supply.	
	UST - Upgraded/Registered - Active						Lower	Spills or improper handling during tank filling or product distribution may impact the drinking water supply.	
11	Other --Historic Shop	Historic Shop	Northwest of well. Off Main St	Monroe	Field-Observation	Between 5-yr and 10-yr TOT	Moderate	Spills, leaks, or improper handling of chemicals and other materials during transportation, use, storage, and disposal may impact the drinking water supply.	Potential risk should be verified during enhanced inventory.
12	Dry Cleaners	Laundry Mat	Northwest of well 2	Monroe	Field-Observation	Between 2-yr and 5-yr TOT	Lower	Spills, leaks, or improper handling of dry cleaning solvents and other chemicals during transportation, use, storage and disposal may impact the drinking water supply.	Risk reduced to Lower because laundry mat is very small.
13	Pesticide/Fertilizer/Petroleum Storage, Handling, Mixing, & Cleaning Areas	Wilbur Ellis Co.	Northwest of well 2	Monroe	Database (2) Field-Observation Interview	Between 5-yr and 10-yr TOT	Higher	Leaks, spills and improper handling of pesticides, fertilizers and petroleum products may impact drinking water source.	
	Above Ground Storage Tanks - Excluding Water						Moderate	Spills, leaks, or improper handling of stored materials may impact the drinking water supply.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

2/8/2002

Page 4 of 6

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100540 MONROE, CITY OF

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
14	Campgrounds/RV Parks	Monroe RV Park	West of well 1 and 2	Monroe	Field-Observation	Between 2-yr and 5-yr TOT	Lower	Leaks or spills of automotive fluids or improperly managed septic systems and wastewater disposal may impact drinking water supply. Heavy usage along edge of waterbody may contribute to erosion, causing turbidity.	
	Campgrounds/RV Parks					Within the 2-yr TOT.	Lower	Leaks or spills of automotive fluids or improperly managed septic systems and wastewater disposal may impact drinking water supply. Heavy usage along edge of waterbody may contribute to erosion, causing turbidity.	
15	Schools	Monroe Middle School	Southwest of well 1 and 2	Monroe		Within the 2-yr TOT.	Lower	Over-application or improper handling of cleaning products, pesticides or fertilizers used on the school grounds may impact drinking water. Vehicle maintenance wastes may contribute contaminants.	
	Schools					Between 2-yr and 5-yr TOT	Lower	Over-application or improper handling of cleaning products, pesticides or fertilizers used on the school grounds may impact drinking water. Vehicle maintenance wastes may contribute contaminants.	
16	Crops - Nonirrigated (inc. Christmas trees, grains, grass seed, pasture)	Non-irrigated crops	Throughout DWPA for well 1and 2	Monroe	Field-Observation	Within the 2-yr TOT.	Lower	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Some agricultural practices may result in excess sediments discharging to surface waters, but non-irrigated crops are generally considered to be a low risk.	A large percentage of the non-irrigated crops are located within DWPA of well 1.
	Crops - Nonirrigated (inc. Christmas trees, grains, grass seed, pasture)					Between 2-yr and 5-yr TOT	Lower	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Some agricultural practices may result in excess sediments discharging to surface waters, but non-irrigated crops are generally considered to be a low risk.	A large percentage of the non-irrigated crops are located within DWPA of well 1.

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

2/8/2002

Page 5 of 6

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100540 MONROE, CITY OF

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
17	Crops - Irrigated (inc. orchards, vineyards, nurseries, greenhouses)	Benton-Lane Winery	Southwest of well 1	Monroe	Database (2) Field-Observation	Between 5-yr and 10-yr TOT	Moderate	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Excessive irrigation may transport contaminants or sediments to groundwater/surface water through runoff. Drip-irrigated crops are considered to be a low risk.	
	Above Ground Storage Tanks - Excluding Water						Moderate	Spills, leaks, or improper handling of stored materials may impact the drinking water supply.	
18	Other -Bird seed production/distributio n	Warehouse-Bird Seed Production	East of well 2	Monroe	Field-Observation interview	Between 2-yr and 5-yr TOT	Moderate	Spills, leaks, or improper handling of chemicals and other materials during transportation, use, storage, and disposel may impact the drinking water supply.	Exact operations within warehouse is unknown. Potential risk should be verified during enhanced inventory.

es and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.
e multiple potential contaminant sources exist at a site, the highest level of risk is used.
able 3 for database listings (if necessary).

Page 6 of 6

Appendix F: Sensitivity Summary: City of Monroe, Well 1

Highly Sensitive Source: ☒ Yes ☐ No

Yes	No	
☒	☐	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☒	☐	Organic Chemical Detection: ***methylene chloride 0.0088 mg/L on 8/18/98; 0.0161 mg/L on 7/13/98 toluene 0.0016 mg/L on 9/11/98; 0.0101 mg/L on 8/18/98***
	☒	Inorganic Chemical Detection (>50% MCL)
☐	☒	Source-related Coliform: total .... fecal .... Date ....
☐	☒	Nitrate-N≥ 5mg/L: Concentration .... Date ....
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: ....
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☐	☒	Casing Seal Not Constructed Properly:. ....
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☐	☒	Inorganic Chemical Detection (<50% of MCL): ....
☒	☐	Well Construction Deficiencies from Site Visit: ***Inadequate screened vent***
☐	☒	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☒	☐	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments: ...Long Tom River ~1,060 feet from well...

Sensitivity Analysis Completed by: Kim Swanson .... **Date:** 10/25/02

42

Appendix F: Sensitivity Summary: City of Monroe, Well 2

Highly Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☒	☐	Organic Chemical Detection: ***methylene chloride 0.0088 mg/L on 8/18/98; 0.0161 mg/L on 7/13/98 toluene 0.0016 mg/L on 9/11/98; 0.0101 mg/L on 8/18/98***
☐	☒	Inorganic Chemical Detection (>50% MCL)
☐	☒	Source-related Coliform: total .... fecal .... Date ....
☐	☒	Nitrate-N≥ 5mg/L: Concentration .... Date ....
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: ....
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☐	☒	Casing Seal Not Constructed Properly:. ....
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

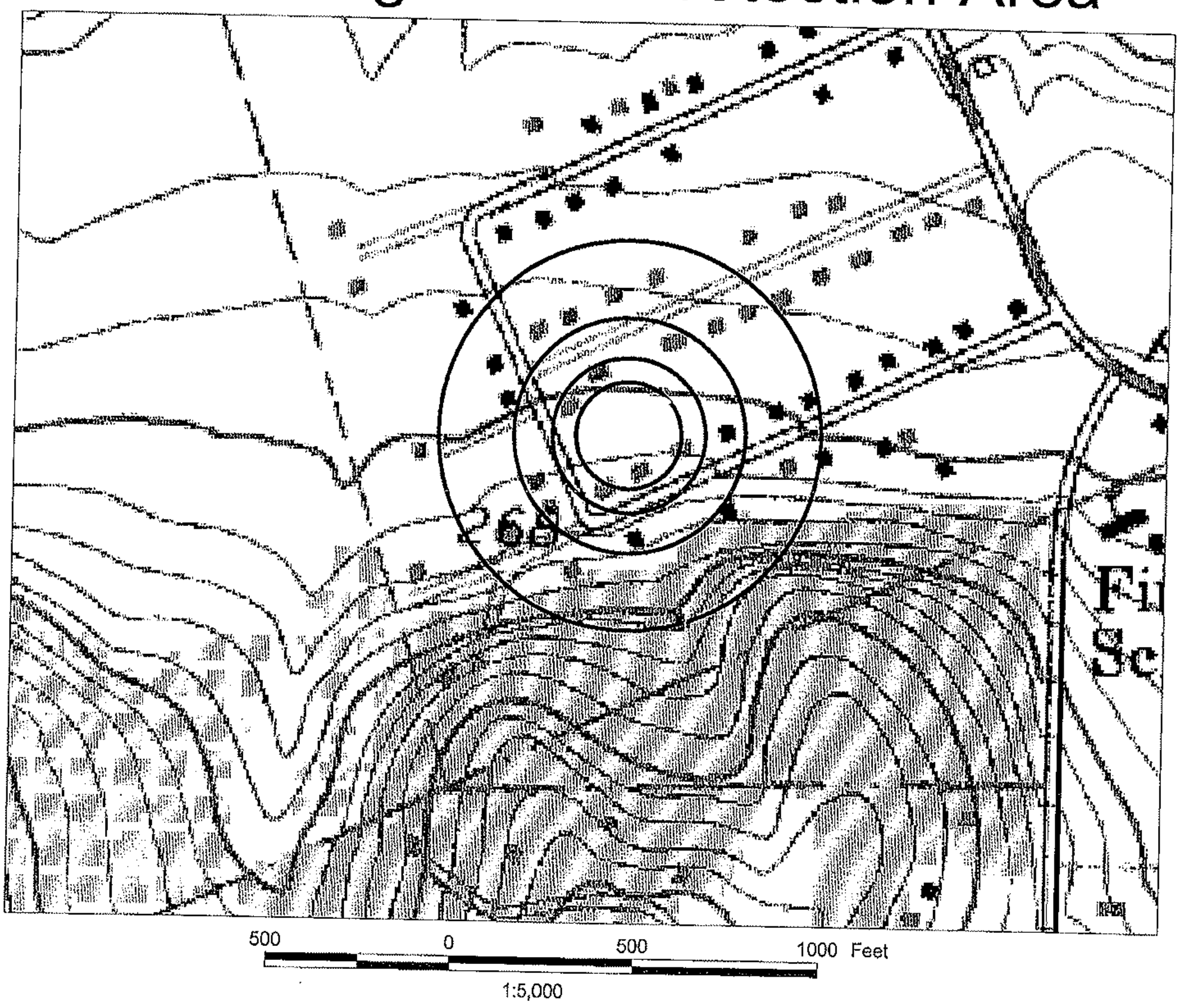
Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☐	☒	Inorganic Chemical Detection (<50% of MCL): ....
☒	☐	Well Construction Deficiencies from Site Visit: ***Inadequate screened vent***
☐	☒	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☒	☐	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments: ..Long Tom River ~1000 Feet from well
....
Sensitivity Analysis Completed by: Kim Swanson.................... **Date:** 10/25/02.

Fir View Water Company Well 1 Drinking Water Protection Area



Drinking Water Protection Area
Circular zones from center outward represent the 1, 2, 5 and 15 year Time-of-Travel for groundwater to the well
Dellineation Method: Calculated Fixed Radius
Model Parameters for Well 1:
Water Use (gal/day): 21,508
Effective Porosity: 0.05
~~Transmissivity~~: 0.0004 = Storativity
Aquifer Character: deep confined fractured sandstone (Spencer Formation)
Thickness of Producing Zone (ft): 350
Total Area of Delineation (mi2): 0.03

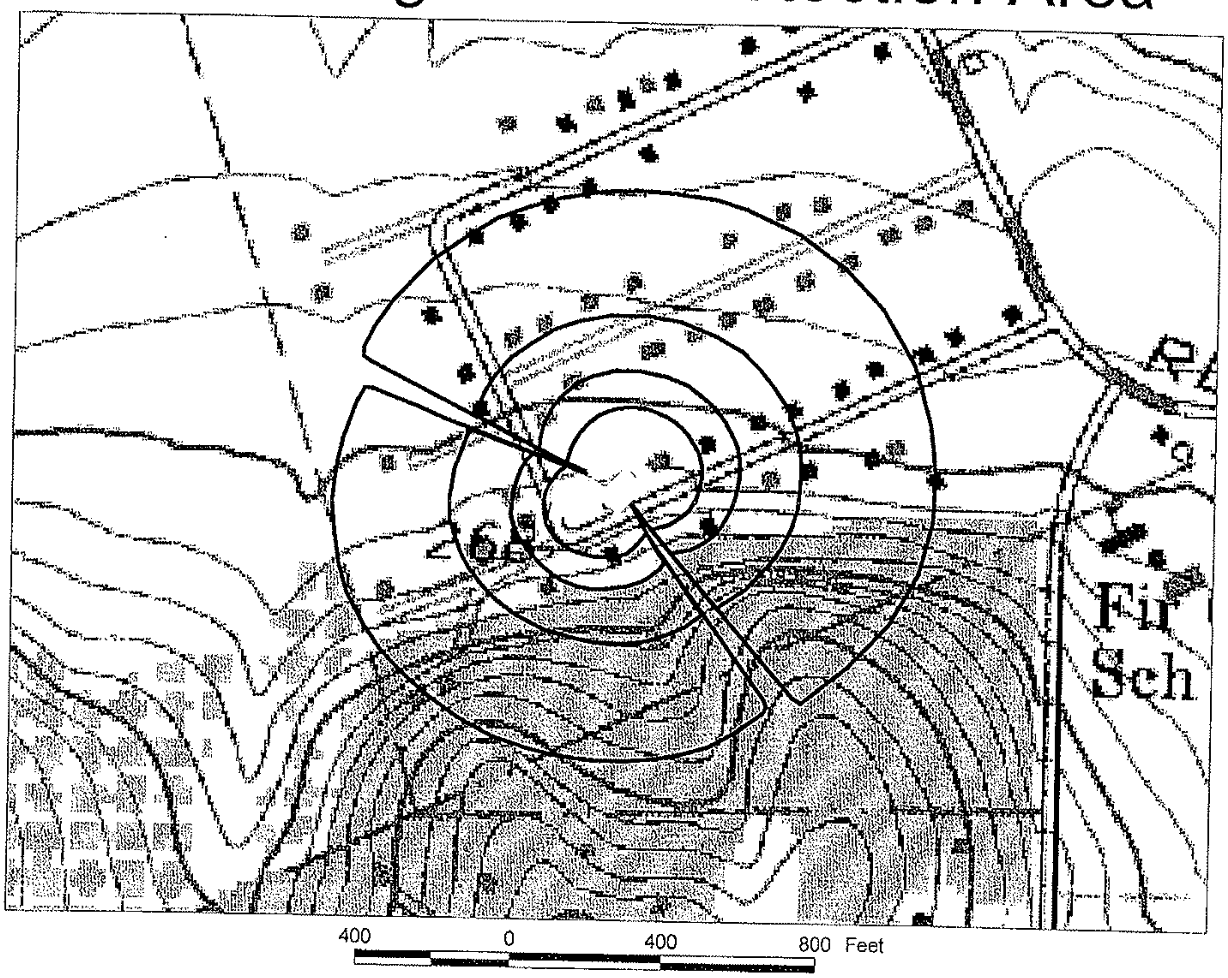
Well Location

T 10S R 4W Sec 23
USGS Lewisburg 7.5- Minute Quadrangle (topographic) Benton County

Prepared by: Kim Swanson
Drinking Water Program, Oregon Health Divison, Dept. of Human Services
Date: 7/10/01
PWS# 4100023

N

Fir View Water Company Wells 2 and 3 Drinking Water Protection Area



Drinking Water Protection Area
Circular zones from center outward
represent the 1, 2, 5 and 15 year
Time-of-Travel for groundwater to the well
Dellineation Method: GPTRAC Analytical Model
Model Parameters:
- Water Use (gal/day):
  - Well 2: 5,583.45
  - Well 3: 3,003
- Effective Porosity: 0.1
- ~~Transmissivity~~: 0.0004 = storativity
- Aquifer Character: deep confined fractured sandstone (Spencer Formation)
- Thickness of Producing Zone (ft):
  - Well 2: 42 ft
  - Well 3: 27 ft
- Total Area of Delineation (mi2):
  - Well 2: 0.039
  - Well 3: 0.016

Well Location
Well 2: [redacted]

Well 3: [redacted]

T 10S R 4W Sec 23
USGS Lewisburg 7.5- Minute
Quadrangle (topographic)
Benton County

Prepared by: Kim Swanson
Drinking Water Program, Oregon Health
Divison, Dept. of Human Services
Date: 7/10/01
PWS# 4100023

N

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100023 FIR VIEW WATER COMPANY

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
1	Septic Systems - High Density (> 1 system/acre)	High Density Housing	Throughout DWPA for Well 1 and 2	Albany	Field-Observation	Within the 2-yr TOT.	Higher	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water. Cumulative effects of multiple systems in an area may impact drinking water supply.	
	Housing - High Density (> 1 House/0.5 acres)						Moderate	Improper use, storage, and disposal of household chemicals may impact the drinking water supply. Stormwater run-off or infiltration may carry contaminants to drinking water supply.	
2	Wells/Abandoned Wells	Rural Homesteads on septic	DWPA for Well 3	Albany	Field-Observation	Between 5-yr and 15-yr TOT	Higher	Improperly installed or maintained wells and abandoned wells may provide a direct conduit for contamination to groundwater and drinking water source.	Most rural homes not associated with Fir View are found within the 15-year time-of-travel zone.
	Homesteads - Rural - Septic Systems (< 1/acre)						Lower	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water. Use of drain cleaners and dumping household hazardous wastes can result in groundwater contamination.	Most rural homes not associated with Fir View are found within the 15-year time-of-travel zone.

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

10/30/2001

Page 1 of 1

Appendix F: Sensitivity Summary: Water Fir View Water Company; Well 1

Highly Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☐	☒	Organic Chemical Detection ....
☐	☒	Inorganic Chemical Detection (>50% MCL) ....
☐	☒	Source-related Coliform: total .... fecal .... Date ....
☐	☒	Nitrate-N≥ 5mg/L: Concentration .... Date ....
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: ....
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☒	☐	Casing Seal Not Constructed Properly:. annular space too small
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☒	☐	Inorganic Chemical Detection (<50% of MCL) . Sodium. 51.2mg/L.on. 12/15/98
☐	☒	Well Construction Deficiencies from Site Visit.................
☒	☐	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☐	☒	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments ....
....
Sensitivity Analysis Completed by: Kim Swanson.............. **Date:** 7/9/02.

33

Sensitivity Summary: Water Fir View Water Company; Well 2

Highly Sensitive Source: ☐ Yes ☒ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☐	☒	Organic Chemical Detection ....
☐	☒	Inorganic Chemical Detection (>50% MCL) ....
☐	☒	Source-related Coliform: total .... fecal .... Date ....
☐	☒	Nitrate-N≥ 5mg/L: Concentration .... Date ....
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: ....
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☐	☒	Casing Seal Not Constructed Properly:. ....
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☒	☐	Inorganic Chemical Detection (<50% of MCL) Sodium. 51.2mg/L. on. 12/15/98
☐	☒	Well Construction Deficiencies from Site Visit.................
☒	☐	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☐	☒	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments ....
....
Sensitivity Analysis Completed by: Kim Swanson .... **Date:** 7/9/02...

34

Sensitivity Summary: Water Fir View Water Company; Well 3

Highly Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☐	☒	Organic Chemical Detection ....
☐	☒	Inorganic Chemical Detection (>50% MCL) ....
☐	☒	Source-related Coliform: total .... fecal .... Date ....
☐	☒	Nitrate-N≥ 5mg/L: Concentration .... Date ....
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: ....
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☒	☐	Casing Seal Not Constructed Properly:. annular space too small
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

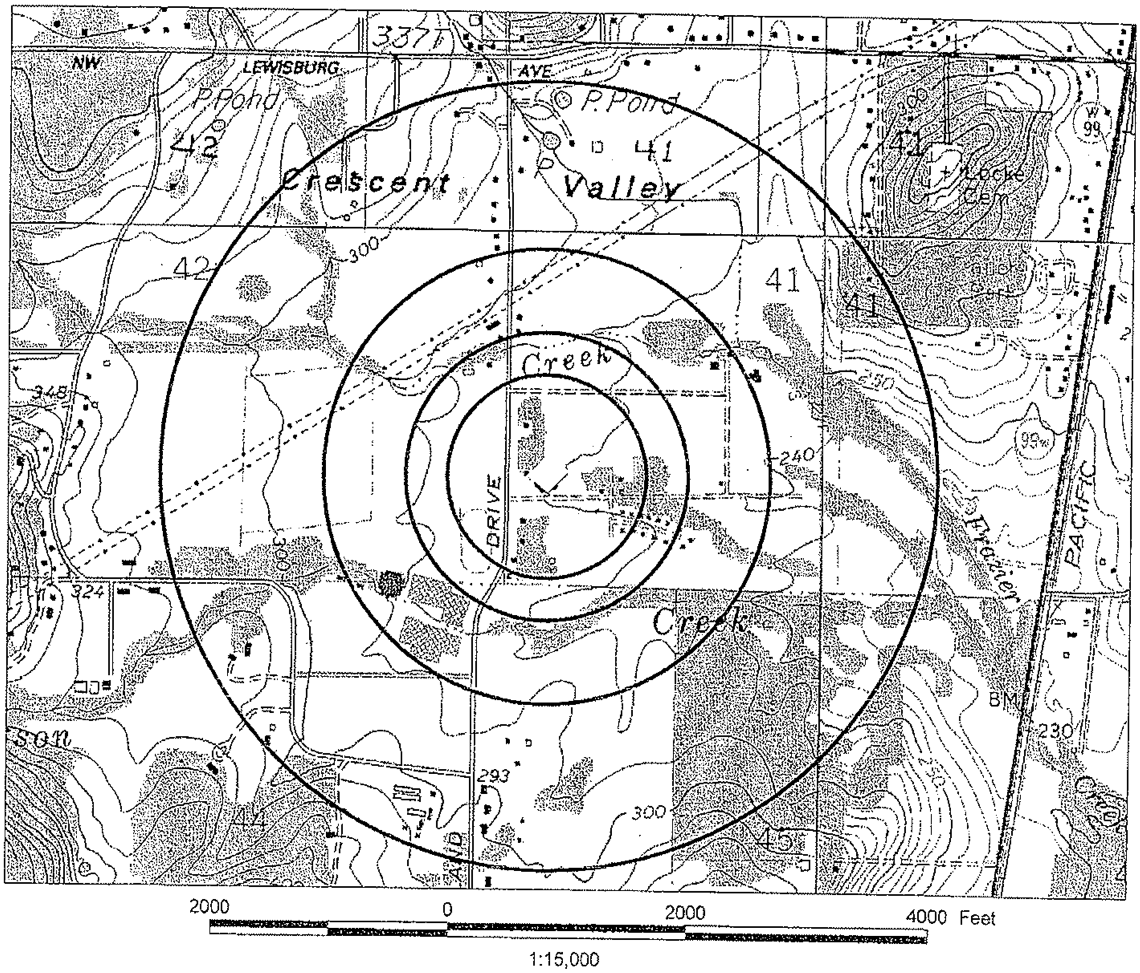
Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☒	☐	Inorganic Chemical Detection (<50% of MCL) Sodium 51.2 mg/L on 12/15/98
☐	☒	Well Construction Deficiencies from Site Visit. ....
☒	☐	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☐	☒	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments ....
....
Sensitivity Analysis Completed by: Kim Swanson .... **Date:** 7/9/02.

35

Jackson Creek Water Association
Drinking Water Protection Area



Drinking Water Protection Area
Circular zones from center outward
represent the 1, 2, 5 and 15 year
Time-of-Travel for groundwater to the well
Dellineation Method: Calculated Fixed Radius
Model Parameters:
Water Use (gal/day): 7,488
Effective Porosity: 0.1
Aquifer Character: shallow confined fractured sandstone (Tyee Formation)
Thickness of Producing Zone (ft): 1.83
Total Area of Delineation (mi2): 1.182

Prepared by Kim Swanson
Drinking Water Program, Oregon Health
Division, Dept. of Human Services
Date: 4/10/01
PWS# 4100977

Well Location:

T 11S R 5W Sec 14
USGS Corvallis 7.5- Minute
Quadrangle (topographic)
Benton County

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100977 JACKSON CREEK WATER SYSTEM

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
1	Schools	Crescent Valley High School	Southwest of well	Corvallis	Database (2) Field-Observation Interview	Between 2-yr and 5-yr TOT	Lower	Over-application or improper handling of cleaning products, pesticides or fertilizers used on the school grounds may impact drinking water. Vehicle maintenance wastes may contribute contaminants.	Large campus with a large parking lot.
	Parking Lots/Malls (> 50 Spaces)						Higher	Spills and leaks of automotive fluids in parking lots may impact the drinking water supply.	Large campus with a large parking lot.
2	Wells/Abandoned Wells	Rural Homesteads on septic	Throughout DWPA	Corvallis	Field-Observation	Within the 2-yr TOT.	Higher	Improperly installed or maintained wells and abandoned wells may provide a direct conduit for contamination to groundwater and drinking water source.	
	Homesteads - Rural - Septic Systems (< 1/acre)						Lower	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water. Use of drain cleaners and dumping household hazardous wastes can result in groundwater contamination.	
3	Sewer Lines - Close Proximity to PWS	Sewer Lines	Southwest of well	Corvallis	Field-Observation Interview	Between 2-yr and 5-yr TOT	Higher	If not properly designed, installed, and maintained, sewer lines can impact drinking water, especially adjacent to a waterbody or within the 2-year time-of-travel zone for drinking water wells.	Potential risk should be verified during enhanced inventory. Pump station, city sewer line serves Crescent Valley High School. Unsure if sewer line falls within 2- year TOT. Verify
4	Transmission Lines - Right-of-Ways	Transmission Lines	Runs NE/SW through DWPA	Corvallis	Field-Observation	Between 2-yr and 5-yr TOT	Lower	Construction and corridor maintenance may contribute to increased erosion and turbidity in drinking water supply. Over-application or improper handling of pesticides or fertilizers may impact drinking water supply.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

10/30/2001

Page 1 of 2

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100977 JACKSON CREEK WATER SYSTEM

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
5	Utility Stations - Maintenance Transformer Storage	Substation	North of well	Corvallis	Field-Observation	Between 5-yr and 15-yr TOT	Higher	Spills, leaks, or improper handling of chemicals and other materials including PCBs during transportation, use, storage and disposal may impact the drinking water supply.	
6	Medical/Vet Offices	Alpine Animal Hospital	Northwest of well	Corvallis	Field-Observation	Between 2-yr and 5-yr TOT	Moderate	Spills, leaks, or improper handling of x-ray, biological, chemical, and radioactive wastes and other materials during transportation, use, storage and disposal may impact the drinking water supply.	
7	Crops - Nonirrigated (inc. Christmas trees, grains, grass seed, pasture)	Non-irrigated crops	East of well	Corvallis	Field-Observation	Within the 2-yr TOT.	Lower	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Some agricultural practices may result in excess sediments discharging to surface waters, but non-irrigated crops are generally considered to be a low risk.	
8	Grazing Animals (> 5 large animals or equivalent/acre)	Grazing Animals	Northwest of well	Corvallis	Field-Observation	Within the 2-yr TOT.	Moderate	Improper storage and management of animal wastes may impact drinking water supply. Concentrated livestock may contribute to erosion and sedimentation of surface water bodies.	Horses may be associated with Alpine Animal Hospital.
9	Boarding Stables	Hill Farm Stables	Northwest of well	Corvallis	Field-Observation	Between 5-yr and 15-yr TOT	Moderate	Improper storage and management of animal wastes and wastewater in areas of concentrated livestock may impact drinking water.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

10/30/2001

Appendix F: Sensitivity Summary: **Water Jackson Creek Water Association; Source Name**

Highly Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☒	☐	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☒	☐	Organic Chemical Detection PCE...0.007 mg/L on 9/21/01...
☐	☒	Inorganic Chemical Detection (>50% MCL) ....
☐	☒	Source-related Coliform: total .... fecal .... Date ....
☐	☒	Nitrate-N ≥ 5mg/L: Concentration .... Date ....
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: ....
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☐	☒	Casing Seal Not Constructed Properly:..........................
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☐	☒	Inorganic Chemical Detection (<50% of MCL) ....
☐	☒	Well Construction Deficiencies from Site Visit................
☒	☐	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☒	☐	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments ....

Sensitivity Analysis Completed by: Kim Swanson .... **Date:** 3/25/02

Knoll Terrace Map not available.

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100174 **KNOLL TERRACE PARK**

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
1	Lagoons/Liquid Wastes	Wastewater Lagoons	West of wells	Corvallis	Database (2) Field-Observation	Within the 2-yr TOT.	Higher	Improper seepage or overflows of liquid wastes may impact the drinking water supply.	Located approximately 50 feet from lagoons.
2	Crops - Nonirrigated (inc. Christmas trees, grains, grass seed, pasture)	Non-irrigated crops	Throughout DWPA	Corvallis	Field-Observation	Within the 2-yr TOT.	Lower	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Some agricultural practices may result in excess sediments discharging to surface waters, but non-irrigated crops are generally considered to be a low risk.	
3	Stormwater Outfalls	Stormwater Outfalls	North and east of wells	Corvallis	Field-Observation	Within the 2-yr TOT.	Lower	Stormwater run-off may contain contaminants from residential (homesites and roads), commercial/industrial, and agricultural use areas.	Treated wastewater from lagoons is released into Mountain View Creek. Frazier Creek Ditch east of wells takes runoff from agricultural fields.
4	Transportation - Railroads	Railroad	Runs north/south through DWPA	Corvallis	Field-Observation	Just outside DWPA	Moderate	Rail transport elevates the risk for leaks/spills of fuel & other haz. materials. Installation/maintenance of tracks may increase erosion & slope failure causing turbidity. Over-application/improper handling of pesticides may impact the water supply.	
5	Transportation - Freeways/State Highways/Other Heavy Use Roads	State Highway 99W	Runs north/south through DWPA	Corvallis	Field-Observation	Just outside DWPA	Moderate	Vehicle use increases the risk for leaks or spills of fuel & other haz. materials. Road building, maintenance & use can increase erosion/slope failure causing turbidity. Over-application or improper handling of pesticides/fertilizers may impact water.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

10/30/2001

Page 1 of 2

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100174 KNOLL TERRACE PARK

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
6	UST - Upgraded/Registered - Active	City Limits Country Store	West of well	Corvallis	Database (2) Field-Observation	Just outside DWPA	Lower	Spills or improper handling during tank filling or product distribution may impact the drinking water supply.	USTs are reported as upgraded - PWS should verify all USTs were upgraded.
	Automobiles - Gas Stations						Higher	Spills, leaks, or improper handling of fuels and other materials during transportation, transfer, and storage may impact the drinking water supply.	USTs are reported as upgraded - PWS should verify all USTs were upgraded.
7	Junk/Scrap/Salvage Yards	Lewisburg Auction	Northwest of well	Corvallis	Field-Observation	Just outside DWPA	Higher	Spills, leaks, or improper handling of automotive chemicals, batteries, and other waste materials during storage and disposal may impact the drinking water supply.	
8	UST - Status Unknown	SCI-Greenberry Tank & Iron Co	South of well	Corvallis	Database (2) Field-Observation	Just outside DWPA	Higher	Spills, leaks, or improper handling of stored materials may impact the drinking water supply.	Name of company is unknown. SCI was observed on truck outside facility. PCS location based on regulatory database search - needs verification.
	Metal Plating/Finishing/Fabrication						Higher	Spills, leaks, or improper handling of solvents, metals, and other chemicals during transportation, use, storage and disposal may impact the drinking water supply.	Name of company is unknown. SCI was observed on truck outside facility. PCS location based on regulatory database search - needs verification.

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

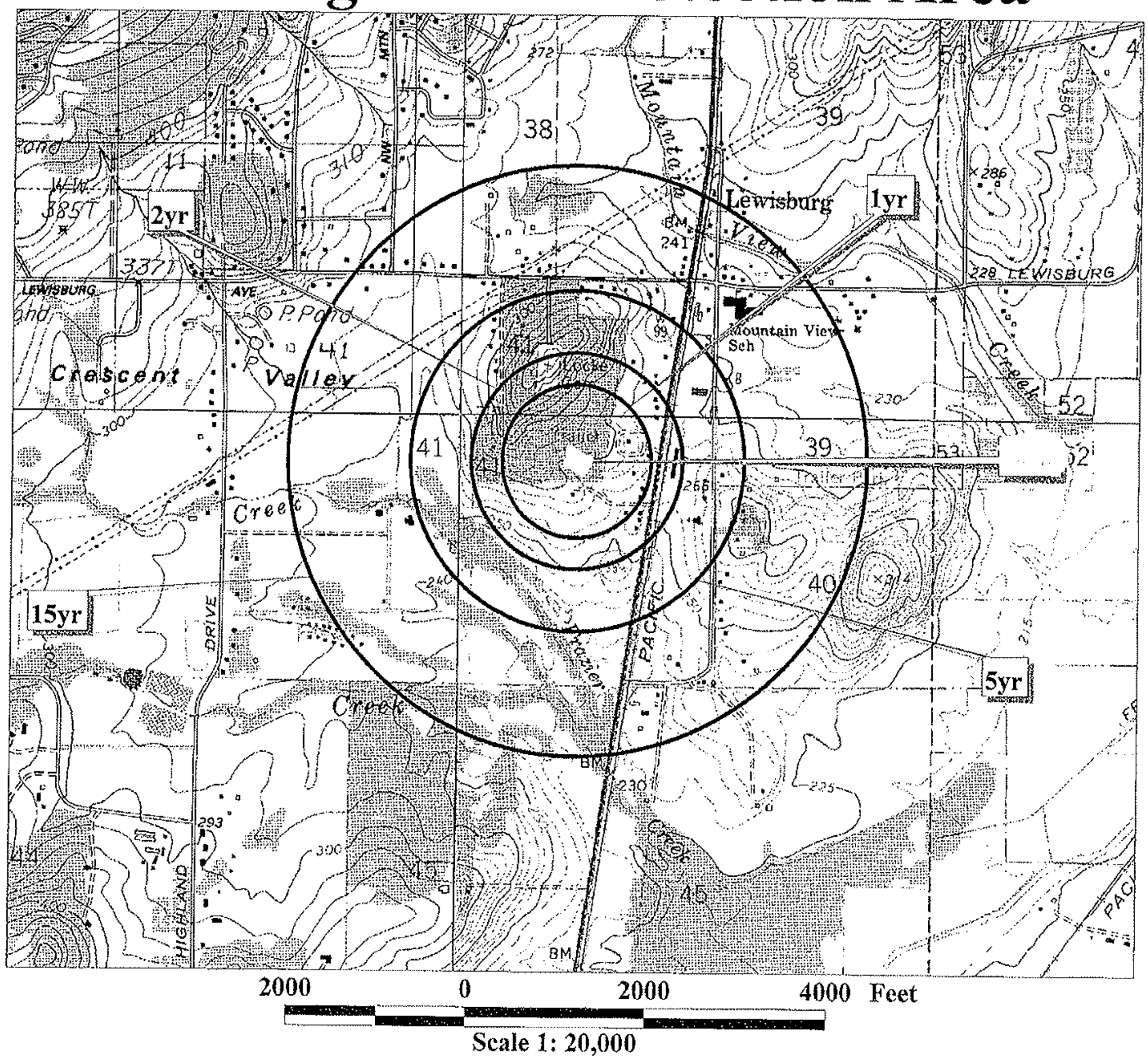
(2) See Table 3 for database listings (if necessary).

10/30/2001

Page 2 of 2

North Corvallis Mobile Home Park Drinking Water Protection Area

Figure 1



Drinking Water Protection Area (DWPA)
1, 2, 5, and 15 year Time-of-Travel (TOT)
Calculated Fixed Radius Method

Model Parameters
Effective Porosity: 0.15
Water Use (gal/day): 25,000
Production Interval (ft): 1

Prepared by: KG Date: 4/26/04
Project Manager: AP
Reviewed by: DN RG#: 1224
File#: 4101158

USGS Riverside 7.5-Minute
Quadrangle (topographic)
T: 11S R: 5W Sec: 12
Benton County

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4101158 NORTH CORVALLIS MHP-WELL #1

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
1	Housing - High Density (> 1 House/0.5 acres)	North Corvallis MHP	Surrounding Well	Corvallis	Field-Observation Interview	Within the 2-yr TOT.	Moderate	Improper use, storage, and disposal of household chemicals may impact the drinking water supply. Stormwater run-off or infiltration may carry contaminants to drinking water supply.	Septic system drainfield north of trailer park in 5 year TOT.
	Large Capacity Septic Systems (serves > 20 people) - Class V UICs						Higher	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water.	Septic system drainfield north of trailer park in 5 year TOT.
2	Crops - Nonirrigated (inc. Christmas trees, grains, grass seed, pasture)	Non-Irrigated Crops	Southwest of Trailer Park	Corbett	Field-Observation	Within the 2-yr TOT.	Lower	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Some agricultural practices may result in excess sediments discharging to surface waters, but non-irrigated crops are generally considered to be a low risk.	
3	Homesteads - Rural - Septic Systems (< 1/acre)	Rural Homes	Throughout DWPA	Corvallis	Field-Observation	Within the 2-yr TOT.	Lower	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water. Use of drain cleaners and dumping household hazardous wastes can result in groundwater contamination.	
4	Cemeteries - Pre-1945	Locke Cemetery	NW of Well	Corvallis	Interview	Within the 2-yr TOT.	Moderate	Embalming fluids (for example, arsenic) and decomposition by-products may impact drinking water supply.	
5	Transportation - Freeways/State Highways/Other Heavy Use Roads	Hwy 99W	Runs N-S Through DWPA	Corvallis	Field-Observation	Within the 2-yr TOT.	Moderate	Vehicle use increases the risk for leaks or spills of fuel & other haz. materials. Road building, maintenance & use can increase erosion/slope failure causing turbidity. Over-application or improper handling of pesticides/fertilizers may impact water.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

4/28/2004

Page 1 of 3

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4101158 NORTH CORVALLIS MHP-WELL #1

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
6	UST - Confirmed Leaking Tanks - DEQ List	Mountain View Storage	NE Elliot Circle	Corvallis	Database (2) Field-Observation Interview	Within the 2-yr TOT.	Higher	Existing contamination from spills, leaks, or improper handling of stored materials may impact the drinking water supply.	Site was formerly Evanite Permaglass and US Intec. PWS needs to verify status of underground storage tanks.
	RV/Mini Storage						Lower	Spills, leaks, or improper handling of automotive fluids and other materials during transportation, storage and disposal may impact the drinking water supply.	Site was formerly Evanite Permaglass and US Intec. PWS needs to verify status of underground storage tanks.
7	Transportation - Railroads	Railroad	Runs N-S Through DWPA	Corvallis	Field-Observation	Within the 2-yr TOT.	Moderate	Rail transport elevates the risk for leaks/spills of fuel & other haz. materials. Installation/maintenance of tracks may increase erosion & slope failure causing turbidity. Over-application/improper handling of pesticides may impact the water supply.	
8	Transmission Lines - Right-of-Ways	Power Lines	NW of Well near Lewisburg Rd.	Corvallis	Field-Observation	Between 5-yr and 15-yr TOT	Lower	Construction and corridor maintenance may contribute to increased erosion and turbidity in drinking water supply. Over-application or improper handling of pesticides or fertilizers may impact drinking water supply.	
9	Homesteads - Rural - Machine Shops/Equipment Maintenance	Home Machine Shop	Lewisburg Rd	Corvallis	Field-Observation	Between 2-yr and 5-yr TOT	Higher	Spills, leaks, or improper handling of solvents, fuels, and other materials or chemicals during transportation, use, storage and disposal may impact the drinking water supply.	
10	UST - Status Unknown	Comcast	NW Lewisburg Rd.	Corvallis	Database (2) Field-Observation	Between 2-yr and 5-yr TOT	Higher	Spills, leaks, or improper handling of stored materials may impact the drinking water supply.	Same address as "applied theory". PWS needs to verify UST status.

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

4/28/2004

Page 2 of 3

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4101158 NORTH CORVALLIS MHP-WELL #1

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
11	Automobiles - Repair Shops	Bud's Auto Wrecking	Hwy 99W	Corvallis	Field-Observation	Between 2-yr and 5-yr TOT	Higher	Spills, leaks, or improper handling of automotive fluids, solvents, and repair materials during transportation, use, storage and disposal may impact the drinking water supply.	
12	Metal Plating/Finishing/Fabrication	Greenberry Tank and Iron	NE Elliot Circle	Corvallis	Database (2) Field-Observation	Between 2-yr and 5-yr TOT	Higher	Spills, leaks, or improper handling of solvents, metals, and other chemicals during transportation, use, storage and disposal may impact the drinking water supply.	
	UST - Decommissioned/Inactive						Lower	Historic spills or leaks may impact the drinking water supply.	
13	Construction/Demolition Areas	Knoll Terrace	NE Elliott Circle	Corvallis	Database (2) Field-Observation	Between 5-yr and 15-yr TOT	Moderate	Construction/demolition activities may contribute to erosion and increased turbidity in surface water drinking water supplies. Equipment usage increases the risks of leaks or spills of fuels and other chemicals.	
	Other - Permitted Dischargers - NPDES							The impacts of this potential contaminant source will be addressed during the enhanced inventory.	
14	Crops - Irrigated (inc. orchards, vineyards, nurseries, greenhouses)	Irrigated Crops	East of NE Elliott Circle	Corvallis	Field-Observation	Between 2-yr and 5-yr TOT	Moderate	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Excessive irrigation may transport contaminants or sediments to groundwater/surface water through runoff. Drip-irrigated crops are considered to be a low risk.	

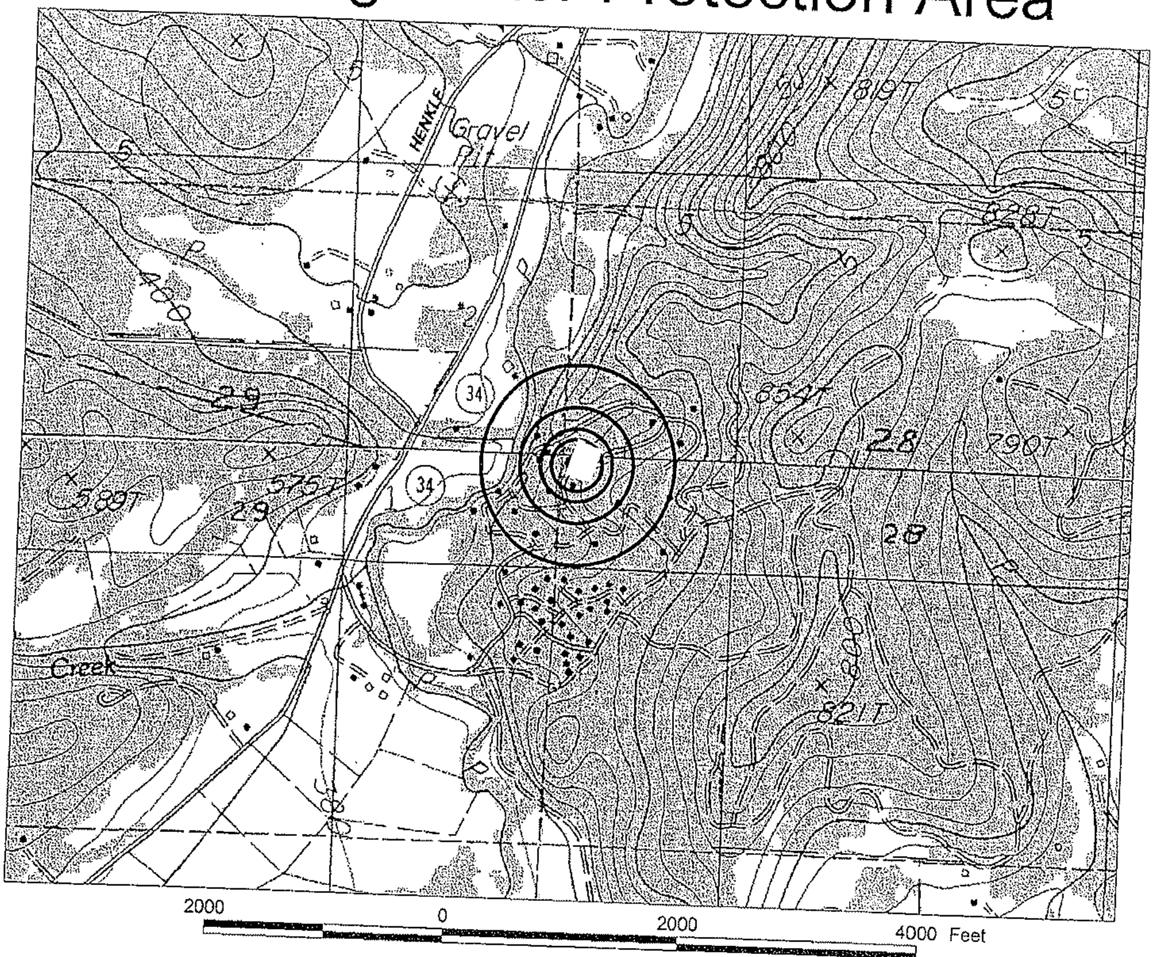
Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

4/28/2004

Pioneer Village Water Company Well 1
Drinking Water Protection Area



Drinking Water Protection Area
Circular zones from center outward
represent the 1, 2, 5 and 15 year
Time-of-Travel for groundwater to the well
Dellineation Method: Calculated Fixed Radius
Model Parameters:
Water Use (gal/day): 881.14
Effective Porosity: 0.1
Aquifer Character: shallow unconfined fractured sandstone
(Tyee Fomation)
Thickness of Producing Zone (ft): 3
Total Area of Delineation (mi2): 0.077

Prepared by Kim Swanson
Drinking Water Program, Oregon Health
Division, Dept. of Human Services
Date: 7/9/01
PWS# 4101296

USGS Flat 7.5- Minute
Quadrangle (topographic)
Benton County

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4101296 PIONEER VILLAGE WATER COMPANY

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
1	Wells/Abandoned Wells	Rural Homestead on septic	Throughout DWPA for well 1 and 2	Philomath	Field-Observation	Within the 2-yr TOT.	Higher	Improperly installed or maintained wells and abandoned wells may provide a direct conduit for contamination to groundwater and drinking water source.	There are private wells outside of Pioneer Village.
	Homesteads - Rural - Septic Systems (< 1/acre)						Lower	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water. Use of drain cleaners and dumping household hazardous wastes can result in groundwater contamination.	There are private wells outside of Pioneer Village.
2	Transportation - Freeways/State Highways/Other Heavy Use Roads	State Highway 34	Runs through DWPA for well 2	Philomath	Field-Observation	Between 2-yr and 5-yr TOT	Moderate	Vehicle use increases the risk for leaks or spills of fuel & other haz. materials. Road building, maintenance & use can increase erosion/slope failure causing turbidity. Over-application or improper handling of pesticides/fertilizers may impact water.	
3	Crops - Nonirrigated (inc. Christmas trees, grains, grass seed, pasture)	Winter Creek Tree Farm	Southwest of well 2	Philomath	Field-Observation	Between 5-yr and 15-yr TOT	Lower	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Some agricultural practices may result in excess sediments discharging to surface waters, but non-irrigated crops are generally considered to be a low risk.	
4	Managed Forest Land - Clearcut Harvest (< 35 yrs.)	Clear cuts	Southeast of well 2	Philomath	Field-Observation	Between 2-yr and 5-yr TOT	Moderate	Cutting and yarding of trees may contribute to increased erosion, resulting in turbidity and chemical changes in drinking water supply. Over-application or improper handling of pesticides or fertilizers may impact drinking water source.	

ote: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

2) See Table 3 for database listings (if necessary).

/13/2002

Page 1 of 1

Appendix F: Sensitivity Summary: Pioneer Village Water Company, Well 1

Highly Sensitive Source: ☐ Yes ☒ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: . . . .
☐	☒	Organic Chemical Detection: . . . .
☐	☒	Inorganic Chemical Detection (>50% MCL) . . . .
☐	☒	Source-related Coliform: total . . . . fecal . . . . . . Date . . . .
☐	☒	Nitrate-N≥ 5mg/L: Concentration . . . . Date . . . .
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: . . . .
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: . . . .)
☐	☒	Inappropriate Casing Seal Material
☐	☒	Casing Seal Not Constructed Properly:. . . . .
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☒	☐	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration . . . . Date . . . .
☐	☒	Inorganic Chemical Detection (<50% of MCL): . . . .
☒	☐	Well Construction Deficiencies from Site Visit. . . . .
☒	☐	Well constructed prior to 1979: Deepened in 2001; Casing seal not changed
☐	☒	Other Wells Score ≥ 400
☐	☒	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments: . . . .

Sensitivity Analysis Completed by: Kim Swanson/Dennis Nelson . . . . **Date:** . . . .

39

Appendix F: Sensitivity Summary: Pioneer Village Water Company, Well 1

Highly Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☐	☒	Organic Chemical Detection: ....
☐	☒	Inorganic Chemical Detection (>50% MCL) ....
☒	☐	Source-related Coliform: total ...X... fecal .... Date .1/18/02, 1/22/02, 2/8/02
☐	☒	Nitrate-N≥ 5mg/L: Concentration .... Date ....
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: ....
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☐	☒	Casing Seal Not Constructed Properly:...........................
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☐	☒	Inorganic Chemical Detection (<50% of MCL): ....
☒	☐	Well Construction Deficiencies from Site Visit. no protective housing, inadequate screened well vent.
☒	☐	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☐	☒	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments: ....

Sensitivity Analysis Completed by: Kim Swanson .... **Date:** 8/20/02.

39

Sensitivity Summary: Pioneer Village Water Company, Well 2

Highly Sensitive Source: ☐ Yes ☒ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☐	☒	Organic Chemical Detection: ....
☐	☒	Inorganic Chemical Detection (>50% MCL) ....
☐	☒	Source-related Coliform: total .... fecal ...... Date ....
☐	☒	Nitrate-N≥ 5mg/L: Concentration .... Date ....
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: ....
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☐	☒	Casing Seal Not Constructed Properly:. ....
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☐	☒	Inorganic Chemical Detection (<50% of MCL): ....
☐	☒	Well Construction Deficiencies from Site Visit. ....
☐	☒	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☐	☒	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments: . . . Housing and screened vent deficiencies rectified ....
....

Sensitivity Analysis Completed by: . . . Kim Swanson/Dennis Nelson .... **Date:** ....

40

Sensitivity Summary: Pioneer Village Water Company, Well 2

Highly Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☐	☒	Organic Chemical Detection: ....
☐	☒	Inorganic Chemical Detection (>50% MCL) ....
☒	☐	Source-related Coliform: total ..X.... fecal .... Date 1/18/02, 1/22/02, 2/8/02
☐	☒	Nitrate-N ≥ 5mg/L: Concentration .... Date ....
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: ....
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☐	☒	Casing Seal Not Constructed Properly:..........................
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☒	☐	Inorganic Chemical Detection (<50% of MCL): ....
☐	☒	Well Construction Deficiencies from Site Visit. no protective housing, inadequate screened well vent
☐	☒	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☒	☐	Soil with TOT <65 hours or lack of soil information in DWPA
☐	☒	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

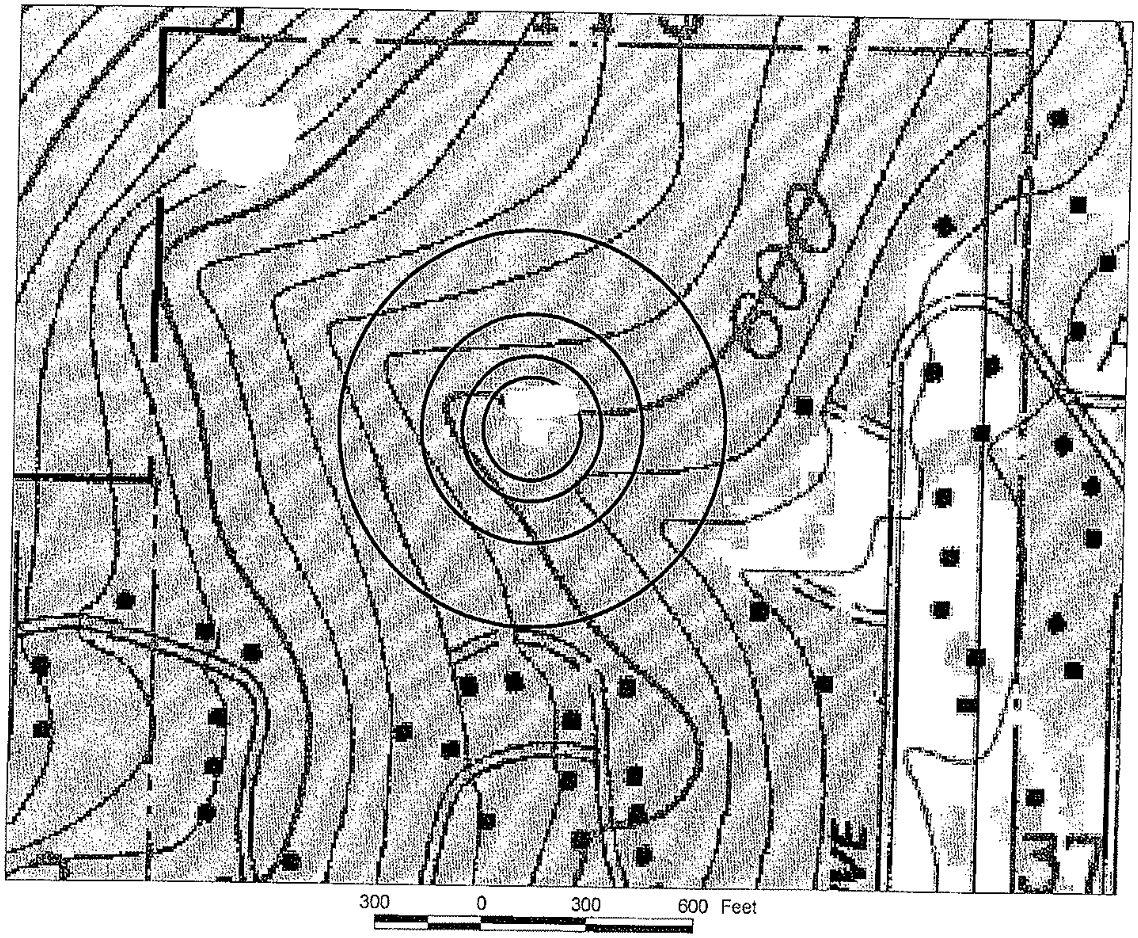
1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments: ....

Sensitivity Analysis Completed by: Kim Swanson .... **Date:** 8/20/02

40

Raintree Estates Well 1
Drinking Water Protection Area

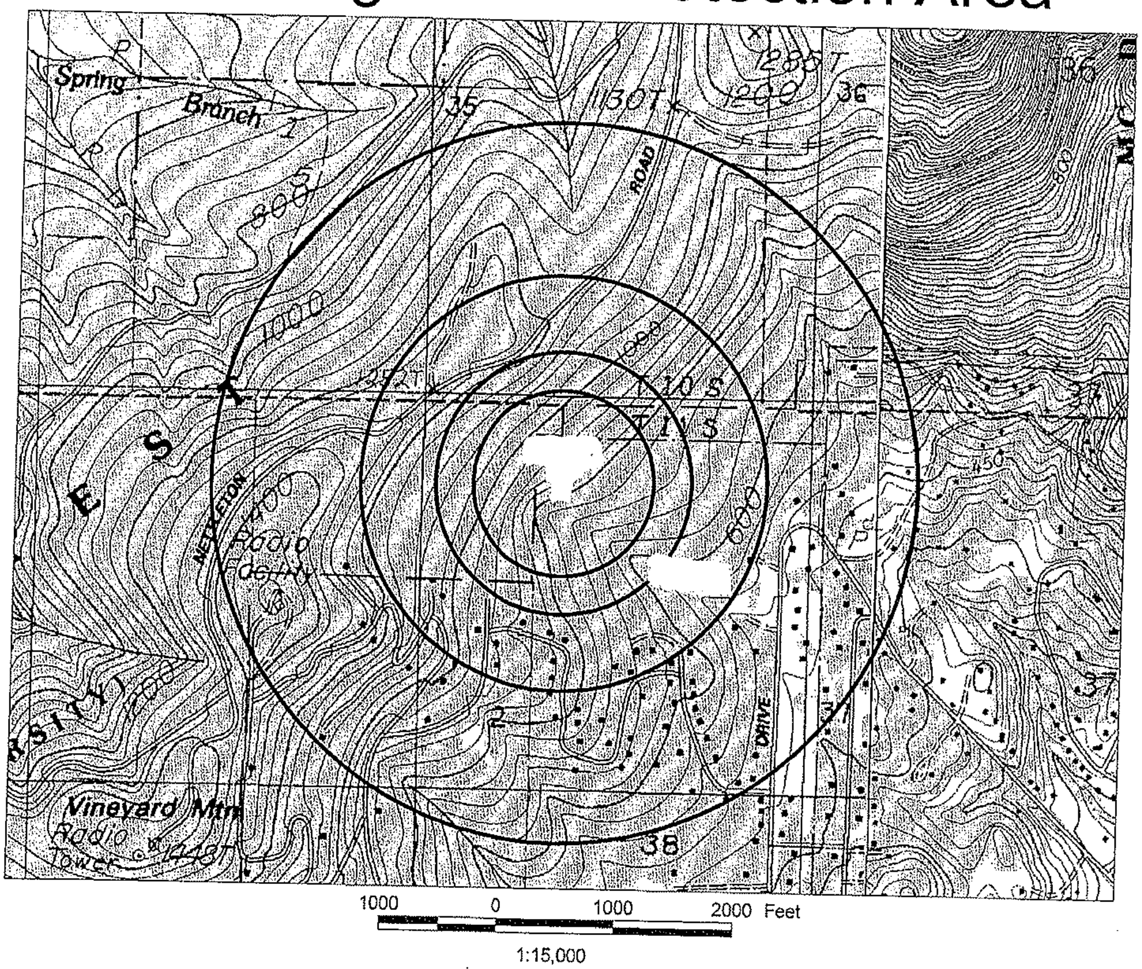


Drinking Water Protection Area
Circular zones from center outward
represent the 1, 2, 5 and 15 year
Time-of-Travel for groundwater to the well
Dellineation Method: Calculated Fixed Radius
Model Parameters for Well 1:
Water Use (gal/day): 700
Effective Porosity: 0.25
Aquifer Character: deep confined fractured interbedded sandstone/basalt
(Siletz River Volcanics)
Thickness of Producing Zone (ft): 1
Total Area of Delineation (mi2): 0.033

USGS Airlie South
7.5- Minute Quadrangle
(topographic) Benton County

Prepared by: Kim Swanson
Drinking Water Program, Oregon Health Division,
Dept. of Human Services
Date: 7/26/01
PWS # 4105548

Raintree Estates Well 2
Drinking Water Protection Area



Drinking Water Protection Area
Circular zones from center outward
represent the 1, 2, 5 and 15 year
Time-of-Travel for groundwater to the well
Dellineation Method: Calculated Fixed Radius
Model Parameters for Well 2:
Water Use (gal/day): 9,573.47
Effective Porosity: 0.25
Aquifer Character: deep confined fractured interbedded sandstone/basalt
(Siletz River Volcanics)
Thickness of Producing Zone (ft): 1
Total Area of Delineation (mi2): 1.006

USGS Lewisburg 7.5- Minute Quadrangle
(topographic) Benton County

N

Prepared by: Kim Swanson
Drinking Water Program, Oregon Health Division,
Dept. of Human Services
Date: 7/26/01
PWS # 4105548

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4105548 RAINTREE ESTATES

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
1	Wells/Abandoned Wells	Rural Homesteads on septic	DWPA of well 2	Corvallis	Field-Observation	Within the 2-yr TOT.	Higher	Improperly installed or maintained wells and abandoned wells may provide a direct conduit for contamination to groundwater and drinking water source.	Uncertain if any homes were located within DWPA for well 1. Needs to be verified.
	Homesteads - Rural - Septic Systems (< 1/acre)						Lower	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water. Use of drain cleaners and dumping household hazardous wastes can result in groundwater contamination.	Uncertain if any homes were located within DWPA for well 1. Needs to be verified.
2	Other --Radio Facility	Radio Facility	Southwest of well 2	Corvallis	Field-Observation	Between 5-yr and 15-yr TOT	Lower	The impacts of this potential contaminant source will be addressed during the enhanced inventory.	
3	Managed Forest Land - Clearcut Harvest (< 35 yrs.)	Clear cuts	North of well 2	Corvallis	Field-Observation	Between 2-yr and 5-yr TOT	Moderate	Cutting and yarding of trees may contribute to increased erosion, resulting in turbidity and chemical changes in drinking water supply. Over-application or improper handling of pesticides or fertilizers may impact drinking water source.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

10/30/2001

Page 1 of 1

Appendix F: Sensitivity Summary: Raintree Estates, Well 1

Highly Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☐	☒	Organic Chemical Detection: ....
☐	☒	Inorganic Chemical Detection (>50% MCL) ....
☒	☐	Source-related Coliform: total ...2... fecal .... Date .6/1/00 ;. 6/5/00
☐	☒	Nitrate-N≥ 5mg/L: Concentration .... Date ....
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: ....
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☒	☐	Inappropriate Casing Seal Depth (depth recommendation: ...477'.....)
☐	☒	Inappropriate Casing Seal Material
☒	☐	Casing Seal Not Constructed Properly:. not enough. bags . of. seal material
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☒	☐	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☐	☒	Inorganic Chemical Detection (<50% of MCL): ....
☐	☒	Well Construction Deficiencies from Site Visit. ....
☒	☐	Well constructed prior to 1979
☒	☐	Other Wells Score ≥ 400
☐	☒	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

Additional Comments: ....

Sensitivity Analysis Completed by: . Kim Swanson.......... **Date:** ..9/20/02

41

Sensitivity Summary: Raintree Estates, Well 2

Highly Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Fractured Confined Aquifer <50 feet Below the Surface
☐	☒	Other Aquifer (describe: ....
☐	☒	Organic Chemical Detection: ....
☐	☒	Inorganic Chemical Detection (>50% MCL) ....
☒	☐	Source-related Coliform: total .. 2 ... fecal .... Date 6/1/00 ; 6/5/00
☐	☒	Nitrate-N≥ 5mg/L: Concentration .... Date ....
☐	☒	Well Construction/Setback or Monitoring Deficiencies from Site Visit: ....
☐	☒	Well Report Missing/Unavailable
☐	☒	Casing Seal Missing/Unknown
☐	☒	Inappropriate Casing Seal Depth (depth recommendation: ....)
☐	☒	Inappropriate Casing Seal Material
☐	☒	Casing Seal Not Constructed Properly:..........................
☐	☒	Traverse Potential >5 (Not performed on TNCWS)
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Alluvial Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer
☐	☒	Fractured Bedrock at Surface
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration .... Date ....
☐	☒	Inorganic Chemical Detection (<50% of MCL): ....
☒	☐	Well Construction Deficiencies from Site Visit................
☐	☒	Well constructed prior to 1979
☐	☒	Other Wells Score ≥ 400
☐	☒	Soil with TOT <65 hours or lack of soil information in DWPA
☒	☐	Infiltration Potential 4 to ≤ 7 (Not performed on TNCWS)
☐	☒	Surface water within 500 feet

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked "yes" indicates that this characteristic contributes to the sensitivity at the indicated level.

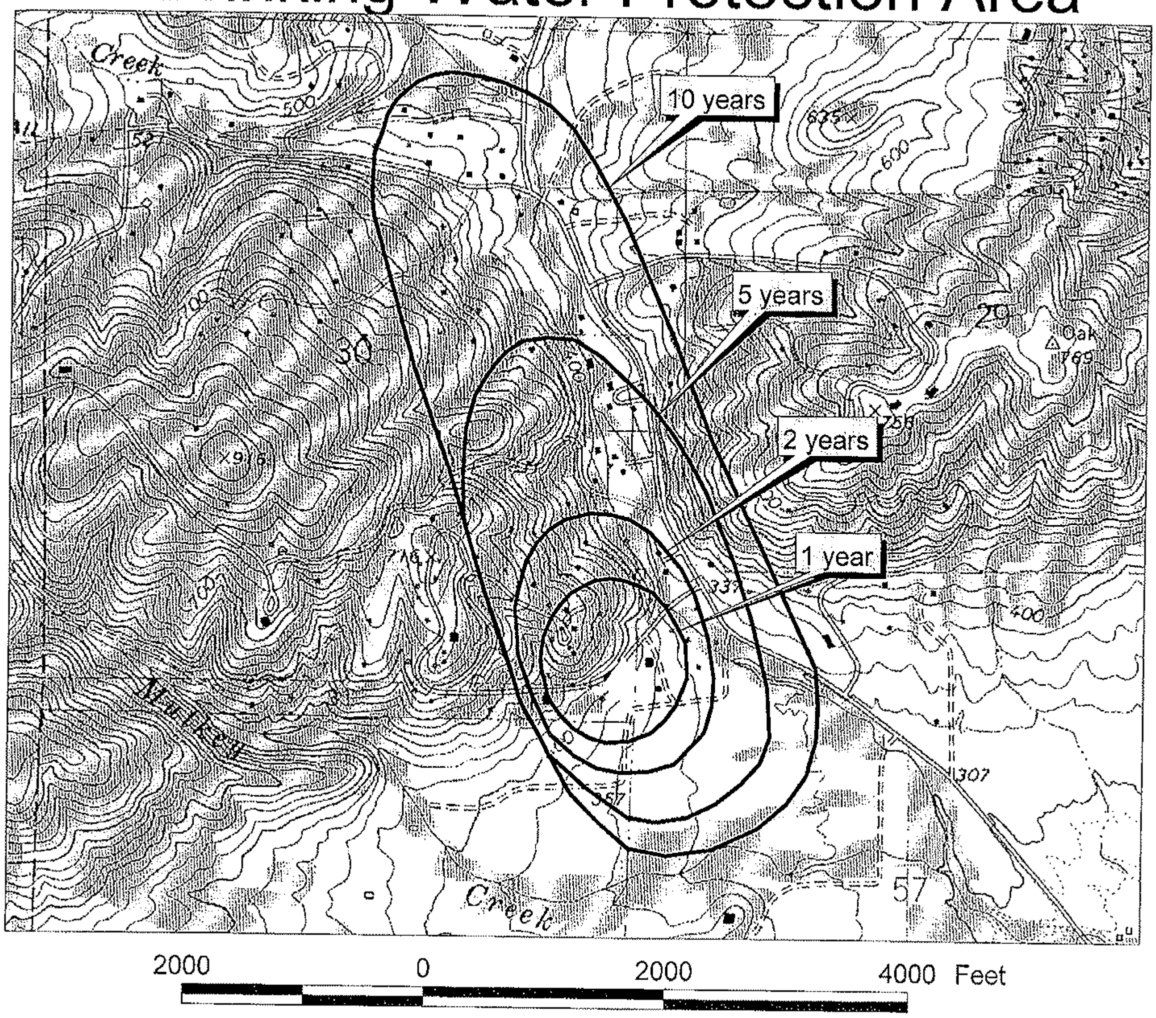
Additional Comments: ....

Sensitivity Analysis Completed by: Kim Swanson .... **Date:** 9/20/02

42

Figure 3

Ridgewood Improvement District Drinking Water Protection Area



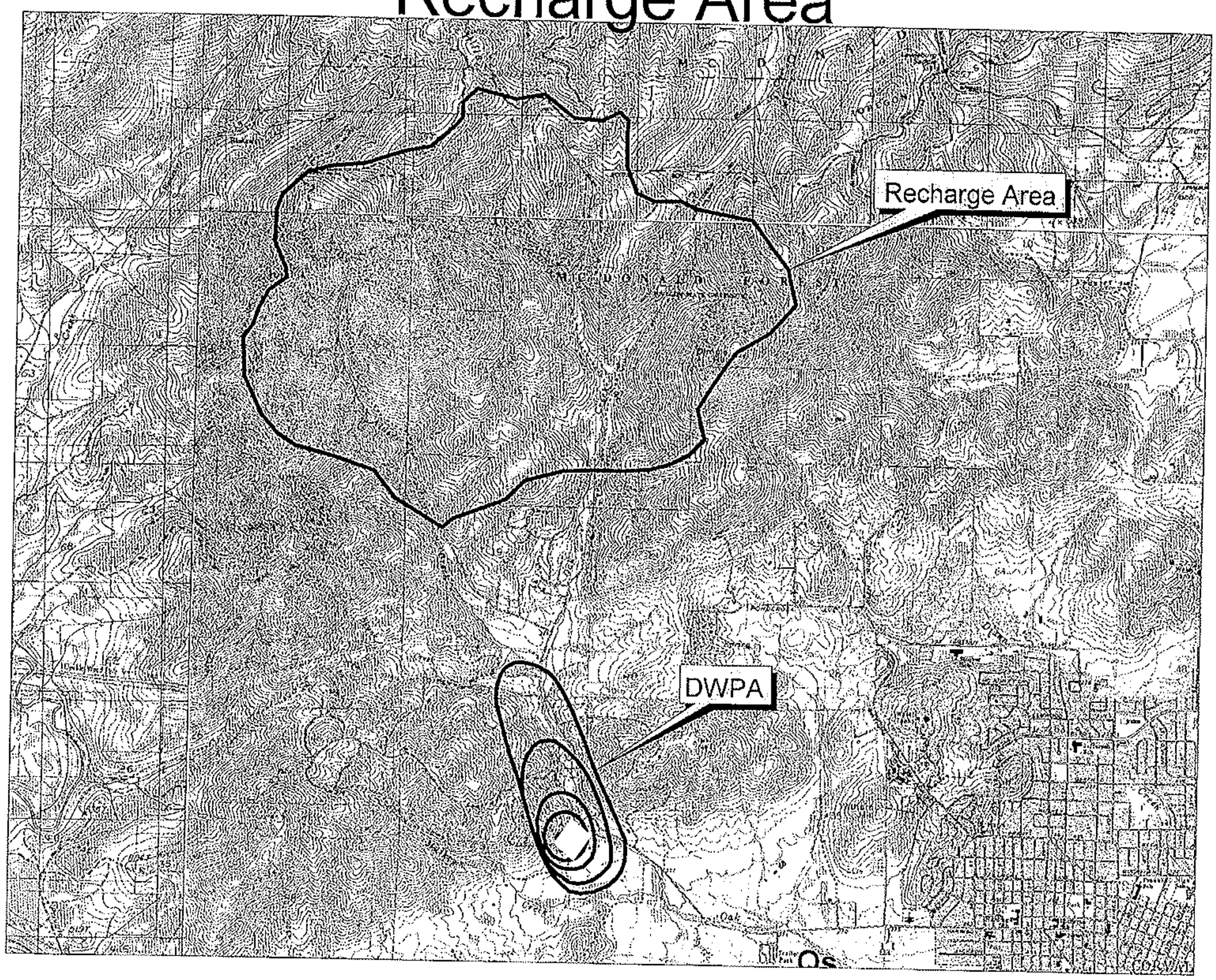
Drinking Water Protection Area
1-, 2-, 5- and 10-year Time-of-Travel zones for Groundwater within the aquifer are indicated.
Area of 10-year Time-of-Travel: 0.475 mi2
Aquifer: Siletz River Volcanic rocks
Delineation Model Used: GPTRAC Analytical
Pumping Rate: 20.8 gpm
Aquifer Characteristics:
Confined
Thickness: 6 to 8 feet
Hydraulic conductivity: 6.7 to 17 feet/day
Effective porosity: 0.15
Hydraulic gradient: 0.006 feet/ft
Direction of groundwater flow: S25E

minute topographic quadrangle
Benton County

Prepared by: Dennis Nelson, RG#1224
Oregon Health Div., Dept. of Human Services
April 17, 2001
PWS# 4100229

Ridgewood Improvement District Recharge Area

Figure 2



5000 0 5000 10000 Feet

Scale 1:50,000

N

Probable recharge area for the Siletz River Volcanics aquifer that supplies Ridgewood Improvement District's Drinking Water Well

Drinking Water Protection Area (DWPA) for the District is also shown.

Drinking Water Program
Oregon Department of Human Services

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100229 RIDGEWOOD DISTRICT IMPROV.CO.,

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (2)	Potential Impacts	Comments
1	Wells/Abandoned Wells	Rural Homestead/septic	Throughout DWPA	Corvallis	Field-Observation Interview	Within the 2-yr TOT.	Higher	Improperly installed or maintained wells and abandoned wells may provide a direct conduit for contamination to groundwater and drinking water source.	
	Homesteads - Rural - Septic Systems (< 1/acre)						Lower	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water. Use of drain cleaners and dumping household hazardous wastes can result in groundwater contamination.	
2	Utility Stations - Maintenance Transformer Storage	Substation	Northeast of well	Corvallis	Field-Observation	Within the 2-yr TOT.	Higher	Spills, leaks, or improper handling of chemicals and other materials including PCBs during transportation, use, storage and disposal may impact the drinking water supply.	
3	Grazing Animals (> 5 large animals or equivalent/acre)	Grazing Animals	East of well	Corvallis	Field-Observation	Within the 2-yr TOT.	Moderate	Improper storage and management of animal wastes may impact drinking water supply. Concentrated livestock may contribute to erosion and sedimentation of surface water bodies.	
4	Crops - Nonirrigated (inc. Christmas trees, grains, grass seed, pasture)	Non-irrigated crops	Southeast/east of well	Corvallis	Field-Observation	Within the 2-yr TOT.	Lower	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Some agricultural practices may result in excess sediments discharging to surface waters, but non-irrigated crops are generally considered to be a low risk.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

8/20/2001

Page 1 of 1

Sensitivity Summary[1]: Ridgewood District Improvement Company Well

Highly Sensitive Source: ☐ Yes ☒ No

Yes	No	
☐	☒	Unconfined Aquifer: Shallow (< 100 Ft), No significant clay layers
☐	☒	Unconfined Aquifer: Cobbles/gravel
☐	☒	Unconfined Aquifer: Fractured bedrock
☐	☒	Other Aquifer (describe
☐	☒	Organic Chemical Detection
☐	☒	Inorganic Chemical Detection (>50% MCL)
☐	☒	Source-related Coliform: total: ..fecal: Date:
☐	☒	Nitrate-N > 5mg/L: Concentration...................................... Date
☐	☒	Well Construction Deficiencies from Sanitary Survey:
☐	☒	Casing Seal Missing
☐	☒	Inappropriate Casing Seal Material:
☐	☒	Traverse Potential >5 (Not performed on TNCWS):
☐	☒	Infiltration Potential >7 (Not performed on TNCWS)

Moderately Sensitive Source: ☒ Yes ☐ No

Yes	No	
☐	☒	Shallow (<50 feet) Confined Aquifer and Thin (<15ft) Confining Unit
☐	☒	Deep Unconfined Aquifer:
☒	☐	Fractured Bedrock at Surface:
☐	☒	Aquifer Character unknown
☐	☒	Commingling of Aquifers Suspected
☐	☒	Nitrate-N 1-4.9 mg/L: Concentration: ....Date
☐	☒	Inorganic Chemical Detection (<50% of MCL)
☐	☒	Well Construction Deficiencies from Sanitary Survey:
☐	☒	Well Report Missing or unavailable
☐	☒	Casing Seal Unknown
☒	☐	Well Constructed prior to 1979
☐	☒	Other Wells Score > 400
☐	☒	Soil with TOT <65 hours in DWPA:
☐	☒	Infiltration Potential 4 to ☐ 7 (Not performed on TNCWS): 5
☐	☒	Surface water within 500 feet:

1. Note that it is possible for a single system to have criteria from both the high and moderately sensitive lists. Having a criterion checked 'yes' indicates that this characteristic contributes to the sensitivity at the indicated level.

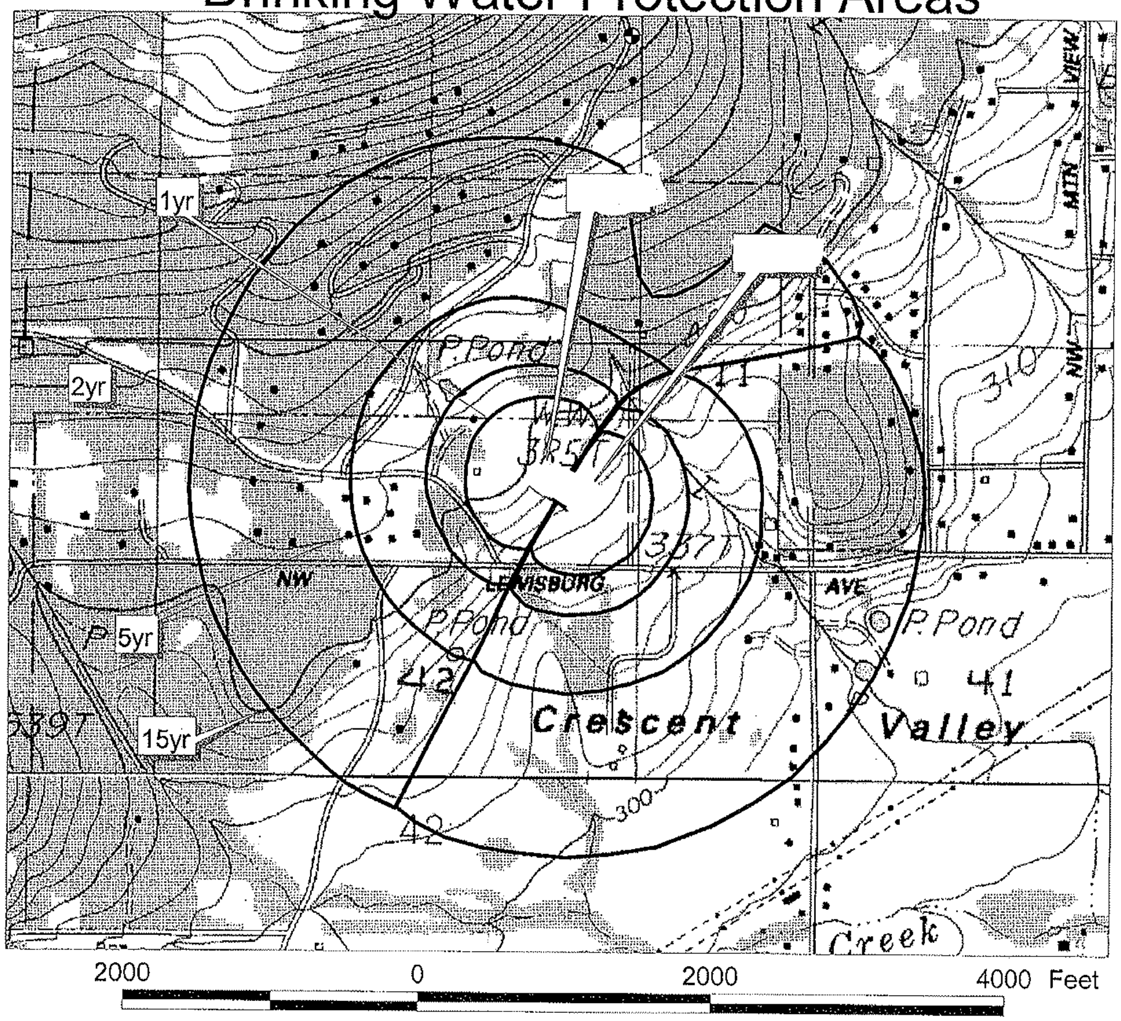
Additional Comments:

Sensitivity Analysis Completed by: Dennis Nelson **Date:** 02/28/01

50

Vineyard Mountain Water Drinking Water Protection Areas

Figure 1



Scale 1:12,000

Drinking Water Protection Area: elliptical zones from well outward represent the 1-, 2-, 5- and 15-year time-of-travel for groundwater to move through the aquifer to the well.
Delineation Method: Enhanced
Calculated fixed radius
Model parameters:
- Water use (g/day): Well 1: 36,600; Well 2: 33,300
- Thickness of water-bearing zone: 12 feet
- Effective porosity: 0.25

Aquifer character: Confined fractured volcanic (Siletz River Volcanics)

T11S R4W Section 11
USGS Arlie South 7.5-minute topographic map
Benton County

N

Prepared by Kim Swanson and
Dennis Nelson RG 1224
Drinking Water Program
Oregon Department of Human Services
July 27, 2001
PWS# 4100231

TABLE 2. INVENTORY RESULTS - LIST OF POTENTIAL CONTAMINANT SOURCES

PWS# 4100231 VINEYARD MOUNTAIN WATER

Reference No. (See Figure)	Potential Contaminant Source Type	Name	Approximate Location	City	Method for Listing	Proximity to Sensitive Areas	Relative Risk Level (1)	Potential Impacts	Comments
1	Wells/Abandoned Wells	Rural Homesteads	Throughout DWPA	Corvallis	Field-Observation	Within the 2-yr TOT.	Higher	Improperly installed or maintained wells and abandoned wells may provide a direct conduit for contamination to groundwater and drinking water source.	
	Homesteads - Rural - Septic Systems (< 1/acre)						Lower	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water. Use of drain cleaners and dumping household hazardous wastes can result in groundwater contamination.	
2	Boarding Stables	Hill Farm Stables	South of well 2	Corvallis	Field-Observation	Between 5-yr and 15-yr TOT	Moderate	Improper storage and management of animal wastes and wastewater in areas of concentrated livestock may impact drinking water.	
3	Utility Stations - Maintenance Transformer Storage	Substation	Southeast of well 2	Corvallis	Field-Observation	Outside DWPA	Higher	Spills, leaks, or improper handling of chemicals and other materials including PCBs during transportation, use, storage and disposal may impact the drinking water supply.	
4	Crops - Nonirrigated (inc. Christmas trees, grains, grass seed, pasture)	Non-irrigated crops	Throughout DWPA	Corvallis	Field-Observation	Between 5-yr and 15-yr TOT	Lower	Over-application or improper handling of pesticides/fertilizers may impact drinking water. Some agricultural practices may result in excess sediments discharging to surface waters, but non-irrigated crops are generally considered to be a low risk.	

Note: Sites and areas identified in this Table are only potential sources of contamination to the drinking water. Environmental contamination is not likely to occur when contaminants are used and managed properly.

(1) Where multiple potential contaminant sources exist at a site, the highest level of risk is used.

(2) See Table 3 for database listings (if necessary).

10/30/2001

Page 1 of 1

Appendix H

Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest

Executive Summary

The signatories of this statement seek to describe the state of scientific knowledge regarding likely impacts of climate change to the Pacific Northwest region. The intent is to assist Governor Kulongoski's Advisory Group on Global Warming in its task of developing a greenhouse gas emission reduction strategy for Oregon. The signatories agree that climate change is underway and that it is having global effects as well as impacts in the Pacific Northwest region. Climate-related changes to date, likely future changes, key questions to answer and research priorities are listed below.

Regional Climate Change Impacts in Recent Decades.
Temperature. Scientists are very certain that the Pacific Northwest is warming and that since 1975 the warming is best explained by human-caused changes in greenhouse gases.
Precipitation. Since the beginning of the 20th century, average annual precipitation has increased across the region by 10% with increases of 30–40% in eastern Washington and northern Idaho.
Sea Level. Land on the central and northern Oregon coast (from Florence to Astoria) is being submerged by rising sea level at an average rate of 0.06 – 0.08 inches (1.5–2 mm) annually, as inferred from data for the period 1930–1995.
Snowpack. Between 1950 and 2000, the April 1 snowpack declined. In the Cascades, the cumulative downward trend in snow-water equivalent is approximately 50% for the period 1950–1995. Timing of the peak snowpack has moved earlier in the year, increasing March streamflows and reducing June streamflows. Snowpack at low-to-mid elevations is the most sensitive to warming temperatures.

Regional Climate Change Projections over the Next 10-50 Years.
Temperature. Scientists have intermediate certainty that average temperatures in the Pacific Northwest will continue to increase in response to global climate change. Assessments suggest that the average warming will be approximately 2.7° F by 2030 and 5.4° F. by 2050. These projected increases are highly likely to result in a higher elevation treeline, longer growing seasons, longer fire seasons, earlier animal and plant breeding, longer and more intense allergy season and changes in vegetation zones.
Precipitation. Precipitation changes are very uncertain. The challenge will be to resolve scientific uncertainties about the interactions among atmosphere, land and ocean before significant climate change impacts occur. Oregon is expected to remain a wintertime-dominant precipitation regime (i.e., most precipitation will continue to occur in the winter). In addition, most precipitation will continue to occur in the mountains. Impacts on water resources due to low summer precipitation and earlier peak streamflow will likely include decreased summer water availability, changes in our ability to manage flood damage, shifts in hydropower

1

production from summer to winter, and decreased water quality due to higher temperatures, increased salinity and pollutant concentration.

Sea Level. Sea level is very certain to continue to rise although the impact will vary depending upon how fast the land is rising. In addition to increases in sea level, maximum wave heights will likely also increase, resulting in increasing erosion in coastal areas.

Snowpack. The April 1 snowpack will continue to decline corresponding to an earlier peak streamflow.

Marine Ecosystems. It is very certain that ocean circulation will continue to change in response to ocean-atmospheric processes. These changes suggest a likely increase in the magnitude and duration of upwelling, which will affect marine ecosystems. It is uncertain whether these changes will have adverse impacts such as more frequent occurrences of the low-oxygen ("dead zone") events seen in 2002 and 2004.

Terrestrial Ecosystems. The impact of changes in temperature and precipitation on terrestrial ecosystems is poorly known. Due to current biomass densities, the anticipated drier summers will likely increase drought stress and vulnerability of forests to insects, disease and fire.

Important Questions that could be Answered by Research.

What will be the trend and pattern of precipitation in the region?
What will be the patterns of coastal ocean winds?
What are the dynamics of large, decadal-scale patterns of ocean/atmosphere interactions?
Do thresholds exist for abrupt climate change and system shifts?
How will these patterns affect ecosystem patterns and resilience?
How will changes impact human health?
How will changes affect regional economic and social conditions?

Research Priorities

1. Improved and sustained observation of critical processes that can resolve interannual/decadal-scale variability.
2. Focused process experiments and studies of critical processes, such as impacts of increased CO_2 on forest dynamics.
3. Improved numerical and statistical models focused on coupled atmosphere/ocean/land processes that include ecological as well as geophysical dynamics.
4. Modeling and analysis of the effects of economics and management policies interannual/decadal-scale processes in the region.

Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest

History and Objective

This Consensus Statement was drafted by a subcommittee of participants in the scientific meeting "Impacts of Climate Change on the Pacific Northwest" convened at OSU on June 15, 2004. The statement has been reviewed and signed by XX meeting participants. The objective of the statement is to assist Governor Kulongoski's Advisory Group on Global Warming (GAGGW) by describing the state of scientific knowledge and uncertainty regarding climate change impacts in the Pacific Northwest. The GAGGW is charged with recommending strategies for reduction of greenhouse gas emission for the State of Oregon. For more information about the consensus process and participants, see Appendix A.

Global Effects of Climate Change

The signatories of this consensus statement agree with the scientific findings about climate change as reported in the Third Assessment Report of Working Group I of the Intergovernmental Panel on Climate Change (IPCC), published in 2001. The IPCC finds that

- over the last century, the global average surface temperature increased about 1° F, and
- sea level rose between 4 and 8 inches.

The IPCC predicts that if current trends continue, by 2100

- the global average temperature will increase 2.5–10.4° F and
- sea level will rise 4–35".

The IPCC report concludes that

> "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

An overview of these and other findings from the IPCC Third Assessment Report is attached in Appendix B.

Regional Impacts of Climate Change

Climate change is also affecting important parameters and processes on a regional scale. This Consensus Statement addresses the following key questions related to the impacts of climate change on the Pacific Northwest:

- What are the areas of consensus on the impacts of climate change on the Pacific Northwest based on scientific findings and observed changes?
- What are the projections for impacts of climate change on the Pacific Northwest over the next 10–50 years?
- What are the areas of uncertainty affecting our ability to understand and predict likely climate change?
- What are the most important questions to be answered in the next 5–10 years?
- What are the priorities for future research?

What are the areas of consensus on the impacts of climate change on the Pacific Northwest, based on scientific findings and observed changes?
Some major parameters and processes in the Pacific Northwest affected by climate change are described below. Areas of consensus on these topics, based on scientific findings and observed changes, were gathered and synthesized from a variety of sources, including the U.S. Global Change Research Program Report (USGCRP 2001), papers in peer-reviewed scientific publications, and scientific presentations and breakout group summaries from the June 2004 Impacts of Climate Change in the Pacific Northwest meeting at OSU.

Temperature
Scientists are very certain that the Pacific Northwest is warming. The USGCRP Report indicates that the annual average temperature has increased 1–3° F (0.6–1.7° C) over most of the region in the last century. Temperature change during this time is characterized by a steep rise from 1900 to 1940, a decline from 1940 to 1975, and a rise thereafter. Model simulations suggest that the earlier warming was largely due to natural causes, whereas the most recent warming is best explained by human-caused changes in greenhouse gases (Water Resources Breakout Group 2004). Since 1920, nearly every temperature monitoring station in the Pacific Northwest—both urban and rural—shows a warming trend (Mote 2003).

Precipitation
While there is little evidence of a consistent global warming signal for precipitation in the West since 1915, precipitation has increased modestly from 1916 to 1997 (Water Resources Breakout Group 2004). Since the beginning of the 20th century, the USGCRP Report indicates that annual precipitation has increased across the region by 10% on average, and the level of increase has reached 30–40% in eastern Washington and Northern Idaho.

Sea Level
During the period 1930–1995, land on the southern Oregon coast between Florence and Coos Bay has generally risen faster than worldwide changes in sea level by about 1 mm per year (Abbott 2004). However, the same data, which are based on geodetic leveling and tide-gauge records, indicate that land on the central and northern coast of Oregon (from Florence to Astoria) is being submerged by rising sea level at a rate of 1.5–2 mm per year.

Snowpack
From 1950 to 2000, warming temperatures across the West have diminished snowpacks. During this period, most monitoring stations in the Pacific Northwest show a decline in April 1 snowpack (or "snow water equivalent") (Miles 2004). In the Cascades, the cumulative downward trend in snow water equivalent is approximately 50%. Model simulations for the period 1950–1995 show that roughly half the reductions in the Cascades are due to warming trends, and half are due to downward trends in precipitation. Trends for the period 1916–1995 show smaller trends due to warming (a 20% decrease in 82 years) and little effect from precipitation (Water Resources Breakout Group 2004).

Simulations of snow-water equivalent from 1916–1997 show that the timing of peak snow accumulation and 90% snowmelt have both moved toward earlier calendar dates across the West (Water Resources Breakout Group 2004; Miles 2004). In sensitive areas like the Cascade, for example, the date of peak snowpack has shifted by as much as 40 days earlier in the year. These simulations are supported by studies of observed snowpack, along with observations of stream flow from 1950–2003 which show systematic reductions in April 1 snowpack and June flow, and increases in March flow, over much of the West (Water Resources Breakout Group 2004; Stewart et al. in review).

Snowpack at low-to-mid elevations is the most sensitive to warming temperatures. Watersheds in the Cascades have shown significant losses of summer water availability due to warming over the last 55 years. The fraction of annual streamflow from May to September in the Cedar River watershed, for example, has declined by 30% in 55 years (Miles 2004). These observed changes in streamflow are not explained by trends in precipitation.

Climate Variability at the Scale of Years to Decades
The USGCRP Report indicates that the climate of the Pacific Northwest shows significant recurrent patterns of year-to-year variability. Warm years tend to be relatively dry with low streamflow and light snowpack, which lead to summer water shortages, less abundant salmon, and increased probability of forest fires. Conversely, cool years tend to be relatively wet with high streamflow and heavy snowpack. Scientists conclude with high certainty that variations in Pacific Northwest climate show clear correlations with the large-scale ocean-atmosphere patterns associated with the El Nino/Southern Oscillation (ENSO) on scales of a few years (interannual) (Abbott 2004). Because of uncertainty about underlying dynamics and lack of predictability about other large-scale ocean-atmosphere patterns, such as the Pacific Decadal Oscillation (PDO), understanding the effects of such patterns on climate variability in the Pacific Northwest is problematic at present.

What are the projections for climate change and its impacts in the Pacific Northwest over the next 10-50 years?

Temperature
There is intermediate certainty that average temperatures in the Pacific Northwest will continue to increase in response to global climate change. The slope of the trend over the last 20 years should continue in the next few decades. The USGCRP Pacific Northwest assessment predicts that there will be average warming over the region of approximately 2.7° F (1.5° C) by 2030 and 5.4° F (3° C) by the 2050s. This change translates into a 0.18 to 0.9° F (0.1–0.5° C) increase per decade. However, the rate of increase may be even higher in the eastern portion of the region. The exact magnitude and rate of increase are difficult to predict, particularly beyond 50 years.

These projected temperature increases are highly likely to result in:
- An increase in elevation of the upper tree line,
- Longer growing seasons,
- Increased length of fire season,
- Earlier breeding by animals and plants,
- Longer and more intense allergy season, and
- Possible changes in vegetation zones.

Other changes, such as prevalence of insect infestations and expansion of woody vegetation, are less certain (Terrestrial Ecosystems Breakout Group 2004), in part because they are affected by additional factors such as precipitation and land use.

Precipitation

Changes in precipitation regimes are generally acknowledged to be very uncertain in comparison with the temperature changes described above. Existing models are unable to make consistent projections of precipitation on regional scales. Recent IPCC global climate model scenarios have suggested the likelihood of modest increases in winter precipitation and decreases in summer precipitation for the Pacific Northwest. These effects are broadly consistent with the expected consequences of an intensified hydrologic cycle at the global level.

Some current research, however, suggests that these scenarios could be wrong for the Pacific Northwest because other factors may influence the outcome. For example, systematic changes in global sea surface temperature patterns, or in other fundamental drivers of global atmospheric circulation, could create systematic changes in storm-track behavior (Water Resources Breakout Group 2004). Based on this hypothesis, the Pacific Northwest could conceivably become drier, despite an intensification of the hydrologic cycle on a global level. These alternate hypotheses underscore the current uncertainty even about the direction of trends (i.e., increasing or decreasing) in precipitation. Better understanding of the interactions among atmosphere, land, and ocean are critical to predicting changes to and patterns of precipitation. The challenge will be to resolve these scientific uncertainties before significant climate change impacts occur.

Regarding specific projections, Oregon now experiences most of its precipitation during winter, with the greatest precipitation occurring in the mountains. The expectation is that this pattern will continue, and that the greatest precipitation (in the form of snow) will remain at high elevations. Changes in cool-season (i.e., October–March) climate are, therefore, likely to have the greatest effect on river flow and water resources.

Due to relatively little precipitation in summer and an earlier summer streamflow recession associated with earlier snowmelt, intensified impacts on water resources likely will include:

- Increased summer water demand (because of population growth) coupled with decreased water availability due to warmer temperatures, systematic reductions in summer streamflow, and limited reservoir storage.

- Changed ability to mitigate flood damage (which could result from increased unpredictability associated with extreme weather events and streamflow forecasting) that may warrant reconsideration of current management schemes for storage reservoirs and flood protection to account for this altered flow regime.

- Increased winter flows (if precipitation remains the same or increases in winter) that enhancement hydropower production in winter months and reductions in summer streamflow that diminish hydropower production in summer months may challenge the current approach to hydropower production in the Columbia River (Water Resources Breakout Group 2004).

- Decreased summer water availability and late-summer flows that may further decrease the overall ability water of water regulators and users to meet instream flow targets using storage reservoirs, and intensify the conflict between winter hydropower production and summer water supply.

- Exacerbated water-quality issues, including increased water temperatures in lakes and rivers, increased salinity and pollutant concentration (because water withdrawals decrease water quantity and concentrate pollutants in remaining water), lower dissolved oxygen content with increasing temperature, increases in certain pathogens that thrive at higher temperatures, and changes in the ecosystem and food web—all of which would stress fish including salmon.

Sea Level
Sea level is very certain to continue to rise. The impacts of sea-level rise, however, will vary because of differences in tectonic processes throughout the Pacific Northwest. In some areas where tectonic processes exceed sea-level rise, land will rise faster than increased sea level. Where tectonic processes do not exceed sea-level rise, the region's shoreline will move landward. Maximum wave heights also will likely increase. This increase in wave height, in association with sea-level rise, has the potential to increase erosion in coastal areas.

Snowpack
It is highly certain that the April 1 snowpack will continue to decline in response to increasing global greenhouse-gas emissions. This decline in snowpack will correspond with an earlier peak runoff of snowmelt, and increased streamflows earlier in the year (see above).

Other effects of warmer temperatures on snowmelt hydrology have been well understood for decades, and the effects of global warming on Pacific Northwest rivers has been quantified in a number of published studies. In basins with significant snow accumulation in winter, warmer temperatures systematically reduce peak snow accumulation, producing more runoff in winter, earlier peak flows in spring, and reduced water availability in summer. Snowpack at high elevations is generally less sensitive to temperature changes and more sensitive to precipitation changes. Thus, at high elevations, snowpack could increase if winter precipitation increases over time. However, even if there is an increase in snowfall at high elevations, the area covered by high elevations is small relative to the area of an entire river basin and consequently the total snow pack in a river basin typically declines if temperatures rise (even if precipitation increases by a modest amount).

Marine Ecosystems
It is very certain that ocean circulation will continue to change in response to ocean-atmospheric processes occurring at the scale of years to decades (see discussion of ENSO and PDO above). These changes in ocean circulation include the intensity and character of upwelling winds, as well as changes in freshwater input (Water Resources Breakout Group 2004). While the patterns of these variations and their impacts on marine ecosystems (e.g., persistent changes in ecosystem structure, directional changes in productivity, etc.) are unknown, paleological records and quantified physical dynamics help to shed light on potential projections. Paleo-records suggest

that over long time scales, warm regimes are associated with strong upwelling. It also is known that a warmer continent results in stronger equator-ward winds that fuel upwelling. In combination, these two trends suggest a likely increase in the magnitude and duration of upwelling along the Pacific Northwest coast (Water Resources Breakout Group 2004).

The emergence of a mass of hypoxic (low oxygen) water (a so-called "dead zone") appearing off the central coast of Oregon in 2002 and 2004 may signal an unanticipated consequence of climate change mediated through changes in ocean circulation.

Projections about climate change in the region also indicate the potential for:

- Influx of seawater into estuaries and lower reaches of rivers due to sea-level rise,
- An earlier influx of freshwater into estuarine and coastal areas,
- Greater seasonal variation, and
- Increased stress on estuarine and nearshore species that are physiologically adapted to particular patterns in physical characteristics of their habitats (e.g., salinity).

Terrestrial Ecosystems

Changes in temperature and precipitation patterns are likely, but the manner in which these changes will affect the terrestrial ecosystems of the Pacific Northwest is poorly known. Likely impacts include shifts in species composition and timing of the growing season, but the details are unpredictable. For example, temperature changes and loss of snowpack are expected to affect forests, particularly those in southwest, central, and eastern Oregon that rely on snowpack for water. Given current biomass densities, the anticipated drier summers will increase drought stress and vulnerability of forests to insects and diseases, and may ultimately lead to widespread fires that may systematically alter the hydrologic response in river basins over time.

What are the greatest areas of uncertainty affecting our ability to understand and predict likely climate change in the Pacific Northwest?

Shifts in regional-scale climate forcing, such as precipitation and winds, are the fundamental processes that affect ecosystems. We have little certainty in the projections about these key processes for the Pacific Northwest, and their effects on outcomes such as extreme events (e.g., flooding and large fires). The next level of uncertainty is the response of marine and terrestrial ecosystems to changes in the patterns of variability as well as long-term trends. Lastly, shifts in management practices, urban development, and other human activities will be convolved with changes in the natural environment and will impact ecosystems.

What are the most important questions to be answered in the next 5-10 years?

- What will be the trend and pattern of precipitation in the Pacific Northwest?
- What will be the patterns of coastal ocean winds and associated upwelling events?
- What are the dynamics of large, decadal-scale patterns of ocean/atmosphere interactions?
- Do thresholds exist for abrupt climate change and system shifts?
- How will the aforementioned patterns affect ecosystem patterns and resilience (including the maintenance of processes and patterns in the face of variability)?

What are the priorities for future research?
The priorities should be based on answering the four questions listed above. To accomplish this, we need to invest in four areas of research.

1. Improved and sustained observations of critical processes that can resolve interannual/decadal-scale variability. These observing systems should be focused on both physical and biological variables, and should be of sufficient quality to resolve local, small-scale processes relative to climate signals.
2. Focused process experiments and studies of critical processes, such as the impacts of increased CO_2 on forest dynamics and the impact of changes in the upwelling regime on coastal marine ecosystems and fisheries.
3. Improved numerical and statistical models focused on coupled atmosphere/ocean/land processes that include ecological as well as geophysical dynamics. Particular emphasis should be on developing regional-scale projections. Close interaction between modeling and analysis and the observing programs should be ensured.
4. Modeling and analysis of the effects of economic and management policies interannual/decadal-scale processes in the Pacific Northwest. This could include forest management, land use changes, fishery management, coastal zone management and water policy.

Appendix A – Consensus Process and Participants

On June 15, 2004, a symposium entitled "Impacts of Climate Change on the Pacific Northwest" was held to provide invited Oregon and Washington-based scientists an opportunity to: 1) share knowledge concerning the present status of global climate change research and regional greenhouse gas emission reduction strategies, 2) share findings on scenarios for climate change and possible impacts in the Pacific Northwest, and 3) identify areas of consensus and uncertainty. Sixty-five people attended the meeting. Participants were primarily scientists working in a variety of fields related to climate change in the Pacific Northwest, such as oceanography, forest ecology, forest economics, agriculture and resource economics, hydrology, paleoclimatology, marine ecology, fisheries biology, estuarine ecology, population biology, geography, ornithology, climatology, and meteorology. Attendees also included a diversity of observers, such as members of the Advisory Group and agency staff providing technical support to the Advisory Group, media, and other individuals working on issues related to climate change policy.

Pre-meeting questionnaires were distributed to participants. Four experts presented overview of scientific understanding in key areas. Responses to the pre-meeting questionnaires, the slideshow presentations, extended abstracts of the presentations, and summaries of four breakout group sessions (terrestrial ecosystems, marine ecosystems, water resources, and the Pacific Northwest as a system) are available as part of the meeting proceedings online at http://inr.oregonstate.edu/policy/climate-change.html.

This Consensus Statement, drafted by a subcommittee of participants and circulated to other participants for review and sign-on, is also part of the proceedings. The statement is signed by 46 Ph.D.-level scientists with expertise on the impacts of climate change in the Pacific Northwest. Names of the signatories appear below.

10

Peter Clark, Professor
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U of O/Political Science

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Alan Mix, Professor
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Richard Hildreth, Director
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Mark Hixon, Professor
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David Turner, Assoc. Professor
OSU/College of Forestry

Dave Lytle, Professor
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Richard Vong, Professor
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Jane Lubchenco, Professor
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Eban Goodstein, Professor of Economics
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Larry Mahrt, Prof. Emeritus
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Kelly Falkner, Professor
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11

Mark Abbot, Dean OSU/College of Oceanic & Atmospheric Sciences	Beverly Law, Assoc. Professor OSU/Dept of Forest Resources
John Barth, Professor OSU/College of Oceanic & Atmospheric Sciences	Nathan Mantua, Professor U of W/Dept of Atmospheric Sciences
Patrick Bartlein, Professor U of O/Dept of Geography	Edward Miles, Professor U of W/School of Marine Affairs
Sherm Bloomer, Dean OSU/College of Science	Philip Mote, Professor U of W/Dept of Atmospheric Sciences
James A. Coakley, Jr. Professor OSU/College of Oceanic and Atmospheric Sciences	Ron Neilson, Professor OSU/Dept of Forest Science
Stella Melugin Coakley, Assoc. Dean OSU/College of Ag Sciences	Roger M. Samelson, Professor OSU/College of Oceanic and Atmospheric Sciences
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12

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13

Appendix B – Overview of Findings from the Third Assessment Report of the Intergovernmental Panel on Climate Change

(Excerpted from *Climate Change 2001: Synthesis Report – Summary for Policymakers, an Assessment of the Intergovernmental Panel on Climate Change*. This summary, approved in detail at IPCC Plenary XVIII (Wembley, United Kingdom, 24-29 September 2001), represents the formally agreed statement of the IPCC concerning key findings and uncertainties contained in the Working Group contributions to the Third Assessment Report.)

Table SPM-1 20th century changes in the Earth's atmosphere, climate, and biophysical system.[a]

Indicator	*Observed Changes*
Concentration indicators	
Atmospheric concentration of CO_2	280 ppm for the period 1000–1750 to 368 ppm in year 2000 (31±4% increase).
Terrestrial biospheric CO_2 exchange	Cumulative source of about 30 Gt C between the years 1800 and 2000; but during the 1990s, a net sink of about 14±7 Gt C.
Atmospheric concentration of CH_4	700 ppb for the period 1000–1750 to 1,750 ppb in year 2000 (151±25% increase).
Atmospheric concentration of N_2O	270 ppb for the period 1000–1750 to 316 ppb in year 2000 (17±5% increase).
Tropospheric concentration of O_3	Increased by 35±15% from the years 1750 to 2000, varies with region.
Stratospheric concentration of O_3	Decreased over the years 1970 to 2000, varies with altitude and latitude.
Atmospheric concentrations of HFCs, PFCs, and SF_6	Increased globally over the last 50 years.
Weather indicators	
Global mean surface temperature	Increased by 0.6±0.2°C over the 20th century; land areas warmed more than the oceans (*very likely*).
Northern Hemisphere surface temperature	Increase over the 20th century greater than during any other century in the last 1,000 years; 1990s warmest decade of the millennium (*likely*).
Diurnal surface temperature range	Decreased over the years 1950 to 2000 over land: nighttime minimum temperatures increased at twice the rate of daytime maximum temperatures (*likely*).
Hot days / heat index	Increased (*likely*).
Cold / frost days	Decreased for nearly all land areas during the 20th century (*very likely*).
Continental precipitation	Increased by 5–10% over the 20th century in the Northern Hemisphere (*very likely*), although decreased in some regions (e.g., north and west Africa and parts of the Mediterranean).
Heavy precipitation events	Increased at mid- and high northern latitudes (*likely*).
Frequency and severity of drought	Increased summer drying and associated incidence of drought in a few areas (*likely*). In some regions, such as parts of Asia and Africa, the frequency and intensity of droughts have been observed to increase in recent decades.

Box SPM-1 Confidence and likelihood statements.

Where appropriate, the authors of the Third Assessment Report assigned confidence levels that represent their collective judgment in the validity of a conclusion based on observational evidence, modeling results, and theory that they have examined. The following words have been used throughout the text of the Synthesis Report to the TAR relating to WGI findings: *virtually certain* (greater than 99% chance that a result is true); *very likely* (90–99% chance); *likely* (66–90% chance); *medium likelihood* (33–66% chance); *unlikely* (10–33% chance); *very unlikely* (1–10% chance); and *exceptionally unlikely* (less than 1% chance). An explicit uncertainty range (±) is a *likely* range. Estimates of confidence relating to WGII findings are: *very high* (95% or greater), *high* (67–95%), *medium* (33–67%), *low* (5–33%), and *very low* (5% or less). No confidence levels were assigned in WGIII.

15

Appendix I All tables documenting forecasted city populations and water use

Benton County Forecasted City- Residential (Population only) Water Demands to Year 2050

Benton County Water Demand Forecast using AAGR +1% of Cities

	2000		2007		2020		2025		2030		2035		2040		2045		2050	
Demands:	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Adair Village (MGD)	0.4	0.2	0.7	0.3	1.2	0.6	1.5	0.8	2.0	1.0	2.6	1.3	3.4	1.7	4.4	2.2	5.7	2.8
(CFS)	0.6	0.3	1.0	0.5	1.8	0.9	2.4	1.2	3.1	1.5	4.0	2.0	5.2	2.6	6.7	3.4	8.8	4.4
Corvallis (MGD)	7.1	3.6	7.9	4.0	10.2	5.1	11.3	5.7	12.6	6.3	14.0	7.0	15.6	7.8	17.3	8.7	19.2	9.6
(CFS)	11.0	5.5	12.2	6.1	15.7	7.9	17.5	8.7	19.5	9.7	21.6	10.8	24.0	12.0	26.7	13.4	29.7	14.8
Monroe (MGD)	0.4	0.2	0.4	0.2	0.6	0.3	0.7	0.4	0.9	0.4	1.1	0.5	1.3	0.6	1.6	0.8	1.9	1.0
(CFS)	0.6	0.3	0.6	0.3	0.9	0.4	1.1	0.5	1.3	0.7	1.6	0.8	2.0	1.0	2.4	1.2	2.9	1.5
North Albany (MGD)	1.4	0.7	1.8	0.9	2.3	1.2	2.6	1.3	2.9	1.5	3.3	1.6	3.6	1.8	4.1	2.0	4.5	2.3
(CFS)	2.1	1.1	2.8	1.4	3.6	1.8	4.0	2.0	4.5	2.2	5.0	2.5	5.6	2.8	6.3	3.1	7.0	3.5
Philomath (MGD)	0.9	0.5	1.1	0.6	1.3	0.6	1.3	0.7	1.4	0.7	1.5	0.7	1.6	0.8	1.6	0.8	1.7	0.9
(CFS)	1.5	0.7	1.7	0.9	1.9	1.0	2.1	1.0	2.2	1.1	2.3	1.1	2.4	1.2	2.5	1.3	2.7	1.3
Total mgd	10.2	5.1	11.8	5.9	15.6	7.8	17.5	8.8	19.8	9.9	22.4	11.2	25.4	12.7	28.9	14.5	33.1	16.5
Total cfs	15.7	7.9	18.3	9.1	24.0	12.0	27.0	13.5	30.5	15.3	34.5	17.3	39.2	19.6	44.6	22.3	51.1	25.5

Note: All figures are rounded estimates

Benton County Water Demand Forecast using AAGR of Cities

	2000		2007		2020		2025		2030		2035		2040		2045		2050	
Demands:	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Adair Village (MGD)	0.4	0.2	0.7	0.3	1.1	0.4	1.4	0.4	1.7	0.5	2.1	0.5	2.7	0.6	3.3	0.6	4.2	0.7
(CFS)	0.6	0.3	1.0	0.5	1.7	0.6	2.1	0.7	2.6	0.7	3.3	0.8	4.1	0.9	5.1	0.9	6.4	1.0
Corvallis (MGD)	7.1	3.6	7.9	4.0	9.2	5.1	9.7	5.6	10.3	6.3	11.0	7.0	11.6	7.7	12.4	8.6	13.1	9.5
(CFS)	11.0	5.5	12.2	6.1	14.2	7.8	15.0	8.7	15.9	9.7	16.9	10.7	18.0	11.9	19.1	13.2	20.2	14.7
Monroe (MGD)	0.4	0.2	0.4	0.2	0.5	0.2	0.6	0.2	0.6	0.2	0.6	0.2	0.6	0.3	0.6	0.3	0.6	0.3
(CFS)	0.6	0.3	0.6	0.3	0.8	0.3	1.0	0.3	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4
North Albany (MGD)	1.4	0.7	1.8	0.9	2.1	0.9	2.2	0.9	2.4	0.9	2.6	0.9	2.7	0.9	2.9	0.9	3.1	0.9
(CFS)	2.1	1.1	2.8	1.4	3.2	1.4	3.5	1.4	3.7	1.4	3.9	1.4	4.2	1.4	4.5	1.4	4.8	1.4
Philomath (MGD)	0.9	0.5	1.1	0.6	1.4	0.7	1.8	0.9	2.4	1.2	3.0	1.5	3.9	2.0	5.0	2.5	6.5	3.2
(CFS)	1.5	0.7	1.7	0.9	2.2	1.1	2.8	1.4	3.6	1.8	4.7	2.3	6.0	3.0	7.8	3.9	10.0	5.0
Total mgd	10.2	5.1	11.8	5.9	14.3	7.3	15.8	8.1	17.4	9.0	19.3	10.1	21.6	11.4	24.2	12.8	27.5	14.6
Total cfs	15.7	7.9	18.3	9.1	22.1	11.3	24.4	12.5	26.9	14.0	29.8	15.6	33.3	17.6	37.4	19.8	42.4	22.5

Note: All figures are rounded estimates

Appendix I (continued)
All tables documenting forecasted total City water use to year 2050

Benton County Water Demand Forecast using Historic AAGR of Cities

		2000		2007		2020		2025		2030		2035		2040		2045		2050	
Demands:		High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Adair Village	(MGD)	0.4	0.2	0.7	0.3	0.8	0.4	0.9	0.5	1.0	0.5	1.0	0.5	1.1	0.6	1.2	0.6	1.3	0.7
	(CFS)	0.6	0.3	1.0	0.5	1.2	0.6	1.4	0.7	1.5	0.8	1.5	0.8	1.7	0.8	1.9	0.9	2.0	1.0
Corvallis	(MGD)	7.1	3.6	7.9	4.0	10.2	5.1	11.3	5.7	12.5	6.3	13.9	7.0	15.4	7.7	17.1	8.6	19.0	9.5
	(CFS)	11.0	5.5	12.2	6.1	15.7	7.9	17.4	8.7	19.3	9.6	21.5	10.7	23.8	11.9	26.4	13.2	29.3	14.7
Monroe	(MGD)	0.4	0.2	0.4	0.2	0.4	0.2	0.4	0.2	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.6	0.3
	(CFS)	0.6	0.3	0.6	0.3	0.6	0.3	0.6	0.3	0.8	0.4	0.8	0.4	0.8	0.4	0.8	0.4	0.9	0.5
North Albany	(MGD)	1.4	0.7	1.8	0.9	1.8	0.9	3.1	1.6	3.7	1.9	4.3	2.2	5.1	2.6	6.0	3.0	7.1	3.6
	(CFS)	2.1	1.1	2.8	1.4	2.8	1.4	4.8	2.4	5.7	2.9	6.6	3.3	7.9	3.9	9.3	4.6	11.0	5.5
Philomath	(MGD)	0.9	0.5	1.1	0.6	1.4	0.7	1.8	0.9	2.4	1.2	3.0	1.5	3.9	2.0	5.0	2.5	6.5	3.3
	(CFS)	1.5	0.7	1.7	0.9	2.2	1.1	2.8	1.4	3.7	1.9	4.6	2.3	6.0	3.0	7.7	3.9	10.0	5.0
Total mgd		10.2	5.1	11.8	5.9	14.6	7.3	17.5	8.8	20.1	10.1	22.7	11.4	26.0	13.0	29.8	14.9	34.5	17.3
Total cfs		15.7	7.9	18.3	9.1	22.5	11.3	27.0	13.5	31.0	15.5	35.0	17.5	40.1	20.1	46.0	23.0	53.3	26.6

Benton County Cities- Total Water Demand Forecast

		2000		2007		2020		2025		2030		2035		2040		2045		2050	
Demands:		High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Adair Village	(MGD)	0.6	0.3	1.0	0.5	1.8	0.9	2.1	1.0	2.4	1.2	2.7	1.3	3.0	1.5	3.3	1.6	3.6	1.8
	(CFS)	0.9	0.5	1.6	0.8	2.8	1.4	3.2	1.6	3.7	1.8	4.1	2.1	4.6	2.3	5.1	2.5	5.5	2.8
Corvallis	(MGD)	11.2	5.6	16.2	8.1	25.5	12.8	29.1	14.5	32.7	16.3	36.3	18.2	39.8	19.9	43.4	21.7	47.0	23.5
	(CFS)	17.2	8.6	25.0	12.5	39.4	19.7	44.9	22.5	50.4	25.2	56.0	28.0	61.5	30.8	67.0	33.5	72.6	36.3
Monroe	(MGD)	0.4	0.2	0.4	0.2	0.5	0.3	0.6	0.3	0.7	0.3	0.7	0.4	0.8	0.4	0.9	0.4	1.0	0.5
	(CFS)	0.6	0.3	0.6	0.3	0.8	0.4	0.9	0.4	1.0	0.5	1.1	0.6	1.2	0.6	1.4	0.7	1.6	0.8
North Albany	(MGD)	1.4	0.7	1.8	0.9	2.1	1.0	2.7	1.3	3.0	1.5	3.4	1.7	3.8	1.9	4.3	2.2	4.9	2.5
	(CFS)	2.1	1.1	2.8	1.4	3.2	1.6	4.1	2.0	4.6	2.3	5.2	2.6	5.9	2.9	6.7	3.3	7.6	3.8
Philomath	(MGD)	1.0	0.5	3.2	1.6	7.4	3.7	9.0	4.5	10.6	5.3	12.2	6.1	13.8	6.9	15.4	7.7	17.0	8.5
	(CFS)	1.5	0.8	5.0	2.5	11.4	5.7	13.9	6.9	16.3	8.2	18.8	9.4	21.3	10.6	23.7	11.9	26.2	13.1
Total mgd		14.5	7.2	22.6	11.3	37.2	18.6	43.4	21.7	49.3	24.6	55.3	27.6	61.2	30.6	67.3	33.7	73.6	36.8
Total cfs		22.3	11.2	34.8	17.4	57.5	28.7	67.0	33.5	76.1	38.0	85.3	42.6	94.5	47.3	103.9	51.9	113.5	56.8

	Demand Multipliers	
City	**High (MDD)**	**Low (ADD)**
Adair Village	0.000731	0.000366
Corvallis	0.000144	0.000072
Monroe	0.000587	0.000294
North Albany	0.000271	0.000136
Philomath	0.000245	0.000123

Appendix J
Buildable Lands Estimate Methodology

<u>**Methods for Phase 1 Water Project Buildable Lands Estimate**</u>

The “parcels” that have been considered are tax lots outside of cities that are zoned for any types of residential, industrial or commercial use.

The following buildable lands assumptions are similar to those that were used for the **City of Corvallis Buildable Land Report for 2002**:

For residential parcels:
Vacant = improvement value of < $5000
Developed = improvement value > $25000
Can be redeveloped = improvement value between $5000 and $25000

The estimation looks at development within urban growth boundaries as potentially occurring at the density for which they are currently zoned.

For industrial and commercial parcels:
Vacant = ratio of improvement value to land value = 0
Developed = ratio of improvement value to land value > 0.25
Can be redeveloped = improvement to land value ratio between 0 and 0.25

<u>Property class codes</u> used for assessment purposes also provided an indication of whether the land is developed or not. <u>Aerial photographs</u> were also referenced to determine the state of development, where the assessed improvement value and property class codes indicated conflicting land use information.

The following assumptions were used in developing the buildable lands estimate.

No development will occur on public and other designated lands, including:
City, county and state government lands for:
Benton County
City of Corvallis
City of Adair Village
City of Monroe
City of Philomath
Oregon State Dept Transport
Oregon State Forestry Board

Schools:
Alsea School Dist 7J
Corvallis School Dist 509J
School District #9

School District #7
School District 26C
Oregon State University
Oregon State Board Higher Ed

Churches and cemeteries:
Assemblies of God Church
Bellfountain Community Church
Blodgett Community Church
Church of God
Palestine Church Cemetery
St Rose of Lima Catholic Church
Alpine Cemetery

Others:
Alsea Rural Health Care Inc
Green Belt Land Trust
Good Samaritan Hospital

Additionally the following assumptions were formed with aid from Benton County Community Development Director and Water Project Committee members, to determine buildout of currently zoned residential areas:

1.) Parcels will not be divided to the maximum density allowed by the zoning. The analysis assumes that residential parcels can be divided at a density that is two-thirds of the maximum allowable. For example, a 10 acre parcel will most likely not produce five 2-acre lots because of the difficulties of siting a house, septic, well, etc. and comply with Federal, State, and County land use regulations. The analysis assumes that 2/3 of each residential parcel (or 66%) can be developed and residential parcels smaller than 10,000 square feet cannot be developed.

2.) Not all parcels can be developed, for various reasons (for example, they are too small or not well suited to fit the necessary facilities.)

Appendix K

Final Benton County Water Project *Phase 1* Questionnaire

Benton County Oregon Water Project **Questionnaire**

1.) What Area of Benton County do you live in?

Kings Valley/Hoskins Area__
Philomath Area__
Summit/Blodgett Area__
Wren Area__
Adair/North Albany Area_
Corvallis/Lewisburg Area__
Monroe Area__
Alpine/Bell Fountain Area__
Alsea Area__

2.) What is your Water User Type

Residential__
Agriculture__
Forestry__
Industrial/Commercial__
Other:______________________

3.) What is your Water Supply Source or Sources:
City__
Community Well__
Private Well__
Surface Water__
Springs__
I'm not sure__
Other:_____________________

4.) Does your community have access to a reliable source of water now in year 2008? Choose One.

YES NO Don't know

5.) Do you believe your community will have access to a reliable source of water in the Future? Choose One

YES NO Don't know

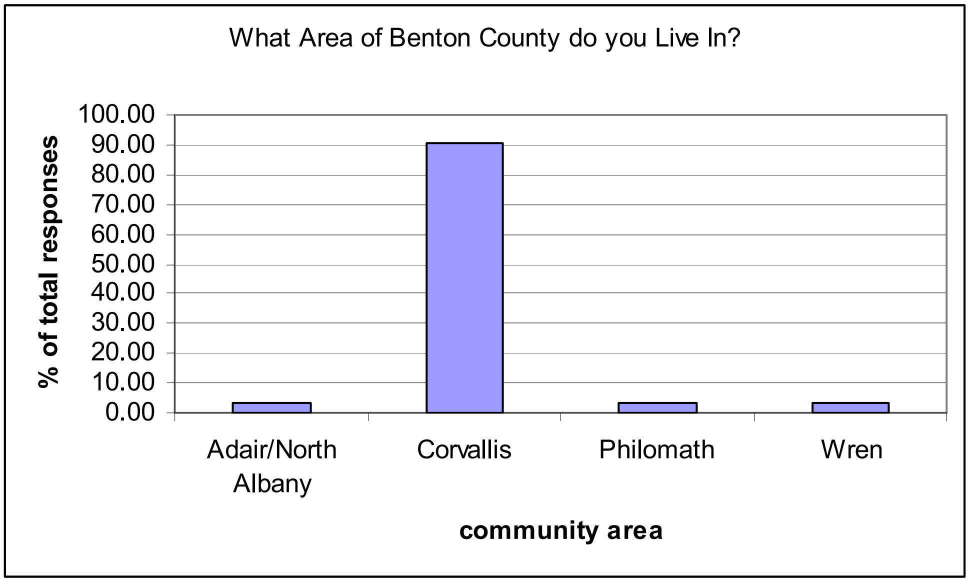
6.) What are your biggest concerns about water in Benton County over the next twenty years? **Check all that apply**

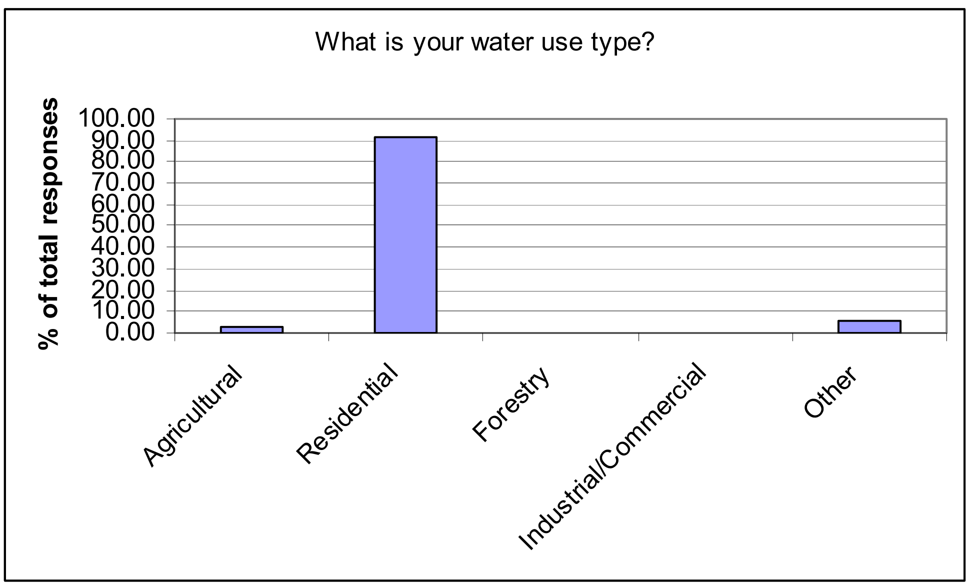
__ Cost of water
__ Clean Drinking Water
__ Industrial/Commercial Water Supply
__ Water Recreation
__ Agriculture
__ Fish and Aquatic Life

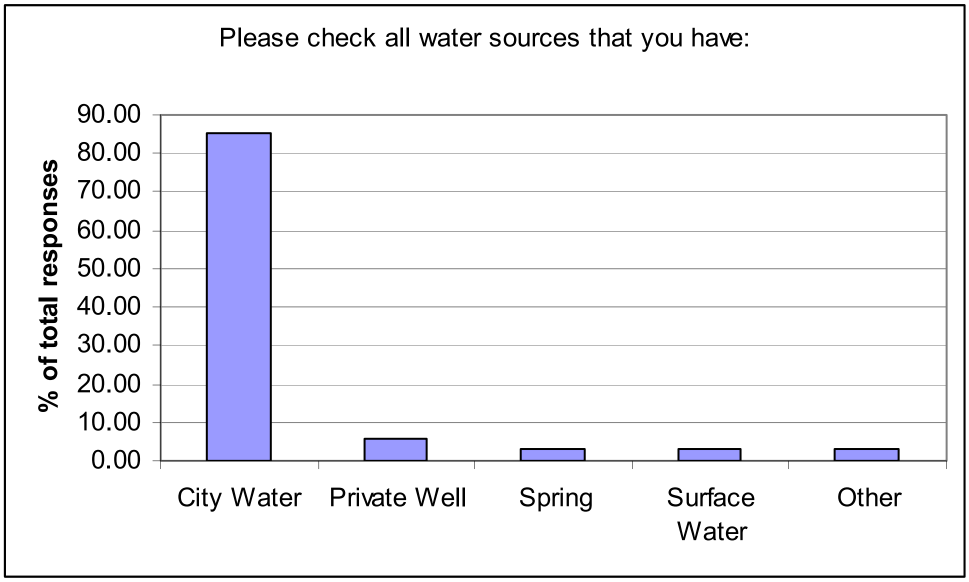
7.) Is there anything else you'd like to tell us about your water related concerns?

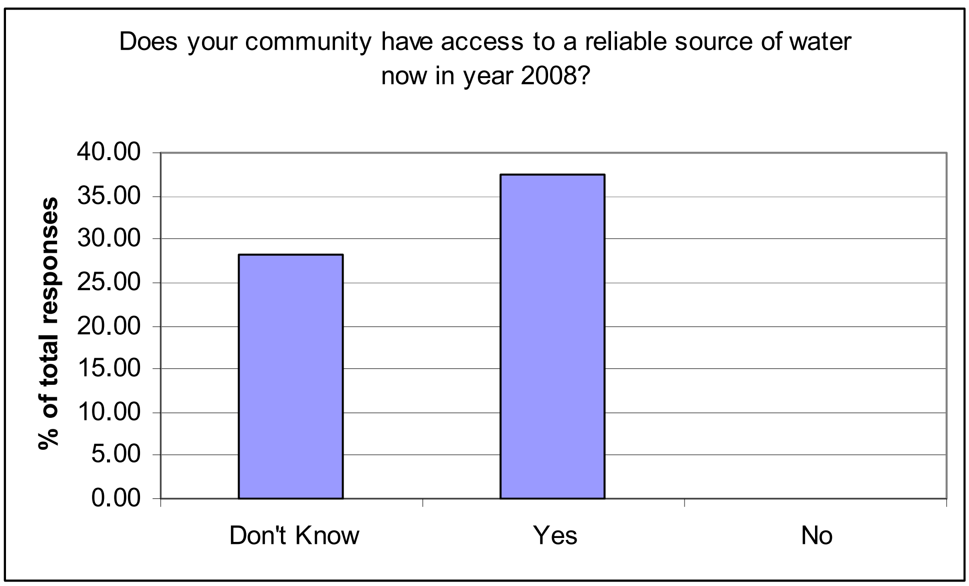
8.) How might we make this Benton County Water Project beneficial to your community?

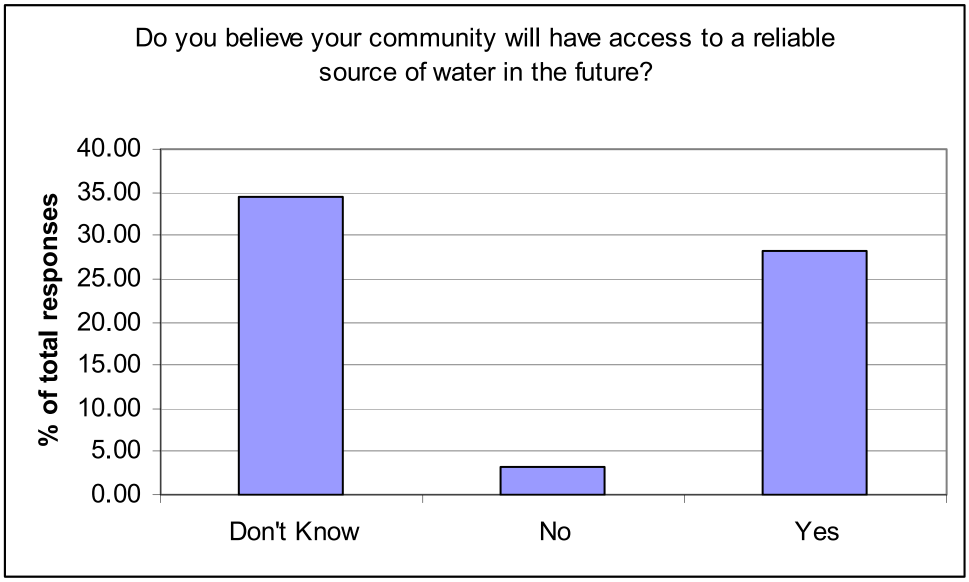
Appendix L
Online Questionnaire Responses

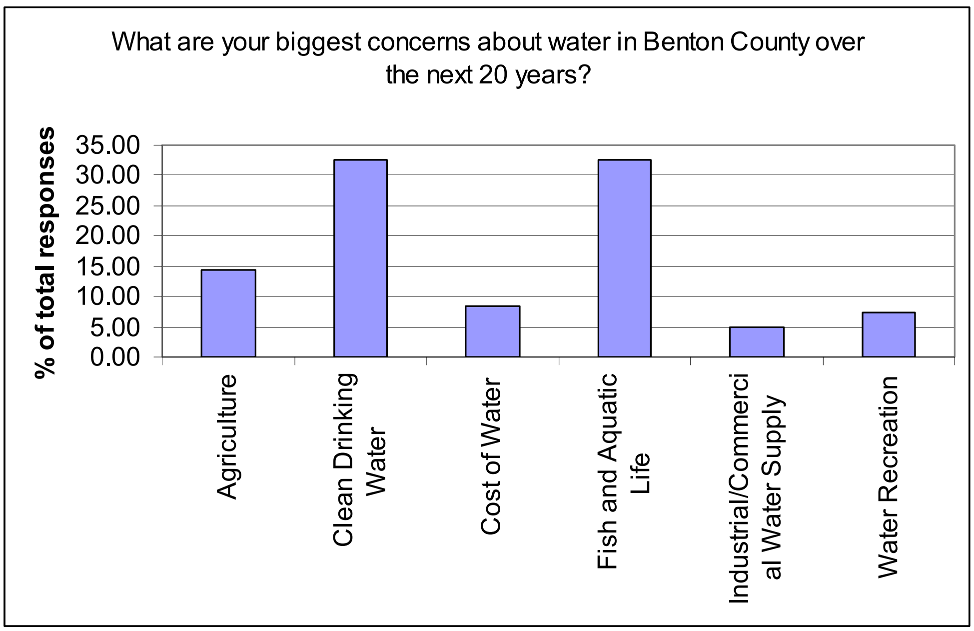





Please check all water sources that you have:
% of total responses
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
City Water
Private Well
Spring
Surface Water
Other


Does your community have access to a reliable source of water now in year 2008?
% of total responses
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Don't Know
Yes
No


Do you believe your community will have access to a reliable source of water in the future?
% of total responses
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Don't Know
No
Yes


What are your biggest concerns about water in Benton County over the next 20 years?
% of total responses
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Agriculture
Clean Drinking Water
Cost of Water
Fish and Aquatic Life
Industrial/Commercial Water Supply
Water Recreation

Is there anything else you'd like to tell us about your water related concerns?

'I would like to divert storm water runoff from the sewage treatment plant through rainwater catchment and rain gardens. I would like to reduce the amount of chlorine in city drinking water. I would like to reduce the amount of purified water that is used for irrigation and flushing toilets.'

'As climate change impacts our supply, I want to make sure there is adequate water for residential, aquatic life, and sustainable agricultural uses.'

'I am unsure of future water access, but do have some worries about how we supply water to a growing population while maintaining protection for fish and wildlife, and how climate change will affect this.'

'I'm concerned about global climate change and how reduced snowpack might impact the availability of freshwater in the Willamette Valley (for humans, wildlife, and agriculture).'

'Important issues for me are that we protect our surface water and ground water supplies from contamination. Source of contamination might be from industrial discharge to streams and rivers; inadequate treatment of sewage effluents from treatment plants or failing septic systems; and improper application of fertilizer and pesticides in commercial agricultural operations.'

'Better start having a discussion about water rights, and seasonal limitations to water supplies. Still may county residents no of no restriction from taking water from streams, even commercial users!! We should be all starting from the sam Chapter.'

'Need to promote and instill a program aimed at the use of recycled/reclaimed water.'

'With global warming causing a change in the precipitation patterns, I'm concerned that our current water plans are inadequate as they were built on a past history of very different precipitation patterns through the year.'

I have a well-head in my backyard, and would like to find out about getting a pump and finding the history of the well, since it is not hooked up at this time.
Thanks,
Jana Seeliger

'The pollution in Willamette is a disgrace and worse than ever. I fear for the wildlife and recreational users. We have enough know how of how to clean it up and keep it that way.'

'I am somewhat concerned over pharmaceuticals and other preventable pollutants that enter our water; increasing public awareness of their own role in keeping water clean would be a valuable effort'

'In the last question: My biggest concern is the supply of ground water with increasind domestic use by neighboring homes.'

groundwater mining, nitrate pollution, inappropriately abandoned wells

'I would very much like to see the restoration of municipal waterways (e.g. Dixon Creek in Corvallis) and inclusion of multi-use paths along these corridors. This would have the obvious ecological benefits, but would help connect residents directly with their watershed.'

'I strongly oppose adding anything to our water, along the lines of fluoride or other "beneficial" additives. We should be drinking plain water. There are other ways to get low-income families access to vitamins and minerals. There could also be harmful consequences of fluoride in water not yet known and could cause major health related problems in the future.'

Quantity and Quality of Surface AND Ground Water Unsustainable Growth/Too High Percentage Impervious Surfaces'

How might we make this Benton County Water Project beneficial to your community?

'Continue taking public input, provide information on progress of plan to the public, and take more input. Keep going. Work on developing a plan which minimizes inputs of energy for the drinking water systems.'

'Assess how freshwater is currently being used, and how we might all protect and conserve it (using less, using graywater, etc.)'

'Please drop the presumption that the county human population will increase, and that we have no means of limiting that. This presumption is anathema to long-term planning.'

'Create a forum for the education of citizens regarding the water challenges the county is facing, time frames, projected costs, and possible projects.'

'Get people to understand that water in the Northwest is not an infinite resource that we've historically had. People are going to have to start using water wisely and not just city people but farmers as well. It's a sad thing that the greatest polluters we have in the northwest (by total poundage of pollution in our waterways) are the farmers who are trying to be stewards of the land.'

'clean up our waterways. No more pollution allowed to be dumped in our rivers.'

'ensure continued sustainability of local farms'

'Are there maps of ground water distribution in Benton Co. based upon well logs?'

'put meters on domestic wells'

'Ensure that Benton County has clean water and healthy watersheds into the future.'