Statewide Groundwater Quality Monitoring Program

2011 Rogue Basin Groundwater Investigation

State of Oregon Department of Environmental Quality

Submitted to:

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Executive Summary

Background

Jackson County is the 6th most populous county in Oregon with 203,206 residents as of the 2010 census, with 62,516 residents (31%) living in unincorporated areas. Many of the people living in unincorporated areas are dependent on groundwater wells for their drinking water supply, although there are small public water systems in mobile home and other housing developments in some places and some residents obtain water from surface water sources. Jackson and Josephine Counties have some of the highest unincorporated populations in the state of Oregon. The USGS reports that over 50% of Jackson County's population relies on well water for their drinking water supply (http://pubs.usgs.gov/sir/2008/5227.html). Several studies have been conducted to evaluate groundwater quality conditions in the Rogue Basin including USGS studies in the 1970s, DEQ studies in the 1990s, and a Jackson County effort in the 1990s. Oregon Health Authority collects Real Estate Transaction data for nitrate, bacteria and arsenic in groundwater.

Project Goals

The goals of this groundwater quality investigation were to:

- Update the DEQ statewide database regarding nitrate concentrations in this basin and determine if levels are rising or falling since previously sampled.
- Investigate the distribution of naturally occurring fluoride, arsenic, boron, and other potentially hazardous constituents in groundwater in the basin.
- Disseminate information about current groundwater quality conditions to local agencies and organizations.

Scope

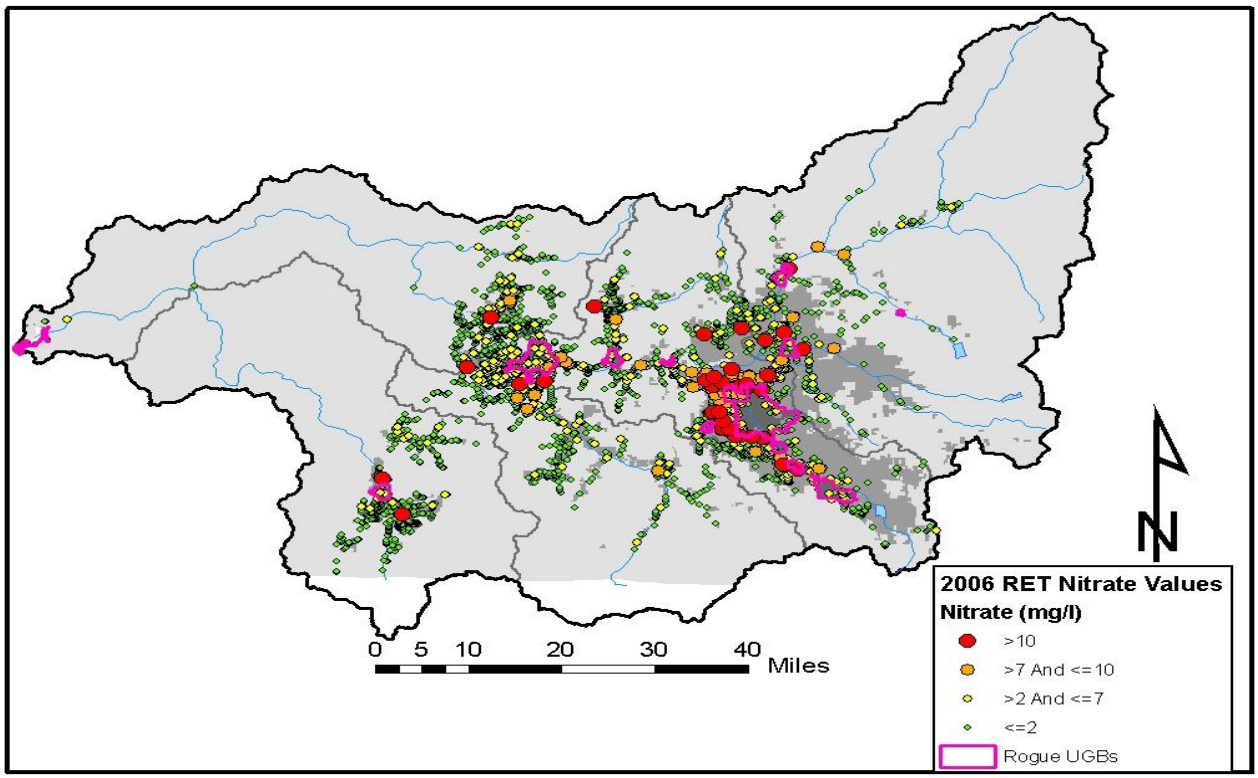
Fifty-two domestic wells were sampled in this study from rural areas extending from Ashland to Shady Cove and Rogue River in Jackson County and out to Grants Pass and Cave Junction in Josephine County. Samples were tested for a suite of metals, chloride, fluoride, and nitrate. The parameters of concern were primarily nitrate as nitrogen, arsenic, fluoride, boron, and manganese. Pesticide sampling was beyond the scope of this investigation. Past groundwater quality studies in the Rogue Basin were reviewed and summarized as part of the investigation. Twelve public education events were held prior to the sampling event and presentations of the investigation findings were presented to the Bear Creek Watershed Council. The report will be disseminated to various state, county, and local government offices.

Findings

Nitrate: Forty-seven percent of the wells sampled in Jackson County have elevated nitrate concentrations (>3 mg/L) and 8% have concentrations above the drinking water standard of 10 mg/L (see map and data table, below). Only 6% of wells sampled in Josephine County had elevated nitrate concentrations in this study. The combined results from Jackson and Josephine Counties (35% of wells with elevated nitrate) are similar to results from studies conducted by USGS in the 1970s (31%) and by DEQ in the 1990s (33%), indicating that the distribution of nitrate in groundwater in the basin may have slightly increased over the years. The majority of groundwater contamination by nitrate was present in Jackson County, centered around Central Point, west Medford, and North Ashland.

Arsenic: Arsenic was detected in 19 out of the 52 wells tested (17%), and in 44% of the Jackson County wells tested. This is significant since arsenic is considered a carcinogen and a safe concentration for consumption has not been determined. Three wells had arsenic levels above the drinking water standard of 10 ppb, in Gold Hill (11.7), Grants Pass (18.1), and Jacksonville (32.1). Neilson Research Corporation, a local drinking water laboratory, reports that many more locations have arsenic above 10 ppb.

Map of Real Estate Transaction Data collected from 1989 to 2006 in the study area.



Fluoride: Fluoride was detected in many of the wells in all sectors of the study area except around Cave Junction, but most wells had very low, barely detectable levels.
Geologic units in which fluoride was most consistently detected include granitic aquifers, basalt aquifers, and sandstone aquifers.

Boron: Elevated boron levels were detected in only two wells in the study area. The highest percentages of boron detections were found in wells drawing from sandstone and claystone aquifers.

Vanadium: Approximately 56% of the wells tested (29 of 52) had some detectable level of vanadium in the water. Since state guidelines appear to vary widely as to the acceptable concentration of vanadium in drinking water, and the EPA has not yet issued a drinking water guideline for the constituent, it is not clear whether these concentrations are a public health concern or not.

Recommendations

Further define the extent of area-wide arsenic, fluoride, and boron concentrations in the Rogue Basin by collecting more data. Re-visit the 1995-1997 Jackson County well ordinance and attempt to implement a similar ordinance to aid in the collection of more, local, information about groundwater quality.

Secure funding to create maps of arsenic, boron, and fluoride data already available in a database available through the Oregon Health Authority (OHA).

Conduct an investigation of potential concerns associated with wide-spread vanadium concentrations in drinking water wells.

Develop a Groundwater Quality Education program, including the dissemination of information about current groundwater quality conditions to local agencies and organizations, and to the public through those organizations.

Evaluate correlations between irrigated agriculture, and eventually, specific agricultural practices, and nitrate contamination of groundwater supplies in order to target public education efforts. Potential correlations between the presence of septic systems and areas with nitrate contamination should also be evaluated.

Evaluate the correlation between rock type of the water-bearing aquifer and the presence of arsenic, fluoride and boron. This will allow a better understanding of the distribution of arsenic, fluoride and boron in basin groundwater supplies.

Consider a declaration of an “Area of Groundwater Concern” under ORS 468B.175 or ORS 448.271 through the Oregon Health Authority (OHA) since there are distinct areas in the Rogue Basin where nitrate from anthropogenic sources has contaminated groundwater. This declaration would raise the prioritization of the area for funding by grants and agency resource and focus a local committee on addressing the issue.

Summary of Groundwater Study Results 1971-2011

	1971-1972 USGS Studies	1973 USGS Study	1971-1973 USGS Studies	1992 DEQ Study	1994 DEQ Study	1994 DEQ Study	1992-1994 DEQ Studies	2011 DEQ Study	2011 DEQ Study	2011 DEQ Study
	Jackson County	Josephine County	Combined	Jackson County	Jackson County	Josephine County	Combined	Jackson County	Josephine County	Combined
Number of Wells Tested	92	14		27	20	20	67	36	16	52
Nitrate >3 mg/L	34%	10%	31%	7%	65%	32%	33%	47%	6%	35%
Nitrate>10 mg/L	14%	0%	13%	0%	15%	10%	7%	8%	0%	6%
Max Nitrate (mg/L)	41	4.2	41	6.7	13	14	14	19.3	4.37	19.3
Wells tested for N	76	10	86							
Arsenic detection	N/A	0%		7%	5%	5%		44%	6%	17%
Max Arsenic (ug/L)		ND		26	16	13		32.1	18.1	32.1
Fluoride >2 mg/L	9%	0%		4%	0%			3%	0%	2%
Fluoride >4 mg/L	7%	0%		4%	0%			3%	0%	2%
Fluoride detection	97%	7%		37%	70%	N/A		78%	56%	71%
Max Fluoride (mg/L)	12	0.5		11	0.7			3.31	0.77	3.3
Boron > 2mg/L	16%	29%		15%	0%	0%		5%	0%	4%
Boron detection	93%	100%		96%	75%	40%		69%	50%	63%
Max Boron (mg/L)	20	4.3		14	0.99	0.32		6.64	0.305	6.64
Vanadium detection	N/A	N/A		0%	0%	0%		56%	56%	56%
Max Vanadium (ug/L)				<30	<30	<30		33.7	29.6	33.7
Pesticides	N/A	N/A		0%	10%	0%		N/A	N/A	N/A
VOCs	N/A	N/A		4%	10%	20%		N/A	N/A	N/A

N/A = Not Tested
ND = Not Detected

Acknowledgements

Many people assisted in the gathering of information presented in this report. Dan Snyder and Leonard Orzal of the Portland USGS Office offered maps and access to the USGS Library. Doug Woodcock of WRD assisted with information about the geology of the Grants Pass area. Shavon Haynes and Jen Woody, in the Jackson and Josephine County Watermasters' office, offered assistance with access to WRD monitoring wells. Southern Oregon University professor Eric Dittmer offered access to maps and data from Jackson County and Shady Cove studies and assisted in plans for report dissemination and next steps along with his former Jackson County colleague Gary Stevens. Geologist Bill Hicks reviewed the report and offered suggestions. Fay Fowler, of Neilson Research Corporation, shared her knowledge of areas in the valley with arsenic, fluoride, nitrate and boron. And volunteers from the Boys and Girls Club of Central Point, DEQ, SOU, the Jackson Soil and Water Conservation District, Bear Creek Watershed Council, RVSS, RVCOG and Master Gardeners assisted with volunteer nitrate testing events around the basin. A big thank you to the ten county libraries and the Rogue River Fire Station who allowed us to use their meeting rooms for our many public education events.

Many thanks to the various staff at DEQ for their assistance in getting this project off the ground. Audrey Eldridge provided guidance and support throughout the project, helping present at public education events, organizing the volunteer nitrate testing supplies, assisting in well selection and project design, mustering up of laboratory resources, quality control, review of report drafts, and feedback about next steps. This project would not have been possible without Audrey's assistance. Many thanks to Ben Johnson, for developing GIS maps of our data and of the real estate transaction data in his spare time. Greg Pettit, Rich Myzak, Ben Johnson, and Wade Peerman provided valuable laboratory support, sample collection and analysis. Heather Tugaw was an energetic assistant with volunteer nitrate testing and helped locate maps for the report. Judy Johndahl assisted by locating the 1992 and 1994 DEQ Groundwater Investigation reports.

And last but not least, appreciation is extended to Oregon Senator Alan Bates and Representative Peter Buckley for supporting the DEQ budget and the groundwater program during the 2012 Legislative Session and succeeding in preserving some groundwater protection resource in Oregon so that projects like this one can be conducted. The majority of time spent on this project was donated, but the project could not have been conducted without DEQ assistance and support.

1. Introductions

1.1 Definition/Regulatory Framework

The Groundwater Quality Protection Act is a critical component in Oregon's overall water quality protection and management strategy. The Act aims to ensure that Oregon's groundwater is protected as a resource for all present and future beneficial uses through a strategy that uses monitoring and assessment to identify groundwater quality problems. The Oregon Department of Environmental Quality (DEQ) and Oregon State University Agricultural Experiment Stations are tasked with the responsibility for statewide groundwater monitoring and assessment [Oregon Revised Statute (ORS) 468.190]. The statute provides further guidance in the event that area wide groundwater contamination is discovered due, at least in part, to nonpoint source activities under ORS 468B.175-177. In addition, local action can be taken, in collaboration with local and state agencies, to increase public awareness through education, research and demonstration projects. Area-wide, naturally occurring groundwater quality concerns, such as high levels of arsenic or fluoride, can be publicized in order to protect public health of private well users. Anthropogenic sources of area-wide groundwater contamination may be addressed through the development and implementation of best management practices, which may be included in a locally developed action plan.

The Oregon DEQ received funds from the 2007 Oregon Legislature to establish a watershed-based toxics monitoring program for Oregon's waters. DEQ began implementing the program in early 2008 with an initial focus on the Willamette Basin. Since 2008, DEQ laboratory staff collected water samples in ten basins across the state. The Rogue Basin Toxic Monitoring Program was conducted in 2011. As part of the Watershed Approach, groundwater monitoring will be used in conjunction with the surface water monitoring to evaluate the 'health' of water quality in the Rogue Basin.

This project focused on evaluation of the groundwater quality of the central portion of the Rogue Basin. The area is located in southwestern Oregon and straddles the border of Jackson and Josephine Counties (See Figure 1).

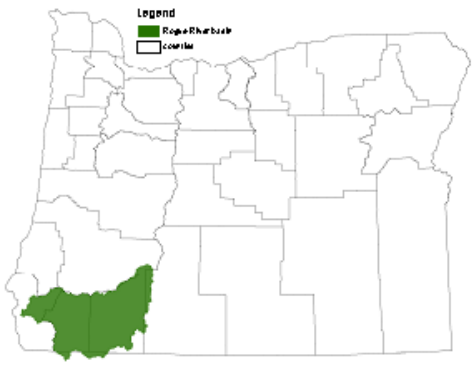


Figure 1: Location of Rogue Basin, Oregon

Previous groundwater quality investigations in the Rogue Basin have been conducted by the United States Geological Survey (USGS), the Oregon Water Resources Department (WRD), DEQ, and Jackson County. Various areas of groundwater quality concerns have been identified, stemming from both natural and human impacts.

1.2 Project Goals

The goals of this groundwater quality investigation were to:

- Update the DEQ statewide database regarding nitrate concentrations in this basin and determine if levels are rising or falling since previously sampled.
- Investigate the distribution of naturally occurring fluoride, arsenic, boron, and other potentially hazardous constituents in groundwater in the basin.
- Disseminate information about current groundwater quality conditions to local agencies and organizations.

1.3 Groundwater Parameters of Concern/Sources

Pollutants are considered to come from two sources: point sources and non-point sources. Point sources are from a defined source, whereas nonpoint sources are landscape wide. Point sources in Oregon are regulated utilizing either a federal National Pollutant Discharge Elimination System (NPDES) permit or a state Water Pollution Control Facilities (WPCF) wastewater discharge permit issued by DEQ.

Pollution from a wide variety of sources is known as non-point source (NPS) pollution. When it rains, water washes over streets, lawns, agricultural lands, construction sites, and logging operations picking up soil, bacteria, toxics, and other pollutants. This rainwater, or excess irrigation water, can carry pollutants into the groundwater as well as discharging to surface water. Non-point sources of pollution are considered to be the largest source of water quality impairment in the Rogue Basin. In addition, there are several naturally occurring groundwater parameters of concern in the Rogue Basin.

Existing information indicates that the prominent parameters of concern in the groundwater of the Rogue Basin include nitrate, arsenic, boron and fluoride and salts in the form of chlorides and sodium. Table 1 identifies parameters of concern identified in a recent DEQ Water Quality Status and Action Plan for the Rogue Basin (Oregon DEQ, September, 2011). Figure 2 identifies the locations of the subbasins noted in the Table (Upper Rogue, Middle Rogue, etc.).

Table 1: Water Resource Concerns by Geographic Area

Ground Water	General Quality	Quality	Nitrate	Bacteria	Pesticides	Volatile & Synthetic Organic Compounds (VOC)	Arsenic	Nickel	Lead	Fluoride
Upper Rogue										
Middle Rogue										
Lower Rogue										
Applegate Subbasin										
Illinois Subbasin										

Note: The yellow boxes in the table above refer to moderate groundwater quality concerns and the red boxes indicate substantial groundwater quality concerns. White boxes indicate unknown conditions (Oregon DEQ, September 2011).

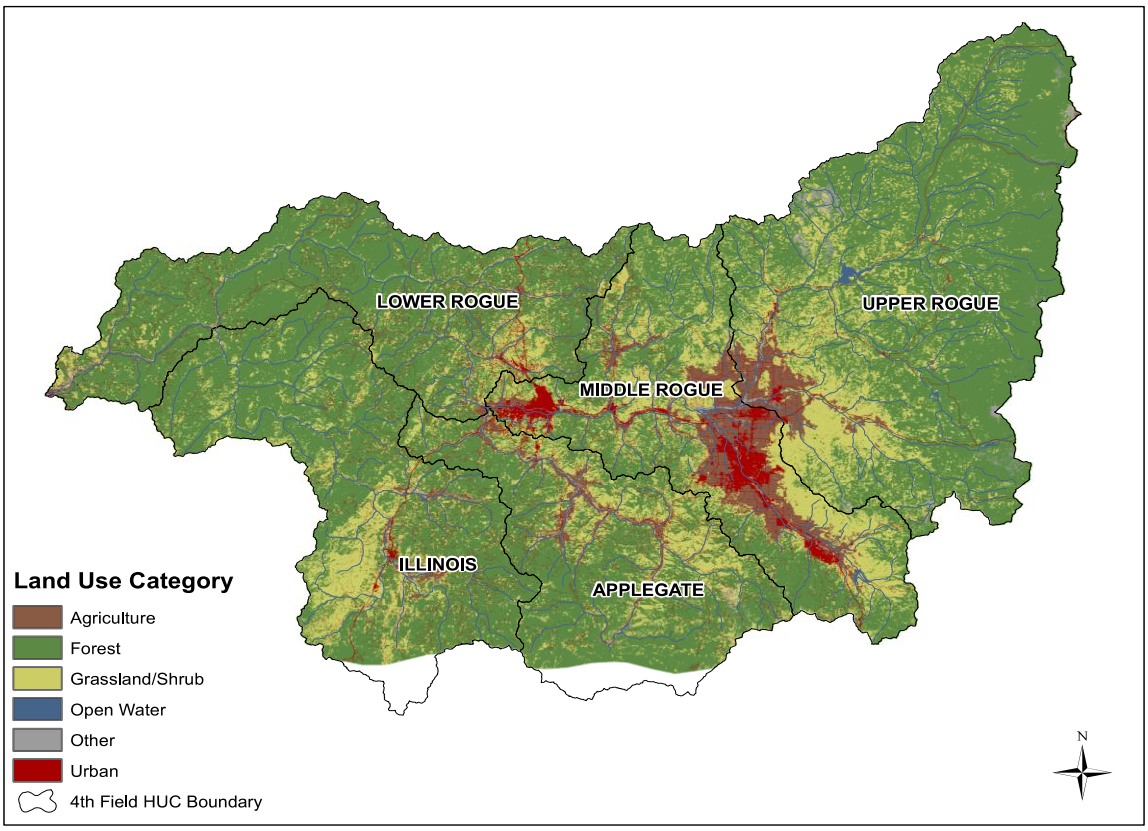
Groundwater quantity is also an increasing concern as regions within the basin are experiencing a rapidly dropping water table.

1.4 Potential Human Health Impacts

In the Rogue Basin there are 22 public water systems using surface water and 251 public water systems relying, in whole or in part, on groundwater. All Public Water Systems (PWS) are required to routinely test their water quality. PWS in the Rogue Basin periodically exceed drinking water standards for a number of parameters including: selected toxics, nitrate, bacteria and turbidity.

Unlike PWS, domestic well owners are not required to test their well water, unless there is a property transfer, in which case the property sellers are required to test for bacteria, nitrate and arsenic. Many contaminants, including these three, have no taste or odor, and are only determined to be present when testing occurs. Jackson County is the 6th most populous county in Oregon with 203,206 residents as of the 2010 census, with 62,516 residents (31%) living in unincorporated areas. Many of the people living in unincorporated areas are dependent on groundwater wells for their drinking water supply.

Figure 2: Rogue Basin Land Uses (Oregon DEQ, September 2011).



One of the primary reasons for this project is to provide further information to private well owners (most rural residents utilize well water for their drinking water supply) and county Health Divisions about naturally occurring constituents in the area's groundwater which may be health concerns, particularly for children.

A summary of EPA drinking water standards also called Maximum Contaminant Levels (MCLs)] and other relevant standards is presented in Table 2 for easy reference. A glossary of water quality standard terms is provided in Appendix A. Manganese and Chloride concentrations were measured in many of

the studies, but are not considered an area-wide concern. They are therefore included in Table 2 for reference levels, but not discussed in detail. More information about the other parameters from Table 2 is provided in the following sections.

Table 2: Drinking Water Standards or Health-Based Concentration Limits*

Parameter	Drinking Water Standard or Health-Based Concentration Limit
Nitrate	10 milligrams per liter (mg/L) = EPA MCL
Arsenic	10 micrograms per liter (ug/L) = EPA MCL; 2 ug/L = 10-4 cancer risk Health Advisory (HA)
Fluoride	4 mg/L = EPA MCL; 2 mg/L = Secondary drinking water regulation (dental fluorosis)
Boron	3 mg/L = Ten-day exposure HA for 20 pound child drinking 1L/day; 6 mg/L = Lifetime exposure HA for adults drinking 2 L/day
Vanadium	50 ug/L = EPA Proposed Action Level; 15 ug/L = California proposed notification level
Manganese	0.3 mg/L + EPA suggested Health Advisory Level (staining, odor)
Chloride	250 mg /L = EPA SMCL (salty taste, corrosivity)

*See Appendix A for a Glossary of Terms relating to Drinking Water Standards

1.4.1 Nitrate

Nitrate may enter ground water from a number of point and non-point sources, including fertilizer, manure, septic systems, natural soil nitrogen, atmospheric deposition, land disposal of municipal waste, and fixation of atmospheric nitrogen. Nitrate concentrations exceeding 3 mg/L generally indicate anthropogenic contributions of nitrate. Although nitrate concentrations below 3 mg/L may also have been influenced by human activities on the surface, this report will concern itself primarily with levels above 3 mg/L (<3 mg/L may be considered "background" levels). The MCL for nitrate (nitrate as nitrogen) in drinking water is 10 mg/L. When nitrate is identified in wells at concentrations greater than 7.0 mg/L area-wide, DEQ may declare a Groundwater Management Area (ORS 468B.180). Area-wide groundwater contamination by nonpoint sources at any level can trigger the declaration of an Area of Concern (ORS 468B.175). Either declaration requires the formation of an Advisory Committee and a focus of research, public education, and monitoring in the area, aimed at evaluation of, and solutions to, the problem (ORS 468B.177 through 187). Nitrate is an important analyte in that it is inexpensive to test, and yet its presence in groundwater indicates that contamination from surface or near surface activities has taken place, and other contaminants may also be present in the area's groundwater.

1.4.2 Arsenic

Higher levels of arsenic tend to be found more in groundwater sources than in surface water sources (i.e., lakes and rivers) of drinking water, although there have been reports of arsenic in several creeks and springs in the upper Rogue Basin, in the vicinity of Coon Creek, Little Butte Creek and Lost Creek.

Compared to the rest of the United States, western states have more drinking water systems with arsenic levels greater than EPA's MCL of 10 micrograms per liter (ug/L). A National Water Quality Assessment of 2167 wells conducted by the U.S. Geological Survey (DeSimone, 2009) found arsenic above the drinking water standard in 6.75% of all wells tested nationwide, and in more than 10% of wells in crystalline rock aquifers in New England and basaltic rocks in Idaho. (Only Willamette alluvial aquifers were tested in Oregon for this USGS study). Arsenic concentrations were found to be positively associated with low dissolved oxygen and high pH (DeSimone, 2009).

The EPA's MCL Goal (MCLG) for arsenic in drinking water is 0 ug/L. The MCLG is a non-enforceable health benchmark that is set at a level at or below which no known or anticipated adverse effect on the

health of persons is expected to occur. A cancer-related Health Advisory of 2 ug/L of arsenic has been set to identify a concentration associated with a cancer probability of 1 in 10,000 (EPA 2012).

Arsenic (chemical symbol As) occurs naturally in soil and bedrock in many parts of Oregon. Demands on groundwater from municipal systems and private drinking water wells may cause water levels to drop and release arsenic from rock formations. Human activities that could have left arsenic residuals include pesticide application in orchards, coal ash disposal, and use of some pressure treated wood. Arsenic has no smell, taste, or color when dissolved in water, even in high concentrations, and therefore only laboratory analysis can determine the presence and concentration of arsenic in water. Arsenic ingestion can result in both chronic (long-term) and acute (short-term) health effects. Acute effects can include nausea, vomiting, neurological effects such as numbness or burning sensations in the hands and feet, cardiovascular effects and decreased production of red and white blood cells which may result in fatigue. Chronic effects include changes in skin coloration and skin thickening and small corn-like growths that can develop especially on the palms of the hand and soles of the feet. Chronic exposure to arsenic is also associated with an increased risk of skin, bladder, and lung cancer. There is also evidence that long-term exposure to arsenic can increase risks for kidney and prostate cancer.

Arsenic usually exists in two different forms, or valences, in a natural setting depending on the amount of oxygen available in groundwater. In more shallow aquifers with higher levels of oxygen, arsenic will usually exist as arsenate, As (V). In deeper, anaerobic ground waters, arsenic usually occurs as arsenite, As (III) http://water.epa.gov/lawsregs/rulesregs/sdwa/arsenic/Basic-Information.cfm.

1.4.3 Fluoride

Fluoride (chemical symbol F) is present in virtually all waters at some level, and it is important to know the fluoride content of drinking water, particularly if children are using the water. The USGS National Water Quality Assessment (DeSimone, 2009) found that 4% of sampled wells had natural fluoride levels above the EPA Secondary Maximum Contaminant Level (SMCL) of 2 mg/L. A smaller set of 1.2% of all wells exceeded the Maximum Contaminant Level (MCL) of 4 mg/L.

With fluoride concentrations above 2 mg/L, the Centers for Disease Control and Prevention (CDC) recommends an alternate drinking water source for children aged 8 years and younger. Children at this age have an increased chance of developing dental fluorosis. Consumption of water with fluoride concentrations over the 4 mg/L MCL for a lifetime may increase the likelihood of bone fractures, and may result in skeletal fluorosis, a painful or even crippling disease. (http://www.cdc.gov/fluoridation/fact_sheets/wellwater.htm)

1.4.4 Boron

Boron (chemical symbol B) is a non-metallic, naturally occurring element found in rocks, soil, and water. Boron does not exist as a pure element but is combined with oxygen as borate minerals and various boron compounds such as boric acid, borax, and boron oxide. The boron compounds listed above are odorless crystals, granules, or powders. Elemental boron is insoluble in water and boric acid and borax are slightly soluble in water.

Boron compounds are used primarily in the production of glass and ceramics, pesticides, fire retardants, plus insulation-grade- and textile-grade-glass fibers. Boron can be present in commercial plant foods and fertilizers. Boron compounds are often found in household laundry and cleaning products.

As levels of boron in drinking water increase above the EPA One-Day and Ten-Day Health Advisory (HA), for children, of 3.0 mg/L and the EPA Longer Term exposure Health Advisory of 2.0 mg/L for children, the potential for adverse effects on the testes of young males increases. As the level of boron in drinking water increases above the Lifetime Health Advisory for adults (6 mg/L), the potential effect on the fetuses of pregnant women and the testes of males increases. Direct effects on a pregnant woman

would occur at doses higher than those that would affect the fetus. Water containing boron at levels above the HA should not be used to prepare food or formula for infants and children http://water.epa.gov/action/advisories/drinking/upload/dwstandards2009.pdf.

1.4.5 Vanadium

Vanadium (chemical symbol V) is a naturally occurring "rare earth" element that is found ubiquitously in the earth's crust. It is a metal that binds with oxygen, sodium, sulfur or chloride, and is often found in ore along with uranium. The V-50 isotope of Vanadium is slightly radioactive. It is considered to be one of the 14 most noxious heavy metals. Vanadium and its compounds are toxic, although the toxicity varies depending on the valence. Pentavalent V is its most toxic form. Vanadium is not considered a carcinogen (Irwin, 1997).

High concentrations of V have been documented in lead corrosion by-products, which, in natural deposits are associated with iron oxides/oxyhydroxides, phases common in iron pipe corrosion by-products. This research, by the University of Cincinnati (Gerke et al, 2010), showed that only a tiny section of corrosion by-product needs to be disturbed to increase V concentrations in the drinking water at the tap to levels well above the 15 µg/L notification level set by the State of California.

In 1997, EPA proposed an action level of 50 ug/L (or 0.05 mg/L) for clean up of vanadium in drinking water. Minnesota's Department of Health established a Health Risk Limit of 50 ug/L for Vanadium, which they consider a level safe to ingest daily for a lifetime. California's Office of Environmental Health Hazard Assessment, in a memorandum Dated August 2000, did not agree with the EPA's Action Level and recommends a notification level of 15 ug/L for long-term consumption. http://oehha.ca.gov/water/pals/vanadium.html. Arizona's 1993 drinking water guidelines propose a 7 ug/L limit for vanadium (Irwin, 1997). There is no current drinking water standard for vanadium although it is present on the EPA's Contaminant Candidate List 3.

2. Study Area Description

2.1 Site Location and Description

The study area is located in the central portion of the Rogue Basin, straddling the Jackson and Josephine County line in Southern Oregon, extending southeast from areas around Ashland, northeast to Shady Cove, west to Grants Pass, and southwest to Cave Junction, (see Figure 1). The Rogue Basin encompasses approximately 5,156 square miles and includes the populated areas of Grants Pass, Medford, Ashland and many smaller towns. The Rogue Basin consists of five sub-basins that drain to the Pacific Ocean: Lower Rogue River, Middle Rogue River, Upper Rogue River, Illinois and Applegate. Land use in the basin is 67% forest, 22% grassland/shrub, 4% agriculture and 4% urban (3% other) according to the USGS 2001 National Land Cover Database (NLCD). Figure 2, Rogue Basin Land Uses, identifies large agricultural areas north and west of Medford and along the Bear Creek corridor from Ashland to Medford. Agriculture is also prevalent west of Grants Pass and in the Cave Junction area of Josephine County.

Most rural residents in the study area use domestic water supply wells and onsite septic systems. Some previously agricultural or rural residential areas have been annexed into the cities of Central Point and Medford, occasionally because the drinking water wells in particular neighborhoods have become contaminated or have gone dry.

2.2 Population / Growth / Groundwater Resource Demand

Jackson County is the 6th most populous county in Oregon with 203,206 residents as of the 2010 census, with 62,516 residents (31%) living in unincorporated areas. Many of the people living in unincorporated areas are dependent on groundwater wells for their drinking water supply, although there are small public water systems in mobile home and other housing developments in some places and some residents obtain water from surface water sources. Jackson and Josephine Counties have some of the highest unincorporated populations in the state of Oregon. The USGS reports that over 50% of Jackson County's population relies on well water for their drinking water supply (http://pubs.usgs.gov/sir/2008/5227.html). In the Rogue Basin there are 22 public water systems using surface water and 251 public water systems relying on groundwater – in whole or in part.

The population of Medford, Jackson County's largest city, increased from 48,774 in 1990 to 74,907 in 2010, an increase of 54%, or 2.7%/year. Population growth slowed from 2000 to 2010 to 1.9%/year. Ashland's population increased from 16,510 in 1990 to 20,078 in 2010, an increase of 22%, or, 1.1%/year. In Central Point, the population increased from 7,752 in 1990 to 12,493 in 2000 to 17,169 in 2010, a growth of 121%. The Central Point growth rate in the 1990s was approximately 6%/year versus a slower growth rate of 3.7%/year from 2000 to 2010. The growth rate in unincorporated areas of Jackson County was much lower, approximately 0.4%/year (http://oregon.gov/DAS/OEA/census_and_acs.shtml).

Josephine County is the 12th most populous county in Oregon. In 2010, the U.S. Census recorded 82,713 people living in Josephine County, with 46,297 (56%) living in unincorporated areas. The growth of unincorporated populations in Josephine County was at a rate of approximately 0.4%/year from 1990 to 2010.

In 1970, the U.S. Census recorded 29,000 people in the greater Grants Pass area, with 12,500 living in Grants Pass. In 2010, 34,533 people were recorded to be living in Grants Pass, indicating a growth of 176%, or, 4.4%/yr. The population growth in the decade from 2000 to 2010 was 50%, or, 5% per year. Approximately 17,000 people live in the Illinois Valley area, around Cave Junction. (http://oregon.gov/DAS/OEA/census_and_acs.shtml).

An evaluation of the volume of groundwater used in the basin versus the volume of groundwater available was beyond the scope of this study.

2.3 Geologic Setting

2.3.1 Jackson County Geology and Soils

The Jackson County section of the study area is located between the Klamath and Cascade Mountain geographic provinces. Faulted Mesozoic sedimentary and meta-volcanic rocks of the Applegate Group, intruded by a granitic pluton, form the uplands to the west and southwest of the Bear Creek valley as well as the basement west of southern Bear Creek. The Cretaceous Hornbrook Formation, a sandstone/conglomerate/mudstone unit overlies the metamorphic Applegate Group and granitic rocks, and outcrops in areas west and east of the Bear Creek valley. This unit extends below the alluvium in the Medford area and the nonmarine sedimentary rocks in the Ashland area (Robison, 1971, Robison, 1972).

In the Ashland area, the Cascade Range to the east is topped with volcanic flows of the Roxy Formation, including layers of tuff and breccia. These overlie the Payne Cliffs Formation, which overlies the older Hornbrook Formation. Much of the area northwestern of Ashland and continuing south along the valley is a mix of Jurassic/Cretaceous-era granitic rocks. Quaternary alluvium deposits from Bear Creek of sand, gravel and silt is present in a maximum thickness of 30 feet along a narrow strip of Bear Creek and lower Neil Creek and Emigrant Creek. Igneous rocks such as diorite and gabbro sills and basalt and rhyolite dikes have intruded the nonmarine sedimentary rocks of the valley in places, occasionally forming bluffs to the east of Ashland (Robison, 1971, Robison, 1972).

In the Medford area, up to 70 feet of semi-consolidated gravel, sand, silt, and clay form the high terrace Quaternary bench gravels located on the east side of the lower Bear Creek Valley. A unit of older alluvium occurs generally west of Bear Creek and consists of unconsolidated sand, silt and clay. This older alluvial unit lies above the present flood plain and below the higher bench gravel terraces and is up to 60 feet thick (Beaulieu and Hughs, 1977). Another series of older deposits have formed benches up to about 100 feet thick in the Agate Desert area west of White City (Robison, 1971). A narrow band of recent alluvium is present along Bear Creek and broadens in the northern part of the study area in the vicinity of the Rogue River. This younger alluvium varies from a few feet thick along streams to up to 20 feet thick along the Rogue River (Beaulieu and Hughs, 1977).

Water-deposited tuffs and conglomerates of the Payne Cliffs Formation underlie volcanic flows of the Roxy Formation in the vicinity of Eagle Point, with alluvial deposits filling the valley along Little Butte Creek. East of Interstate 5 and the Crater Lake Highway, nonmarine sedimentary rocks are exposed in the Cascade foothills to the east, and extend down the valley beyond Ashland and into California. These rocks are overlain to the east by the extensive Roxy Formation flows, extending south of Ashland (Roxy Ann Peak, Grizzly Peak, Buck Point, Pilot Rock). The nonmarine sedimentary rocks also outcrop northwest of the Rogue River, capped by small remnants of a Rogue River Valley basalt flow on the two Table Rocks northwest of White City (Robison, 1971).

The Agate-Winlo Soil Series, occurring east of Bear Creek, consists of loam to clay loam. These clayey soils were formed on sandstone, colluvium and mixed alluvial materials, predominately Quaternary bench gravels. Permeability is slow to moderately slow and moderately to poorly suited for irrigation.

Recommended agricultural use of these soils is pasture, rangeland, and hay production. These soils create severe limitations for location of septic systems and sewage lagoons due to shallow soil and a seasonably high water table (Power and Rother, 1969).

The soils west of Bear Creek include Central Point sandy loam, Medford silt loam, Barron sandy loam, Coleman loam and Ruch loam. These soils were formed on water-lain alluvial deposits, mostly older Quaternary alluvium. Except for Barron sandy loam, these soils are moderately to well-drained. Due to its coarse texture, the Barron sandy loam is excessively drained. These silty soils west of Bear Creek are moderately well to well suited for irrigation and support pear, vegetable, fruit, pasture and forage crops. Location of septic systems on these soils is generally limited due to low permeability clays or a high water table (Power and Rother, 1969).

2.3.2 Josephine County Geology

Josephine County geology is dominated by a Jurassic- or Cretaceous-age batholith, a granitic intrusive oval-shaped outcrop centered just west of Grants Pass and extending north beyond Merlin and south to the Applegate River. Extensive alluvial deposits along the Rogue River and its tributaries, extending in some cases to 150 feet thick, overlie the granite. A thick (up to 165 foot) deposit of Tertiary or Quaternary conglomerate is present in the vicinity of Merlin, along upper Louse Creek. Triassic-age, Metavolcanic rocks of the Applegate Group surround the batholith to the east. These include greenstones, altered lava flows, breccias and tuffs. Some outcrops of Jurassic-age, ultra-mafic intrusives are found along the edges of the batholith (Robison, J.H., 1973).

West of the batholith, the outcrops are predominantly Jurassic-aged, Galice Formation conglomerates, slate, tuffacious sandstones and shales. Some metamorphic gneiss and schists are found around the edges of the batholith, altered due to contact metamorphosis (Robison, J.H., 1973).

To the southwest, in the Selma area, the geology becomes more structurally complex, as the mostly Jurassic-aged granodiorites, gabbro, shales, mudstones and sandstones are broken up with numerous faults. Alluvial deposits of multiple ages are present in the form of older terrace gravels. The youngest alluvial deposits are in the current river and creek valleys. East of the valley, the Jurassic formations include faulted basalts, gabbro dikes, and volcanic agglomerate (Page, Norma, 1981).

Much of the study area around Cave Junction consists of partially cemented Pleistocene alluvium or younger, alluvial fan, deposits. These alluvial units overlie a thick deposit of meta-sedimentary rocks. A large, Jurassic peridotite unit is present to the west (Ramp, L. 1986).

2.4 Hydrogeology

2.4.1 Jackson County Hydrogeology

There are several aquifers providing groundwater within the Jackson County portion of the study area. There are three alluvial aquifer units and several Tertiary and older, granitic and metamorphic rocks which produce water via fractures. Surface water from creeks, rivers, reservoirs and lakes, irrigation, and seepage from irrigation ditches in the valley locally recharge the alluvial aquifers. Additionally, precipitation in the highlands recharges the bedrock aquifers which may recharge alluvial aquifers via fracture flow (Orzal, 1993).

Other than shallow stream deposits, most formations have little or no primary porosity so wells depend on secondary porosity, or, fractures. Steep slopes hinder the recharge of groundwater and encourage runoff. However, precipitation stored as snowfall at higher elevations will allow higher infiltration rates. The Tertiary volcanic rocks, the Tertiary sedimentary rocks and the Paleo-Mesozoic rocks each have low permeability, capable of yielding only small quantities of groundwater. The quantities are generally

adequate, however, for domestic or livestock use (Young, 1985). Some of the aquifers accessed by fractures, can produce substantial volumes of water, but perhaps not sustainably.

Alluvium provides the most productive aquifer in the area. Where total thickness is generally 30 feet or more, the units generally had a saturated thickness of more than 10-15 feet and would yield 10 to 50 gallons per minute (gpm) (per bailer test results prior to 1971). In a few areas, yields of 100 gpm or more were obtainable (Robison, 1971).

The Tertiary Roxy Formation volcanics are located above the water table in much of the area but is capable of yielding 10 gpm where available. Water is likely to be of good quality. The older, Colestine Formation, tuffs and conglomerates are capable of yielding about 20 gpm in many places. Water may be hard or saline in some areas. The Tertiary nonmarine sedimentary rocks are capable of yielding 5 to 15 gpm in most areas, however it can yield water with excessive boron and fluoride and may be too saline in some areas. Wells in the Sams Valley area and in the area near Jacksonville commonly draw from this formation (Robison, 1971).

Of Cretaceous age, the Hornbrook Formation sandstones can yield 5 to 10 gpm in some areas and less than 1 gpm in others. The chemical quality of the water varies. Granodiorite and quartz diorite units of Jurassic or Cretaceous age yield less than 5 gpm generally, yet water is expected to be of good quality (Robison, 1971).

2.4.2 Josephine County Hydrogeology

At the time of the USGS study in 1973, the alluvial aquifer was reported to be the major aquifer in the Grants Pass area. The aquifer mostly yielded more than 5 gpm and had some reported yields of 40 gpm. The depth of most wells in the alluvium were 50 to 80 feet below ground, the median depth to water in the alluvial aquifer was 9 to 15 feet in various sections. In the vicinity of Merlin, the depth of wells ranged from 38 to 200 feet deep, with depth to water of 1 to 82 feet below ground. Well yields of less than 8 gpm were common, and the water commonly had excessive iron (Robison, 1973).

In the granitic batholith, yields up to 50 gpm were reported in heavily weathered granites. Less weathered rock yielded less than 5 gpm. Well depths ranged from 70 to 106, and yielded calcium magnesium bicarbonate type water. Wells to the west, in the Galice Formation, provided unpredictable yields of 1 to 10 gpm. To the east, the yields in the Applegate Group metavolcanics were generally less than 10 gpm. Wells drilled in the small areas of gneiss and schist along the edge of the batholith (in the Fruitdale Creek area) provided highly unpredictable yields of 0 to 60 gpm with highly variable quality (Robison, 1973).

The general groundwater gradient reflects the topography and influence of the Rogue River. The gradient is generally toward the river, with a westerly (downstream) component of flow (Woodcock, 1993)

2.4.3 Groundwater Avaliability

The Oregon Department of Water Resources (WRD) has a data base of water well records (well logs) available at http://apps.wrd.state.or.us/apps/gw/well_log. This site contains thousands of well records accessible by address, original well owner or township, range, section. A review of all wells drilled in Jackson and Josephine Counties was beyond the scope of this study.

2.4.3.1 Jackson County Groundwater Avaliability

The average well depth is increasing over the years, as drillers need to drill deeper to encounter adequate water yields. In the 1950s and 1960, the typical well depth was 100 to 200 feet. In the 1990s, wells were usually 300 to 400 feet deep, occasionally extending to 800 or 1,000 feet deep. Over 13% of wells

drilled from August 1991 to July 1992 yielded less than 1 gpm and 4% were dry. Nevertheless, the increase in number of wells in the early 1990s was approximately 2.7% per year (Dittmer, 1994).

Southern Oregon University (then Southern Oregon State College) graduate student Gail Elder conducted a statistical study of 7500 wells drilled in the Shady Cove area between 1950 and 1995. Elder found that the average depth of wells drilled increased in each decade of her study period, from an average depth of 88.5 feet in the 1950s to an average depth of 229 feet in the 1990s. This corresponded to a consistent increase in depth to first water encountered, from an average of 57 feet in the 1950s to an average of 133 feet in the 1990s. Average water yield of the wells stayed between 18 and 21 gpm. However, yields vary significantly, with many wells yielding barely 1 gpm to others yielding 100 to 224 gpm. Elder notes that "many people I talked with buy their drinking water." They say, "our water used to taste better than it does now" (Elder, 1995). Shady Cove is the only municipality in the study area that does not have a public water supply and is supplied primarily by private water wells. They are considering a public system, however, and city residents will vote to proceed with that plan in November 2012. The City of Rogue River utilizes groundwater for a portion of its public water supply. Butte Falls also utilizes groundwater (from Ginger Springs) for its water supply.

There are areas where groundwater resources have a reputation for low yields. These areas are Shady Cove, Sam's Valley (northwest of Central Point), the upper Griffin Creek and Sterling Creek areas, Pioneer, Dark Hollow, Corp Ranch, Livingston and Old Military Roads (Dittmer, 1994).

A Jackson County Water Resources Study was compiled in December 2001 to evaluate the adequacy of available water supplies through 2050. This report states
that groundwater is generally being used in many locations faster than it is being recharged. It was estimated that the population in the Eagle Point through Ashland area in 2001 was approximately 176,000 and approximately 1/3 of that population (60,000) relied on groundwater for their water supply, suggesting a groundwater usage of about 10,000 acre-feet per year (AF/Y). This is an increase from the approximation of 50,000 people dependent on groundwater in 1992, and an estimated use of 8,400 AF/Y. At the time of the 2001 report, the Medford Water Commission was selling over 4.8 million gallons (14.73 AF) of water per year through vending machines (Ryan and Dittmer, November 2001). New numbers were not available.

The report concludes that some rural homeowners are facing groundwater shortages and deteriorating water quality. Limitations in groundwater quantity and/or quality may influence the decisions of new comers to Jackson County as to whether to live in cities where the water supply is more reliable or choose to live on property served by a well. It is also likely that residents dependent on marginal well yields or wells with poor water quality will seek alternate sources (Ryan and Dittmer, November 2001).

Demand for groundwater is not expected to increase dramatically through the year 2050 for the following reasons: growth of rural areas is reduced (anticipated at 1%), urban areas expand by annexation of rural areas, replacing wells with municipal supplies. Of note, however, is that, in 2001, virtually all tributaries to the Rogue River in Jackson County showed deficit conditions during some portion of the year and there were indications that the Rogue River was effectively over-appropriated. Surface water storage in reservoirs was reported to be adequate through 2020 and conservative estimates showed a deficit of 2,963 AF/YR by 2050 (Ryan and Dittmer, December 2001). No new water rights have been approved for the Rogue River since the 1970s, which create a continually increasing demand on groundwater supplies.

2.4.3.2 Josphine County Groundwater Avaliability

The City of Grants Pass obtains their public water supply from the Rogue River. A reservoir and irrigation district supplies water for 40,000 acres in the Merlin area (Robison, 1973) and the Grants Pass Irrigation District supplies water from the river to approximately 19,500 acres located primarily west and south of Grants Pass. The average annual rainfall in the Grants Pass area is 31 inches per year.

The Illinois River supplies the majority of city water for residents of Cave Junction, although a high-producing municipal well is also regularly utilized. The city has adopted a municipal code to aid in the protection of their groundwater supply. Cave Junction also provides water to the Kerby Water District. Rainfall in the Cave Junction area is around 61 inches per year.

3. Groundwater Quality Sampling History

Public Water Suppliers (PWS) obtaining their water from groundwater wells are required to sample water regularly and report results to the Oregon State Health Authority (OHA). EPA has required this process since the mid 1970s, and the Oregon Health Authority established a database of public drinking water data in 1987. This database is available to the public at http://170.104.63.9 . Data is accessible by PWS name or identification number. A summary of this data was outside the scope of this report, however.

Beginning in 1989, private well owners were required to test for E. coli bacteria and nitrate as nitrogen at time of property transfer. Arsenic testing requirements were added more recently. This data is referred to in later parts of this report as Real Estate Transaction (RET) data. Other than that, there are no other testing requirements for private drinking water supplies. Although the OSU Well Water website does provide some basic information, there are no statewide efforts to provide rural property owners with guidance as to what to sample for and how often to collect water samples.

Government agencies have conducted a number of small studies in the Rogue Basin in an effort to define the area's groundwater quality. Summaries of these studies are provided in the following sections of this report.

3.1 1971 and 1972 USGS Jackson County Studies

USGS compiled water quality data from 92 wells in the Medford and Ashland areas, tested between 1951 and 1970 (Robison, 1971 and 1972). This data is presented in Table 3. The USGS study showed that the alluvial aquifers commonly yield hard water of the calcium bicarbonate type, mostly free of high concentrations of fluoride or boron. Nitrate concentrations were elevated above 3 mg/L in 34% of the wells tested and above the EPA drinking water standard for nitrate (10 mg/L) in 14% of the wells, with the highest recorded concentration at 41 mg/L. Nitrate was generally found in groundwater from alluvium and the nonmarine sedimentary rocks and was likely to have entered groundwater from surface inputs.

The Colestine Formation was found to have calcium sodium bicarbonate water that was usually softer than that from alluvial sources, but with higher, naturally occurring, boron and fluoride levels. The nonmarine sedimentary rocks were mostly calcium bicarbonate water sources except in Sams Valley where the water was sodium bicarbonate dominant. The high sodium waters were likely to be high in boron, fluoride, or both.

Fluoride concentrations above the EPA drinking water standard for fluoride of 4 mg/L were detected in 7% of wells, with a high of 12 mg/L. 12% of wells tested had fluoride levels over 1.3 (Medford) and 1.2 mg/L (Ashland), which were the U.S. Public Health Service drinking water standards at the time, notably altered based on site-specific climate. EPA currently has a non-enforceable guideline of 2 mg/L for fluoride to protect against dental fluorosis.

Table 3: USGS Groundwater Study Results 1971-1973

	USGS 1971-1972 Study Jackson County	USGS 1973 Study Josephine County
Total Number of Wells Tested	92	14
Nitrate >3 mg/L	34%	10%
Nitrate >10 mg/L	14%	0%
Max Nitrate (mg/L)	41	4.2
Wells tested for this analyte	76 wells tested	10 wells tested
Arsenic Detection	N/A	0%
Max Arsenic (ug/L)		ND
Wells testing for this analyte	0 wells tested	4 wells tested
Fluoride >2 mg/L	9%	0%
Fluoride >4 mg/L	7%	0%
Fluoride Detection	97%	7%
Max Fluoride (mg/L)	12	0.5%
Wells tested for this analyte	92 wells tested	11 wells tested
Boron > 2 mg/L	16%	29%
Boron Detection	93%	100%
Max Boron (mg/L)	20	4.3
Wells tested for this analyte	89 wells tested	7 wells tested
Vanadium	N/A	N/A
Pesticides	N/A	N/A
VOCs	N/A	N/A
N/A = Not Tested ND = Not Detected		

Note: Lithia Water, a natural mineral spring water in Ashland, was reported to have 36 mg/L nitrate concentration, and 74 mg/L boron when tested in the 1971-1972 USGS Study. (When the City of Ashland tested Lithia Water in 2011, nitrate was not detected and 87.6 mg/L boron were detected). Lithia Water is not considered potable water.

Sixteen percent of wells tested had boron concentrations above the EPA Longer Term Health Advisory level of 2 mg/L. Arsenic testing was not conducted in these studies. At the time of the 1971 and 1972 reports, US Public Health Service drinking water standards for nitrate were 44 mg/L and there was no reported standard for boron.

Of note, Lithia Water, which was first developed from a series of springs and wells in south Ashland around 1911, and is piped to access points in town, was found in 1969 to contain 36 mg/L of nitrate, and 74 mg/L of boron. Lithia Water also has very high bicarbonate (3,410 mg/L), chloride (1,570), and sodium (1,800 mg/L) concentrations and is not used as a primary drinking water source.

3.2 1973 USGS Josephine County Study

The USGS compilation of groundwater quality samples in the Grants Pass area included 14 wells and found groundwater of generally acceptable quality (Table 3). The water was moderately to very hard and some contained excessive iron. No high nitrate was detected in the area, but 10% of the wells tested had elevated nitrate concentrations (above 3 mg/L). It was not expected that fluoride or arsenic would be present at excessive concentrations, although only 4 wells were tested for arsenic (no detections) the 1973 study. Of 11 wells tested for fluoride, there were minimal concentrations detected in 7%. It was estimated that boron concentrations might be excessive in sedimentary and volcanic rocks and boron was found in all 7 wells tested; 29% of the wells had more than 2 mg/L. Excessive sulfides were only expected in areas with high Total Dissolved Solids (Robison, 1973).

3.3 1980s USGS and WRD Groundwater Resource Study

In the 1980s, USGS and the Oregon Water Resources Department conducted a large study of groundwater quality and quantity in the Rogue Basin, which was never published due to lack of funding. Data from this study, the Jackson County Health Department, and from Neilson Research Corporation (a Medford laboratory) indicate that arsenic occurs generally in the eastern part of the Bear Creek watershed extending from east of Ashland northward behind Roxy Ann Peak to Highway 140, Trail and Butte Falls. Fluoride has been found to extend along the foothills west of Bear Creek from Ashland extending around Jacksonville and up south-westward toward Applegate, with some found north of Central Point (Dittmer, 1987).

Dittmer's report in 1987 also notes: "There seems to be a pattern of well water quality problems near irrigation ditches indicating older or improperly sealed wells are directly affected by irrigation ditch flows".

3.4 1988 – 1994 DEQ Statewide Groundwater Monitoring – Grants Pass

From 1988 through 1994, the Oregon Department of Environmental Quality conducted groundwater quality monitoring at over 30 locations in the Grants Pass area as part of a statewide groundwater quality monitoring program. Samples were collected quarterly in 1989 and 1990 to evaluate seasonal effects on quality of water that may be influenced by surficial sources. These data are available in Appendix B.

In most wells, nitrate concentrations did not seem to change significantly throughout the year. One well (14845), located in a subdivision of Grants Pass had winter concentrations that were double or quadruple that of summer concentrations, but the concentrations were very low (see Figure 3).

Figure 3: Repeat sampling showed an increase in nitrate concentrations at this well in wet winter months, although concentrations are very low.

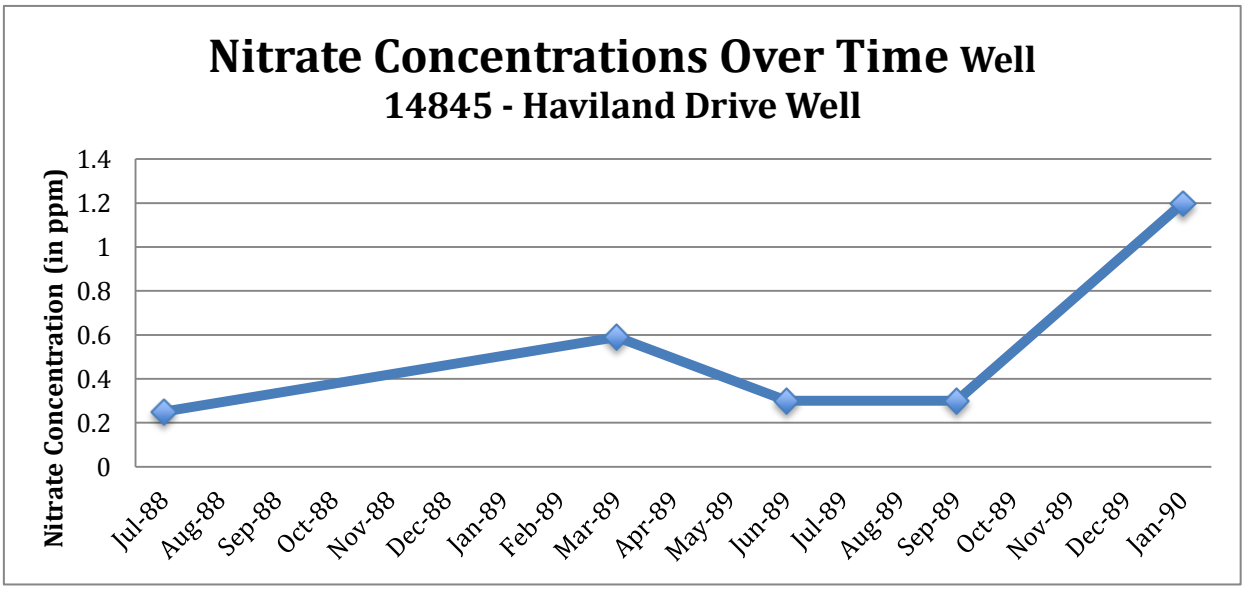
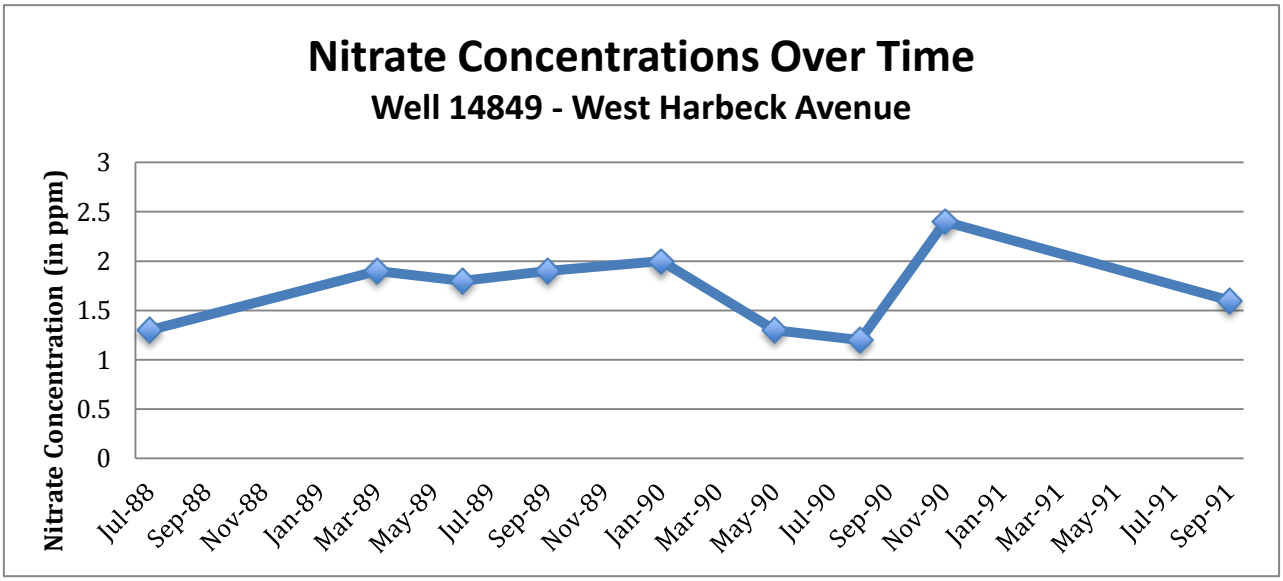


Figure 4 similarly demonstrates some signs of winter increases in nitrate concentration in a second well (14849), with data from July 1988 through September 1991. These wet weather nitrate increases are likely due to flushing of nitrate from the surface or shallow soils into the groundwater. A concentration increase of 0.6 mg/L was noted in the winter of 1988 (from 1.3 mg/L in July 1988 to 1.9 mg/L in March 1989). An increase of 1.2 mg/L was recorded in the winter of 1990 (from 1.2 mg/L in August 1990 to 2.4 mg/L November 1990). Interestingly, the data showed decreasing nitrate concentrations for the dry summer months of 1988, 1990, and 1991, but not for the summer of 1989. A comparison of nitrate concentrations with precipitation patterns for those years would be an interesting further study.

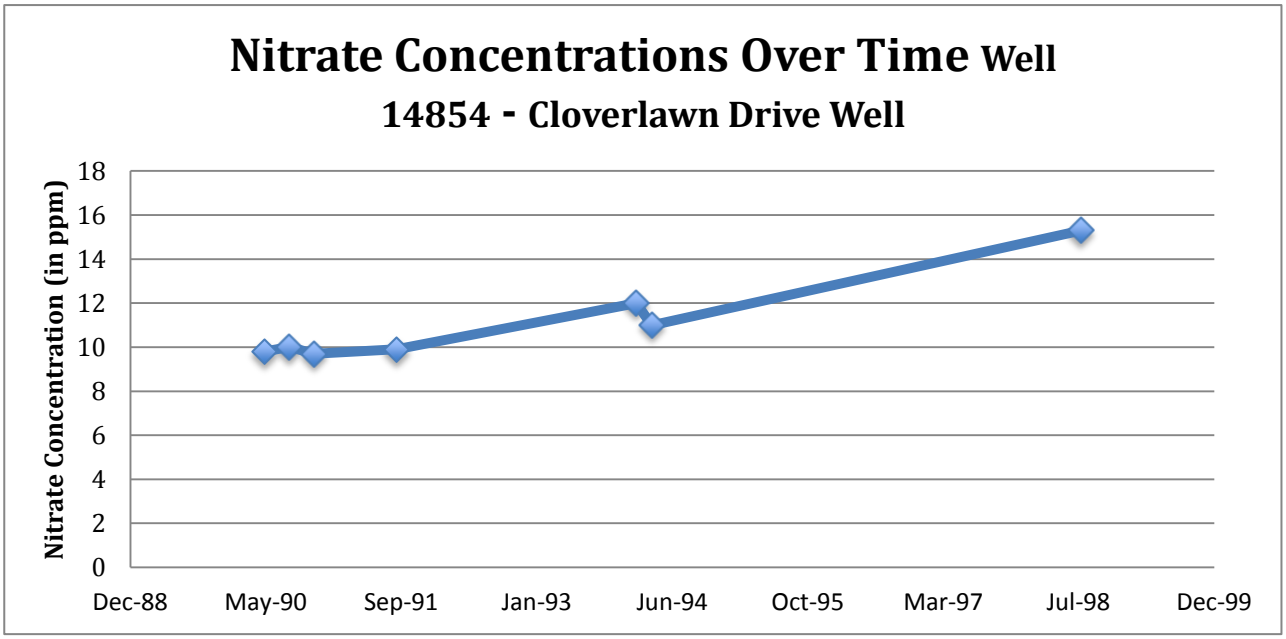
Figure 4: Nitrate concentrations in this well are lowest in the dry summer months of 1988, 1990, and 1991, but remain high during the summer of 1989.



Of the 33 wells sampled during the 1988 to 1991 period, six wells had nitrate concentrations around 1 to 2 mg/L. One well had concentrations hovering above and below the MCL of 10 mg/L, and one well had moderate concentrations of 6 to 7 mg/L.

These two wells with elevated nitrate concentrations were within a half-mile of each other, in a rural residential, small farm agricultural area south of Grants Pass (Cloverlawn Drive, MacNew Lane). The Cloverlawn Drive well had increasing concentrations through January 1994, but showed a slight decrease by March 1994, at the time of DEQ's last sampling. Real Estate Transaction (RET) test data for a well at the Cloverlawn address, however, showed much a higher nitrate concentration (15 mg/L) at the site in 1998 (see Figure 5). Attempts to reach the well owner in order to re-sample this well in 2011 were not successful.

Figure 5: DEQ and RET data for this well indicate a trend of increasing nitrate contamination at this location, exceeding drinking water standards.



Other groundwater quality parameters were detected at levels of concern in a few of the wells tested during the 1988-1994 period. One well, on Hugo Road (north of Grants Pass) had dissolved manganese concentrations of 0.9 to 2.1 from 1988 through 1993. These levels are far above the EPA suggested Health Advisory level of 0.3 mg/L. Another well, in an irrigated agricultural area west of Grants Pass (Hunt Lane), had manganese concentrations above 0.5 mg/L in the fall of 1990 and 1991. A third well in Grants Pass (on Webster Street) showed levels of 1 mg/L. Manganese was detected at 0.63 mg/L in a well on Wagner Creek Road in Talent in January 1992. Concentrations of 0.11 and 0.22 mg/L were detected on Ventura Lane and Truax Road in Central Point in 1994. A majority of the wells tested demonstrated very low to non-detectable levels of manganese, however.

Boron was not detected above the Health Advisory levels in any of the wells tested. Arsenic and Fluoride were not analyzed during the 1988 to 1991 sampling events.

3.5 1992 DEQ Rouge Valley Groundwater Quality Investigation

Two detailed groundwater quality investigations were conducted by DEQ in 1992 and 1994 in Jackson County. The 1992 Investigation was a cooperative study in which USGS, Jackson County, and DEQ participated. The study consisted of groundwater sampling from 27 wells in an area stretching from the cities of Shady Cove and Rogue River down to Ashland and out to the unincorporated town of Ruch (Figure 6). The investigation included only wells that were properly constructed, with completed well records available through the Water Resources Department. Due to these limitations, the 27 wells selected for this investigation tended to be newer, deeper, and located around the fringes of the valley. Only 2 wells were less than 100 feet deep and only 7 were less than 140 feet deep.

Moderate nitrate (6.7 and 4.6 mg/L) was only found in two (alluvial) wells in the north and west Central Point area. One well east of Phoenix had nitrate at 2.9 mg/L. Arsenic was detected in two wells near Shady Cove at 6 and 26 micrograms per liter (ug/L). A Ruch well had arsenic at 8 ug/L. Fluoride was detected at 11 mg/L in one well in Phoenix and at 1.4 mg/L in another in SE Medford, a concern since the Maximum Contaminant Level (MCL) for fluoride is 4 mg/L and secondary standard is 2 mg/L. A boron concentration of 12 mg/L was also measured in the well with the highest fluoride concentration, and a concentration of 14 mg/L in a well in southwest Medford. Some level of boron was detected in all but one well, although mostly at low concentrations. A map of well locations and a table of laboratory results are included as Figure 6 and Table 4.

3.6 1994 DEQ Northern Bear Creek Valley Groundwater Investigation

The objective of the 1994 Groundwater Investigation was to evaluate the groundwater quality from primarily alluvial water table aquifers in the Northern Bear Creek Valley to assess potential groundwater contamination from nonpoint sources.

Nonpoint sources are non-discrete sources, such as fertilizer, pesticides, and area-wide sources such as densely located septic systems. Oregon Department of Agriculture provided assistance in the evaluation of pesticide use in the study area and the ODA laboratory provided pesticide analysis. The Oregon State University Agricultural Chemistry Department assisted in pesticide analyte selection and data interpretation. Oregon Department of Environmental Quality Water Quality staff conducted the project management and planning and DEQ Laboratory staff assisted with sampling plans, sampling, and conducted laboratory analyses. After receiving results from the November 1994 sampling, confirmation sampling was conducted in January 1995.

Most of the 19 wells selected for this study were older, located in more established areas of the valley, and tended to be more shallow (Figure 7). Of the wells sampled, only 4 were deeper than 100 feet and 9 were completed at less than 80 feet deep. Three wells had no well logs. Ten of the 20 wells sampled were drilled after 1980. Most of the others were drilled in the 1960s or 1970s.

This investigation covered areas west and northwest of Medford, north of Central Point, and in the western part of White City. Nitrate above 3 mg/L was found in 65% of the wells sampled. Nitrate concentrations at moderate levels and some at or above the EPA drinking water standard (10, 12, 13 mg/L) were detected in three wells in an agricultural area between Central Point and Jacksonville.

Figure 6: DEQ 1992 Rogue Valley Groundwater Investigation Locations

Table 4: Rogue Valley Groundwater Quality Investigation Results , Department of Environmental Quality 1992.

Station Identifier	Nitrate/nitrite as N (mg/L)	Total Arsenic (mg/L)	Fluoride (mg/L)	Dissolved Boron (mg/L)	Dissolved Manganese (mg/L)
ROG001	<0.02	<0.005	0.8	1.3	<0.01
ROG002	0.06	<0.005	0.2	0.17	0.02
ROG003	<0.02	<0.005	0.2	0.39	0.02
ROG004	0.68	<0.005	0.2	0.38	<0.01
ROG005	<0.02	<0.005	11	12	<0.01
ROG006	1.1	<0.005	0.1	0.07	0.63
ROG007	<0.02	<0.005	1.4	2.8	<0.01
ROG008	<0.02	<0.005	0.5	0.36	0.13
ROG009	2	<0.005	0.1	0.08	<0.01
ROG012	0.81	<0.005		0.43	<0.01
ROG013	0.04	<0.005		14	<0.01
ROG014	2.7	<0.005		0.15	<0.01
ROG015	0.51	<0.005		0.37	0.1
ROG016	0.02	<0.005		1.2	0.16
ROG017	4.6	<0.005		0.12	<0.01
ROG018	2.9	<0.005		0.16	<0.01
ROG019	<0.02	<0.005		2.2	0.05
ROG020	6.7	<0.005		0.05	<0.01
ROG021	<0.02	0.006		0.61	<0.01
ROG022	<0.02	0.026		1	0.02
ROG023	0.02	<0.005		1.6	0.01
ROG024	<0.02	<0.005		1.1	<0.01
ROG025	1.3	<0.005		0.08	0.03
ROG026	0.15	<0.005		0.04	<0.01
ROG027	<0.02	<0.005		0.43	0.18
ROG028	0.06	<0.005		<0.03	<0.01
ROG029	1.9	<0.005	0.1	0.06	<0.01

Figure 7: DEQ 1994 Bear Creek Valley Groundwater Investigation Locations

9.2 mg/L nitrate was also detected in a well near Four Corners, northeast of Central Point. A map, and table of results are included as Figure 7 and Table 5.

Water samples were also analyzed for selected pesticides (those expected to be in use in the area). Pentachlorophenol was detected in one well near a parking lot and area of intensive agricultural activity. Dacthal Acid, a pesticide, was detected in another well—surprisingly—in the deepest well (200 feet deep) of the study. The Dacthal was not detectable in a confirmation sample collected two months later, although Trichlorofluoromethane and Chloroform were detected in an increased Volatile Organic Compounds scan.

Table 5: Bear Creek Valley Groundwater Quality Investigation Results, Department of Environmental Quality 1994

Station Identifier	Nitrate/nitrite as N (mg/L)	Total Arsenic (mg/L)	Fluoride (mg/L)	Dissolved Boron (mg/L)	Total Manganese (mg/L)
BCV01	3.1	<0.005	0.1	<0.03	<0.01
BCV02	3.9	<0.005	0.1	<0.03	<0.01
BCV03	<0.02	0.016	0.2	0.19	0.23
BCV04	<0.02	<0.005		0.13	0.11
BCV06	9.2	<0.005	0.1	<0.03	0.02
BCV07	4.5	<0.005		0.35	<0.01
BCV08	4.5	<0.005		0.35	<0.01
BCV09	3.9	<0.005	0.5	0.54	<0.01
BCV10	13	<0.005	0.2	0.19	<0.01
BCV11	5	<0.005	0.1	0.29	<0.01
BCV12	12	<0.005		0.37	<0.01
BCV13	10	<0.005		0.34	<0.01
BCV14	0.85	<0.005	0.1	0.17	<0.01
BCV15	4.2	<0.005	0.7	0.99	0.03
BCV16	5.7	<0.005	0.2	0.24	<0.01
BCV17	0.34	<0.005	0.2	0.36	<0.01
BCV18	3.3	<0.005	0.2	<0.03	<0.01
BCV19	2.4	<0.005	0.2	<0.03	<0.01
BCV20	<0.02	<0.005	0.6	0.8	0.01

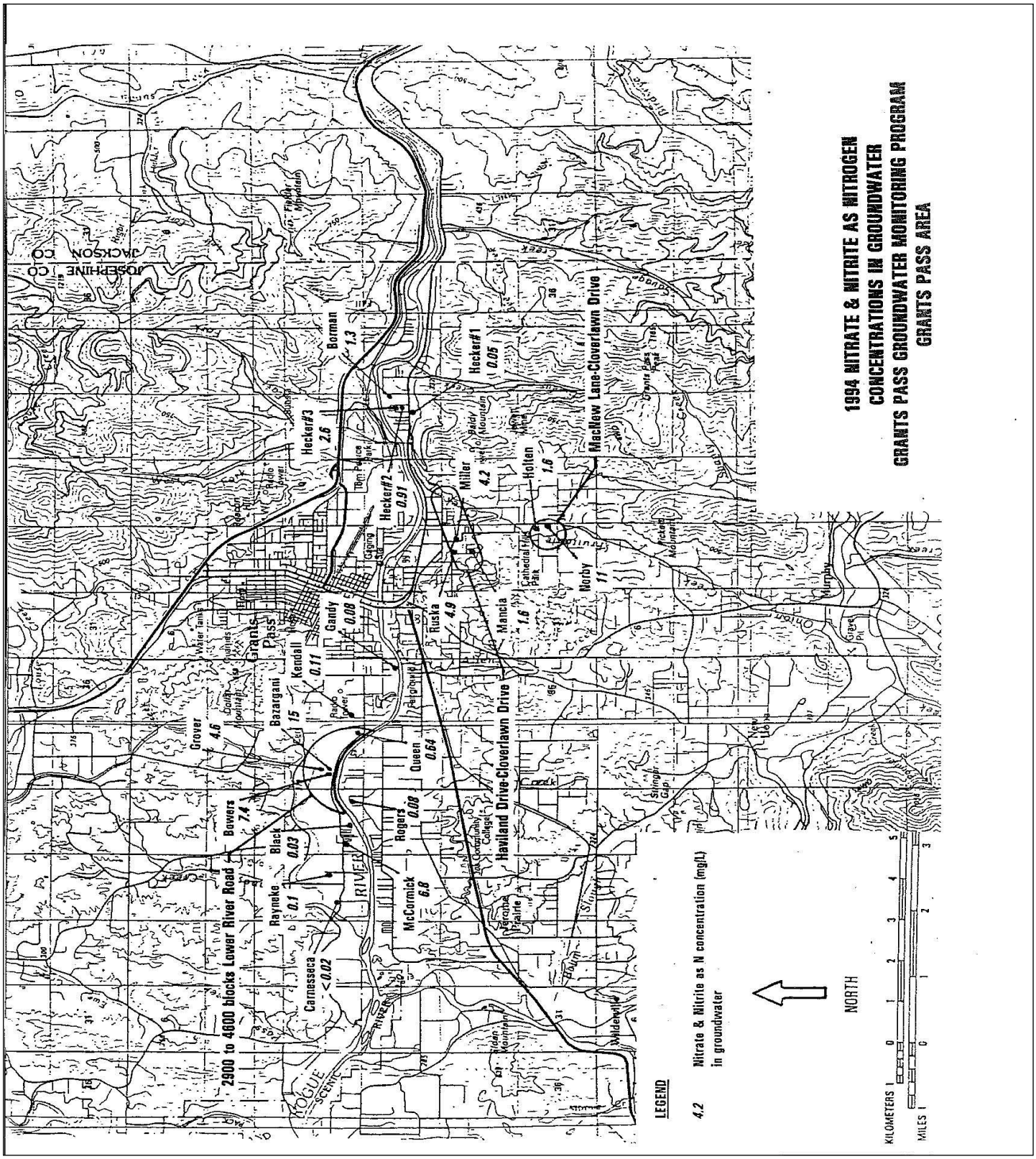
3.7 1994 DEQ Grants Pass Groundwater Investigation

Twenty wells were sampled in the Grants Pass area in February and April of 1994. Nitrate above 3 mg/L was detected in seven (35%) of the wells, and high nitrate (over 10 mg/L) was detected in two wells (see Table 6). The three areas with elevated nitrate concentrations were the 2900 to 4600 blocks of Lower River Road, the Haviland Drive-Cloverlawn Drive area, and the MacNew-Cloverlawn Drive portion of Fruitdale Creek (see Figure 8). Onsite septic systems, and possible canal leakage or nearby agricultural sources were considered potential causes for the nitrate in groundwater at these locations. Volatile organic compounds (VOCs) were also detected in four wells in the Laureldale Lane area, possibly due to a leak of solvents from a nearby source. As of 2012, this contamination was under investigation through the DEQ Environmental Cleanup Section of the Land Quality Division.

Table 6: Grants Pass Groundwater Quality Investigation Results, Department of Environmental Quality 1994

Station ID	Nitrate / nitrate as N (mg/L)*	Dissolved Arsenic (mg/L)	Total Arsenic (mg/L)	Dissolved Boron (mg/L)	Chloride (mg/L)	Dissolved Manganese (mg/L)	Total Manganese (mg/L)
ROG 030	4.6	<0.005	<0.005	0.03	25	0.02	0.02
ROG 031	14	<0.005	<0.005	<0.03	27	<0.01	<0.01
ROG 032	7.4	<0.005	<0.005	<0.03	10	<0.01	<0.01
ROG 033	0.03	<0.005	<0.005	0.05	7.9	<0.01	<0.01
ROG 034	6.8	<0.005	<0.005	<0.03	11	<0.01	<0.01
ROG 035	0.1	<0.005	<0.005	0.25	410	<0.01	<0.01
ROG 036	<0.02	<0.005	<0.005	0.32	480	<0.01	<0.01
ROG 037	0.08	<0.005	<0.005	0.03	43	<0.01	<0.01
ROG 038	0.08	<0.005	<0.005	0.06	34	1	1
ROG 039	0.11	<0.005	<0.005	<0.03	8.4	<0.01	<0.01
ROG 040	0.64	<0.005	<0.005	0.21	72	<0.01	<0.01
ROG 041	1.3	<0.005	<0.005	<0.03	4.5	0.02	0.02
ROG 042	0.05	0.013	0.011	<0.03	5.5	<0.01	<0.01
ROG 043	0.91	<0.005	<0.005	<0.03	3.8	<0.01	<0.01
ROG 044	2.6						
ROG 045	4.2	<0.005	<0.005	<0.03	5.8	<0.01	<0.01
ROG 046	4.9	<0.005	<0.005	<0.03	5.7	<0.01	<0.01
ROG 047	1.6	<0.005	<0.005	<0.03	3.6	<0.01	<0.01
ROG 048	1.6	<0.005	<0.005	0.16	280	<0.01	<0.01
ROG 049	11	<0.005	<0.005	0.22	84		

Figure 8: DEQ 1994 Bear Creek Valley Groundwater Investigation Locations



3.8 1995 – 1997 Jackson County Well Ordinance Data

Jackson County, together with the Rogue Valley Council of Governments, initiated a groundwater quantity and quality investigation in the late 1980s. The goals were to:

- Build upon the existing data base by a) a cooperative effort with the US Geological Survey (USGS) to establish monitoring wells in strategic locations throughout the county, and b) requiring key information be provided by the applicants seeking a well permit with Jackson County.

- Determine if there were areas of water quantity and/or quality concern that might affect public health or threaten the integrity of groundwater itself.

- Provide better information to planners and land use decision makers as to areas of concern related to groundwater quality and/or quantity.

- Inform the public about well construction, operation and potential concerns related to groundwater quantity and quality.

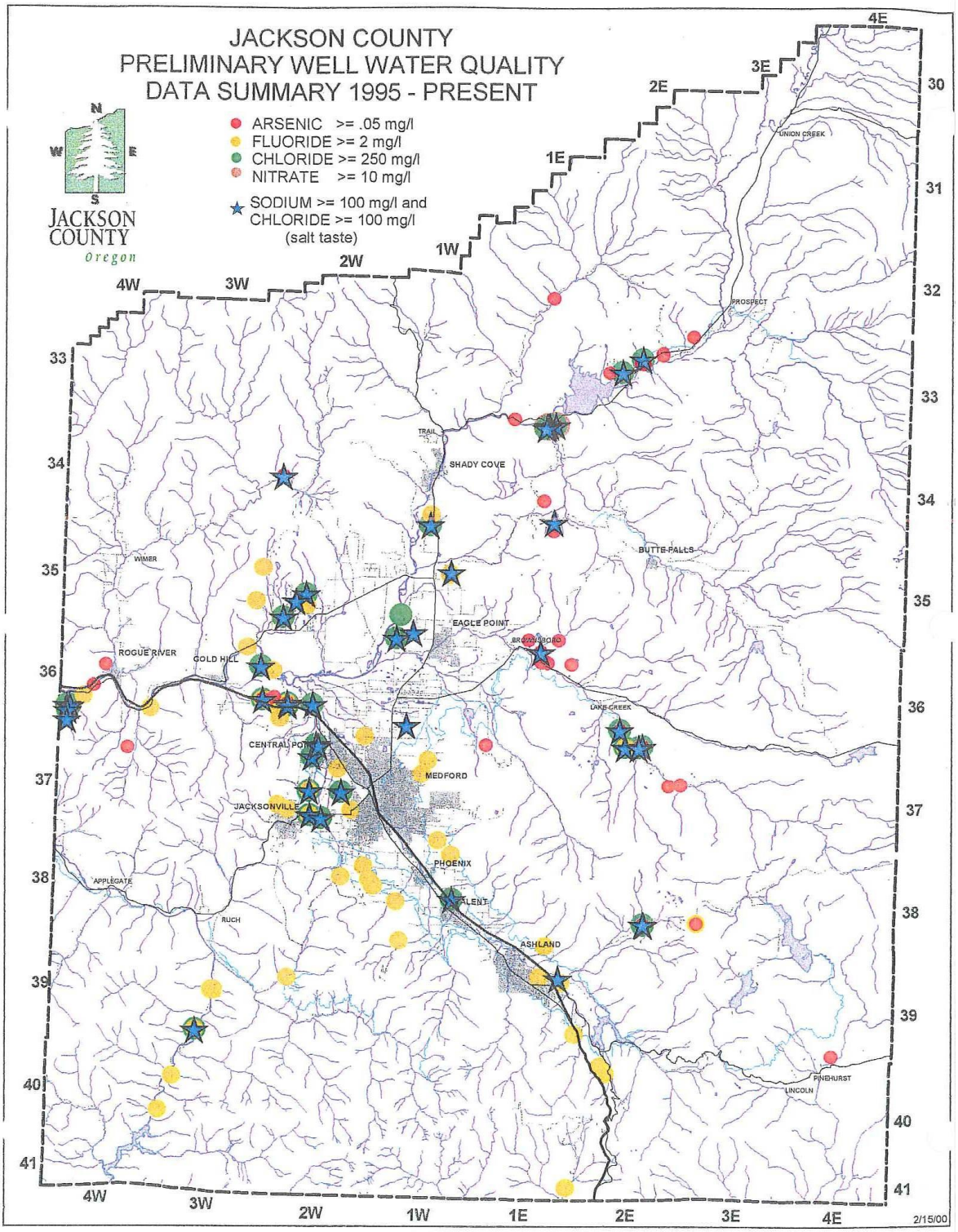
The USGS established several monitoring wells in Jackson County, but local funding ran out before much data and analyses were obtained. The effort shifted to developing a mechanism whereby reliable long-term data could be generated as part of a revision to the county groundwater ordinance. After several years of drafting and with the help of the Jackson County Ground Water Advisory Committee, the County adopted a revised groundwater ordinance which called for applicants for a well permit to a) provide the results of a "top ten" water quality test, including nitrate, fecal coliform, boron, arsenic and fluoride levels, b) a "4 hour" flow test and c) an "as built" map of the well's final location.

Three years of data were collected (from 1995 to 1997) before the ordinance was rejected by the Oregon Supreme Court on the basis that the "as built" map requirement duplicated the State requirement of an initial well location on the driller's "Start Card". The revised county groundwater ordinance as well as the one it replaced were cancelled and no longer in effect. Currently Jackson County has no ordinance specifically addressing groundwater issues.

The data, from 1,612 wells, show the presence of arsenic at levels greater than 50 ug/L (5 times the current drinking water standard) east of Shady Cove, Eagle Point, southeast of Lake Creek, and east of Ashland and some detections north and south of Rogue River and west of Medford. Fluoride was detected west of Medford, Phoenix and Talent, northwest of Central Point, east of Ashland and south along the Interstate 5 corridor, southwest and southeast of Rogue River, and along the Applegate Road south of Ruch. Boron and Chloride detections were sporadic around the area. Nitrate concentrations above the drinking water standard of 10 mg/L were detected in two wells southwest of Lost Lake (See Figure 9).

The termination of the ordinance hindered the county's efforts to address local ground water issues and prevented achievement of the goals of the initiative.

Figure 9: Jackson County Well Ordinance Data 1995-1997

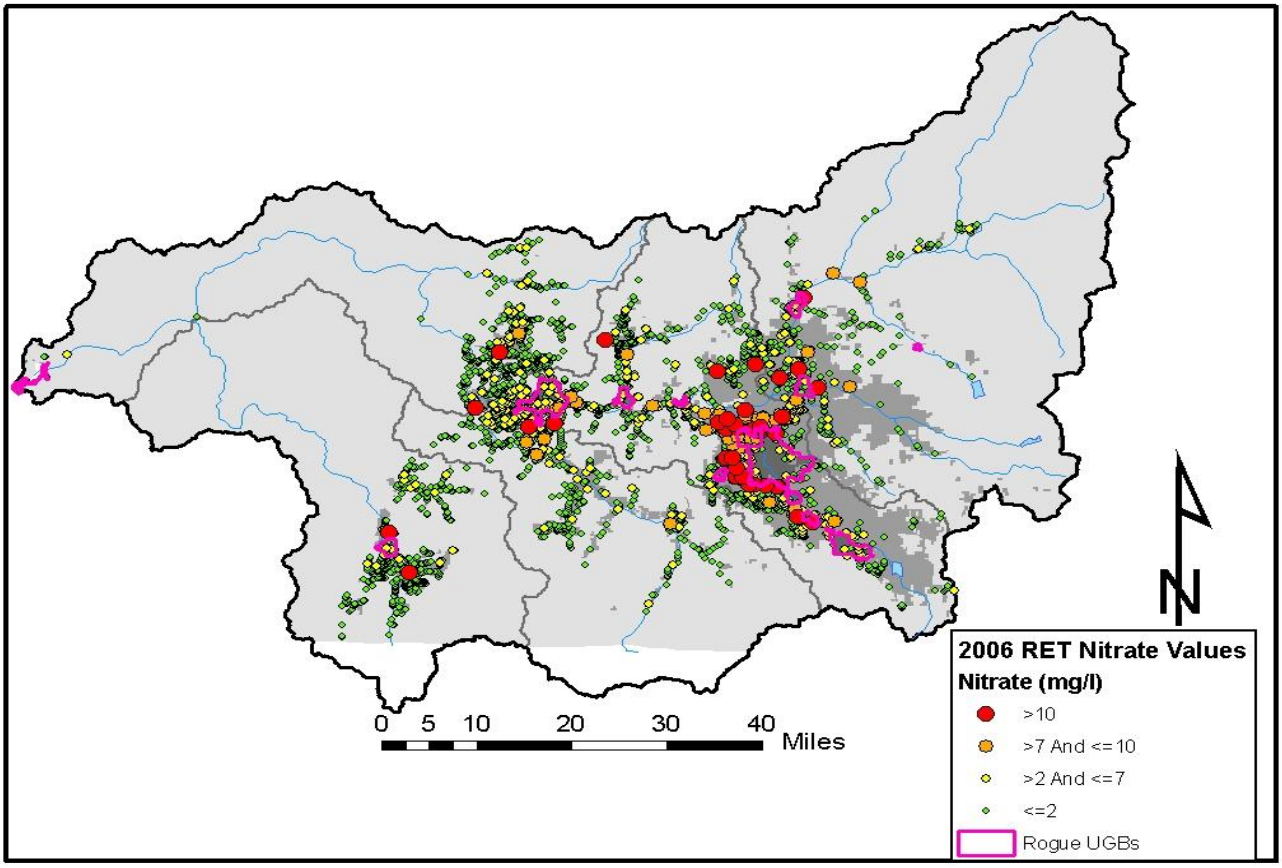


3.9 1989 – 2006 Real Estate Transaction Data – nitrate and Bacteria

Beginning in 1989, private well owners were required to test for E. coli bacteria, nitrate as nitrogen at time of real estate property transfer. A requirement to test for arsenic was added later. At the time of this report, data was processed and available for mapping through 2006. Of the over 5700 Real Estate Transaction data record collected from 1989 through 2006, 4950 samples (87%) recorded for the Rogue Basin study area showed no significant concentration of nitrate (less than 2 mg/L). Thirteen percent, however, showed some nitrate concentration impact due to anthropogenic activities. 124 of the wells sampled (2%) showed results of 7 mg/L or higher. 49 well samples had concentrations greater than the EPA drinking water standard of 10 mg/L. 16 samples were over 15 mg/L (although 2 of those samples were from the same address, one collected in 1990 and one in 1995). Figure 10 shows the distribution of nitrate concentrations around the basin.

The most hazardously high nitrate levels were detected on Holland Loop Road in Cave Junction (118 mg/L), White Oak Drive in Cave Junction (106 mg/L), on Old Ferry Road in Shady Cove (41.9 mg/L), Adeline Drive in Grants Pass (35.9 mg/L), Orchard Home Drive in Medford (28 mg/L), Queens Branch Rd in Rogue River (22.5 mg/L) and on Vilas Road in Central Point (22.3 mg/L). Several of these sites are surrounded by agricultural activity and yet some appear (according to Google Earth locators) to be away from urban and agricultural areas. It is possible that such high nitrate concentrations are associated with activities in close proximity to the wells.

Figure 10: Real Estate Transaction Data, Rogue Basin, 1989 to 2006



Nitrate levels in the 7 to 20 mg/L range showed some similarities of locations. More than one high nitrate sample was reported on Old Stage Road, Merrita Terrace, Larch Ave, Orr Drive, Blackwell Road, Truax Road, Ventura Lane and Scenic Ave in Central Point, South Stage Road in Medford, Cloverlawn Drive in Grants Pass, and Dutton Road in Eagle Point.

For several properties that had reported samples on different dates, a downward or upward trend in nitrate concentration was noted. These changes in concentration could be due to groundwater level fluctuations, seasonal changes, or changes in nitrate inputs at the surface over time.

At one property on South Stage Road in Medford, levels reduced from 19.8 mg/L in September of 1998 to 9.04 mg/L in January of 2005. A Dutton Road property in Eagle Point, however, showed an increase in nitrate concentration from 8.5 mg/L November 1999 to 9.18 mg/L in March of 2000. Nitrate concentrations at an Old Stage Road well in Central Point remained relatively unchanged from 18.9 mg/L in August 1990 to 18.3 mg/L in May of 1995. In one case, however, 2 samples collected at the same address within a 2-week period had fairly different results: 13.2 mg/L and 15.3 mg/L. This differentiation could be due to a difference in sample collection and handling processes but could also indicate a sample collected from a second well on the property, drawing from a different depth of aquifer.

3.10 Public Water Supply Systems with Nitrate above 5mg/L

The Drinking Water Program of the Oregon Health Authority (OHA) oversees state drinking water regulations for public water system providers in the state. Systems of various sizes and providing to stable or to “transient” (temporary) populations are required to test for different parameters at differing frequencies. The OHA provided a printout of public water supply systems using groundwater that have reported nitrate concentrations above 5 mg/L at some point between 2002 and 2010.

In Jackson County, the systems which have had nitrate above 5 mg/L include: Applegate River Lodge and Restaurant, Box R Ranch Cabins, COE Takelma Park, Cypress Grove RV Park, Dardanelle Trailer Park, Farm Kids & Critters, G&B Market, Jackson Co Parks Rogue Elk Park, Ruch Library, Lakewood RV Park, Living Praise Tabernacle, Medford Moose Lodge #178, Stage Stop Store, Trinity Baptist Church, Westhills Country Store, and Willies Bar & Grill. The only sites with nitrate concentrations exceeding the drinking water standard at some point were Lakewood RV Park and the Rogue Elk Park.

Josephine County systems which have had nitrate above 5 mg/L include: Baldinis, Beavercreek RV Park, College Heights Baptist Church, Doubletree Place, Josephine County Parks Whitehorse Park, Merlin LDS Church, Pine Tree Tavern, Provolt Community Church, Redwood Select Market, and River Haven Mobile Home Estates.

All sites have made adjustments to keep their water supplies within the drinking water standards as required by the State of Oregon.

4. Project Description – Rogue Basin Groundwater Investigation

4.1 Approach

The Rogue Basin Groundwater Investigation began with a series of public education and free nitrate testing events. Permission for further well testing was also obtained from property owners at these events. Wells for the study were then selected from among these well owners, wells previously sampled by DEQ, WRD, or USGS, and newly selected wells.

4.2 Spring 2011 Volunteer Nitrate Testing Data

From March to June of 2011, twelve volunteer nitrate testing and public education events were conducted in eleven cities within the Rogue Basin. These events drew more than 400 attendees. Approximately 325 samples were analyzed and permissions received to conduct further analysis at 118 properties (see Appendix C).

To preserve privacy, data results were not recorded at these events. However, a map was provided at the events and participants encouraged to record their nitrate results using colored dots. Approximately 85% of nitrate sample participants recorded results in this way. 16 red dots (indicating nitrate over 7 mg/L), 23 yellow dots (indicating nitrate between 3 and 7 mg/L), and 183 green dots (indicating nitrate below 3 mg/L) were recorded on the Jackson County map. Approximately 18% of well tests (as recorded on the map) had elevated nitrate above 3 mg/L.

Areas in Jackson County with the highest percentages of elevated nitrate (above 3 mg/L) included Central Point (59% of wells – 8 red, 5 orange, and 9 green), Gold Hill (40% of wells – 3 red, 3 orange, 9 green), Applegate (25% of wells – 0 red, 3 orange, 12 green), Medford (21% of wells – 1 red, 3 orange, 15 green), and Ashland (20% of wells – 3 red, 1 orange, 16 green).

In Josephine County, there was only 1 red dot, 5 orange, and 46 green recorded on the map, indicating 12% wells with elevated nitrate above 3 mg/L. Areas with the highest percentages of elevated nitrate included Williams, near Applegate (22% - 2 orange, 7 green), and Grants Pass (15% - 2 orange, 13 green). Hugo only had one sample – an orange.

4.3 Well Selection

Fifty-two wells were selected to be part of this study. Wells selected were generally less than 200 feet deep and had reasonably reliable well logs on file with the Oregon Water Resources Department (WRD). An attempt was made to select a representative number of wells in each area where, based on historic data, nitrate, fluoride, boron and arsenic might be located. The goal of the study was to assist in the delineation of these areas. Identification of boundaries of high nitrate, fluoride, arsenic and boron concentrations in groundwater would assist to focus public education campaigns for private well owners who may not be aware of health impacts of drinking water with elevated levels of those constituents. Limitations on well selection were the ability to contact owners and obtain permission and identification

of an accurate well record from WRD files. Not all wells selected had well records, however. Well records for wells tested are included as Appendix D.

In all cases, the owner's pump was used to pull samples from the well. In a couple cases, well water ran first to a large holding tank. In these cases, the water sample was not fresh, but taken from the tank via piping to an outdoor spigot. Where a treatment system was in use, a bypass valve were used to collect water samples before the treatment system. It is possible that, at a few sites, the residential treatment system was not bypassed and some groundwater constituents were removed or reduced.

4.4 Laboratory Analyte Selection

Laboratory analyte selection was based on prominent parameters of concern in the groundwater of the Rogue Basin. Parameters selected for testing are listed in Table 7 along with the limit of quantitation (LOQ) for each analyses. Vanadium was not a targeted parameter but was analyzed and reported as part of a suite of analytes.

Field parameter testing for pH, conductivity, temperature and dissolved oxygen were used to ensure collection of representative samples from the groundwater formation (or, in some cases, from a holding tank when no tank bypass was available).

Due to budget constraints, pesticide sampling was not conducted for this study.

4.5 Sampling Procedures

DEQ staff Rich Myzak and Ben Johnson, Audrey Eldridge and assistant Amy Patton sampled 52 domestic and irrigation wells during a one-week period of July 2011. GPS readings were collected to record latitude and longitude for all wells. All field monitoring equipment was tested for accuracy and/or calibrated daily in accordance with the procedures outlined in the DEQ Watershed Assessment Mode of Operations Manual (MOM).

Sampling was conducted using the standard DEQ protocol described in the Field Sampling Reference Guide Revision 5.0 and MOM. Field parameter data were collected for temperature, conductivity, pH, and dissolved oxygen. Samples collected for dissolved constituent analyses were run through an 0.45 micron filter. Specific sample preservation methods and holding times are summarized in Table 8. Separate field data sheets were maintained for each sampling event. Information recorded on data sheets included: Project name, data and time of sampling events, well address, LASAR numbers, general weather conditions, and names of field staff, time of each sample or measurement, results and equipment ID numbers. Samples were held in coolers on ice, and transported to the laboratory via courier or by DEQ staff.
Duplicate, quality assurance (QA) samples, were collected at a minimum of 10% of the total number of monitoring sites, or at least one duplicate per sample day for each sampling team. Each sample team collected at least one field transfer blank each day.

5. July 2011 DEQ Groudwater Quality Sample Results

Water quality results from this study are presented in Table 9. The full laboratory reports are included as Appendix E. The data considered most carefully for the purposes of this report were nitrate, arsenic, fluoride, boron, and vanadium concentrations. Manganese and chloride concentrations were observed, but not considered an area-wide concern.

TABLE 7: Sample Parameter List and Limits of Quantification (LOQ)

Parameter	Method	LOQ	Units	Matrix
Field Parameters				
Field Conductivity	2510 B	1	µmhos/cm @ 25° C	Aqueous
Field Dissolved Oxygen	LDO	1	mg/L	Aqueous
Field pH	150.1	N/A	SU	Aqueous
Field Temperatrue	2550 B	N/A	°C	Aqueous
General Chemistry				
Chloride	300.0	0.50	mg/L	Aqueous
Fluoride	300.0	0.10	mg/L	Aqueous
Nitrate/nitrite as N	4500-NO3 F	0.005	mg/L	Aqueous
Metals (Metal Cations by ICP, Dissolved)				
Dissolved Aluminum	200.7	0.050	mg/L	Aqueous
Dissolved Boron	200.7	0.020	mg/L	Aqueous
Dissolved Calcium	200.7	0.10	mg/L	Aqueous
Dissolved Iron	200.7	0.050	mg/L	Aqueous
Dissolved Lithium	200.7	0.015	mg/L	Aqueous
Dissolved Magnesium	200.7	0.10	mg/L	Aqueous
Dissolved Manganese	200.7	0.0050	mg/L	Aqueous
Dissolved Potassium	200.7	0.50	mg/L	Aqueous
Dissolved Silicon as Silica (SiO2)	200.7	0.15	mg/L	Aqueous
Dissolved Sodium	200.7	0.30	mg/L	Aqueous
Dissolved Calculated Hardness as CaCO3	2340 B	0.70	mg/L	Aqueous
Metals (Metal Cations by ICP, Total Recoverable)				
Total Recoverable Aluminum	200.7	0.050	mg/L	Aqueous
Total Recoverable Boron	200.7	0.020	mg/L	Aqueous
Total Recoverable Calcium	200.7	0.10	mg/L	Aqueous
Total Recoverable Lithium	200.7	0.050	mg/L	Aqueous
Total Recoverable Magnesium	200.7	0.015	mg/L	Aqueous
Total Recoverable Manganese	200.7	0.0050	mg/L	Aqueous
Total Recoverable Potassium	200.7	0.50	mg/L	Aqueous
Total Recoverable Silicon as Silica	200.7	0.15	mg/L	Aqueous
Total Recoverable Sodium	200.7	0.30	mg/L	Aqueous
Total Recoverable Hardness as CaCO3	2340 B	0.70	mg/L	Aqueous

TABLE 7 (Continued): Sample Parameter List and Limits of Quantification (LOQ)

Parameter	Method	LOQ	Units	Matrix
Metals (Metals in Source Water by ICPMS, Dissolved)				
Dissolved Arsenic	200.8	2.0	µg/L	Aqueous
Dissolved Antimony	200.8	2.0	µg/L	Aqueous
Dissolved Lead	200.8	0.20	µg/L	Aqueous
Dissolved Selenium	200.8	2.0	µg/L	Aqueous
Dissolved Thallium	200.8	0.10	µg/L	Aqueous
Dissolved Copper	200.8	1.5	µg/L	Aqueous
Dissolved Zinc	200.8	5.0	µg/L	Aqueous
Metals (Metals in Source Water by ICPMS, Total Recoverable)				
Total Recoverable Arsenic	200.8	2.0	µg/L	Aqueous
Total Recoverable Antimony	200.8	2.0	µg/L	Aqueous
Total Recoverable Lead	200.8	0.20	µg/L	Aqueous
Total Recoverable Selenium	200.8	2.0	µg/L	Aqueous
Total Recoverable Copper	200.8	1.5	µg/L	Aqueous
Total Recoverable Zinc	200.8	5.0	µg/L	Aqueous

Table 8: Sample Preservation Methods and Holding Times

Test	Number of Samples	Holding Time (Contract Lab)	Container	Sample Preservation
Boron	50-80	6 months	250 TM Poly	Cool on ice to 4 degrees C
Nitrate	50-80	28 days	500 ml R* poly	H2SO4 to pH<2; 4 degrees C
Arsenic	50-80	6 months	250 TM Poly	Cool on ice to 4 degrees C
Fluoride	50-80	6 months	250 TM Poly	Cool on ice to 4 degrees C

5.1 Nitrate Results

Water quality results from this study are presented in Table 9. The graph in Figure 11 shows the distribution of nitrate concentration results. Two wells, in rural residential and agricultural areas of Central Point and Ashland, had nitrate concentrations close to 20 mg/L, almost twice the drinking water standard.

Two other wells with concentrations hovering around the drinking water standard (11.3 and 8.7 mg/L) were located north of Ashland, in rural residential and irrigated agricultural areas, and in Gold Hill. Twenty-two wells with moderately high nitrate (between 3 and 7 mg/L) were detected in rural areas mostly north and west of Medford. Only low nitrate concentrations were noted in the Jacksonville, Rogue River, Shady Cove, Merlin, Cave Junction and Talent areas. Eagle Point also had 3 wells with low nitrate levels.

Figure 11: Approximately one third of the wells sampled have moderate nitrate concentrations (3 to 5 mg/L) and more than 10% have concentrations above 5 mg/L. Note that concentrations reading 0 mg/L in the graph above are actually <0.005 mg/L (the analysis limit of quantitation, LOQ).

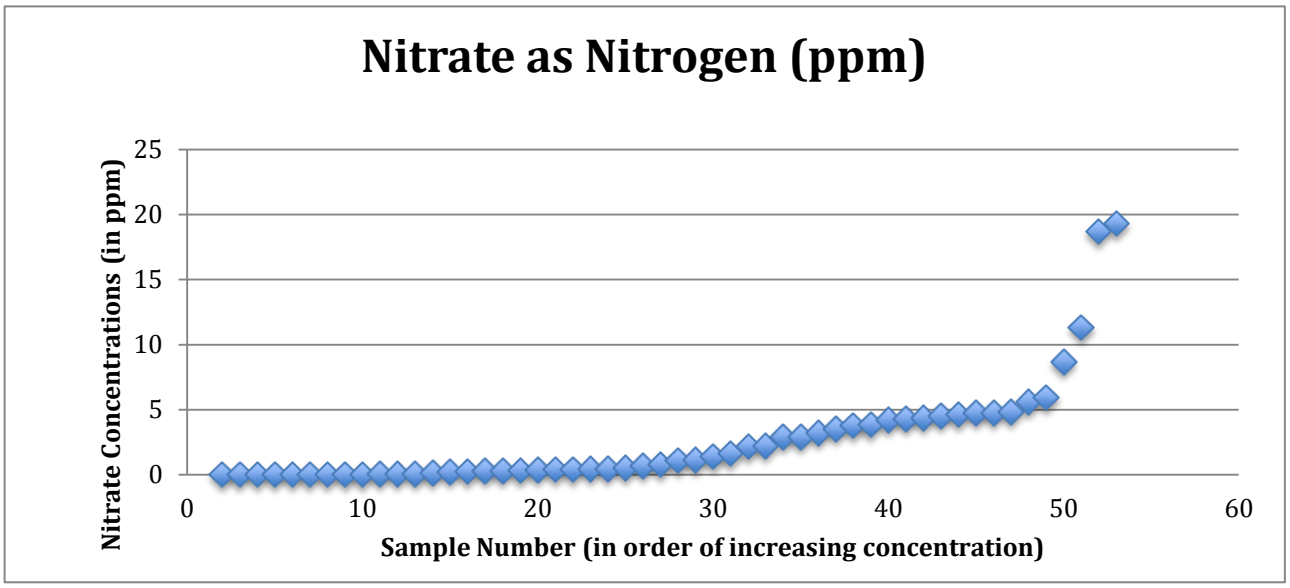


Table 9: Rogue Basin Groundwater Quality Investigation Results, July 2011, Department of Environmental Quality.

Sample ID	Nitrate	Total Aresenic	Flouride	Total Boron	Total Vanadium	Total Manganese	Well Depth	Aquifer Type	First Water	Static Water	Well Date
	ppm	ppb	ppm	ppm	ppb	ppm	feet		feet	feet	
RV-001	19.3	<1.0	0.11	0.035	<4.0	<0.005	200	claystond under br clay		60	1991
RV-003	2.18	<1.0	<0.1	<0.02	8.2	<0.005	90	br clay, small-med gravel	75	21	1987
RV-004	0.04	18.0	<1.0	0.02	8	1.18	50	no log alluvial			1989
RV-005	0.01	<1.0	0.46	0.305	4.5	<0.005	75	br clay, med gravel, sandy	50	6	1991
RV-006	5.94	2.5	0.5	0.39	33.7	<0.0085	35	sand / gravel lense over clay			1969
RV-008	3.5	<1.0	0.58	0.67	<4.0	<0.005	60	sand / gravel lense u clay	21	6	1971
RV-009	2.9	1.6	0.13	0.062	9.8	<0.005	100	blue / gr clay stone	78	15	1989
RV-010	0.3	1.4	0.1	0.597	<4.0	0.0273	100	br / gr volcanic tuff	41	17	1996
RV-011	0.29	<1.0	0.13	0.133	<4.0	0.0256	180	gray claystone	151	19	1993
RV-013	1.15	3.0	<0.10	0.063	7.7	<0.005	300	gr / green sandstone w/qtz	139	12	2005
RV-014	0.05	2.2	0.1	0.31	<4.0	0.0115	171	bl / grey / br claystone		14	1970
RV-015	2.89	<1.0	0.11	0.028	4.4	<0.005	103	br stand stone over claystone	51	38	1971
RV-016	4.74	<1.0	<0.10	<0.02	16.2	<0.005	60	br gravel	35	12	2003
RV-017	0.14	11.7	0.13	0.161	<4.0	0.0061	240	grey basalt u claystone	210	220	1993
RV-018	0.02	<1.0	1.42	0.041	<4.0	<0.005	404	metemor-phic sed / black	103	51	1998
RV-019	0.01	<1.0	0.11	0.087	<4.0	0.0075	150	gravel u clay	120	15	1992
RV-020	3.2	1.8	0.21	<0.02	29.6	<0.005	122	fractured basalt	92	8	1978
RV-022	0.01	<1.0	0.88	2.53	<4.0	<0.005	275	Blue / grey sandstone	110	103	1988
RV-024	18.7	2.6	0.14	0.036	14.5	<0.005	142	sandstone conglom layers	0	31	1992
RV-027	0.06	<1.0	<0.10	<0.020	6.7	<0.005	100	Sm / med boulders over clay	80	18	2002
RV-028	0.8	<1.0	0.1	<0.02	4.6	<0.005	120	de-composed basalt over clay	64	20	1973

Table 9 (Continued): Rogue Basin Groundwater Quality Investigation Results, July 2011, Department of Environmental Quality.

Sample ID	Nitrate	Total Aresenic	Flouride	Total Boron	Total Vanadium	Total Manganese	Well Depth	Aquifer Type	First Water	Static Water	Well Date
	ppm	ppb	ppm	ppm	ppb	ppm	feet		feet	feet	
RV-029	4.37	<1.0	0.13	<0.02	<4.0	<0.005	185	Granite u sandstone	95	19	1981
RV-032	1.41	<1.0	0.17	0.041	15.9	<0.005	75	De-composed granite over granite		25	1966
RV-033	3.84	<1.0	<0.10	0.783	<4.0	<0.005	300	gray claystone	64	35	2002
RV-037	3.78	<1.0	0.18	0.248	6.9	<0.005	140	br / gray claystone	36	20	1999
RV-038	4.74	<1.0	<0.10	<0.020	19	<0.005	97	blue claystone	32	17	1975
RV-041	5.56	1.1	0.23	<0.02	5	<0.005	83	Conglomer ate o basalt	56	18	1975
RV-044	0.41	1.3	0.25	0.044	<4.0	<0.005	320	grey basalt	73	49	1997
RV-047	1.64	<1.0	<0.10	<0.02	5.8	<0.005	320	hard dk green rock / basalt	35	20	2009
RV-051	<0.005	<1.0	0.77	0.275	<4.0	<0.005	146	fractured tombstone / granite	127	41	1977
RV-052	0.26	<1.0	<0.10	0.224	<4.0	0.0683	62	course gravel, sand, boulders	30	11	1972
RV-053	0.45	<1.0	<0.10	<0.02	<4.0	<0.005	140	fine / med graval w/ clay	20	20	1987
RV-054	0.67	<1.0	<0.10	<0.020	<4.0	<0.005	525	sand / gravel layers	19	21	2001
RV-055	0.21	<1.0	0.21	0.029	20.3	<0.005	95	fractured tombstone / granite	63	27	1976
RV-056	0.42	<1.0	0.15	0.092	6.1	<0.005					
RV-057	0.27	<1.0	0.17	<0.02	10.4	<0.005	79	no log – granite u clay	70	26	1983 ?
RV-059	4.26	1	<0.10	<0.02	20.6	<0.005		no log – clay o sandstone			
RV-062	11.3	1.5	<0.10	0.133	20.5	<0.005	80	no log – claystone . congl layers	26	10	2005 ?
RV-063	8.65	<1.0	0.18	0.058	<4.0	<0.005		no log – shaley claystone / chert	33	34	
RV-064	4.82	1.7	0.14	0.024	15.3	<0.005	100	no log – clay stone u gravel			
RV-065	2.22	<1.0	0.22	0.134	<4.0	0.0102	194	sandstone / conglom layers	59	34	1963
RV-066	4.5	<1.0	<0.1	<0.02	19.3	<0.005	58	br / blue clay o sandstone	47	23	1998
RV-067	4.21	<1.0	0.12	<0.02	18.2	<0.005	65	gravel o br/ green clay	45	20	1995

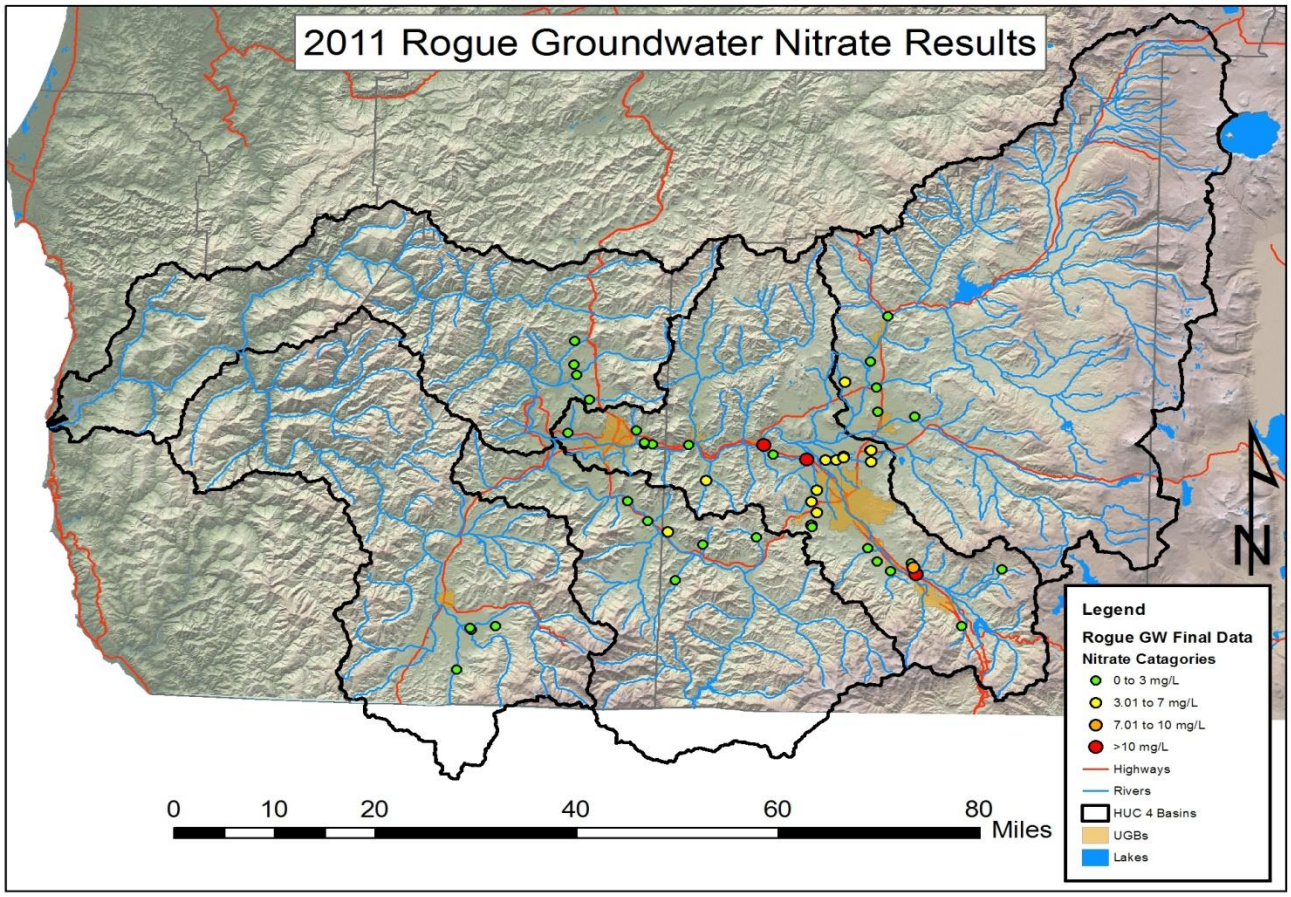
Table 9 (Continued): Rogue Basin Groundwater Quality Investigation Results, July 2011, Department of Environmental Quality.

Sample ID	Nitrate	Total Aresenic	Flouride	Total Boron	Total Vanadium	Total Manganese	Well Depth	Aquifer Type	First Water	Static Water	Well Date
	ppm	ppb	ppm	ppm	ppb	ppm	Feet		feet	feet	
RV-068	4.61	1	0.1	0.028	19	<0.005		no log – bl / grn sandstone u clay	40	8	
RV-069	.041	<1.0	3.31	6.64	<4.0	0.012					
RV-071	<0.005	<1.0	0.3	1.14	<4.0	0.0216	283	sandstone fracture, claystone	122	21	1994
RV-080	<0.005	<1.0	0.45	0.158	<4.0	0.0153					
RV-081	0.51	<1.0	0.32	<0.02	27.1	<0.005	80	fractured tombstone / granite		16.5	1986
RV-110	0.36	<1.0	0.11	<0.02	23.4	<0.005	120	fractured gray rock	77	30	1981
RV-111	<0.005	32.1	0.2	<0.02	<4.0	0.0842	120	schist under claystone	80	7	1980
RV-112	1.09	1.8	<0.10	<0.02	9	<0.005	95	clay w/ sand / gravel o rock	80	38	1995
RV-113	<0.005	<1.0	0.28	0.312	<4.0	0.251	223	fractured claystone / siltstone grey / black	191	Flow	1997 ?

5.1.1 Analysis

Location and Nitrate Concentrations: As anticipated, all of the Central Point wells tested had moderate to high levels (3 to 7 mg/L) to high (7 to greater than 10 mg/L) of nitrate (see Figure 12). And moderate nitrate concentrations were detected in all wells sampled immediately north and west of Medford. Since nitrate concentrations exceeding 2 mg/L generally indicate anthropogenic contributions of nitrate, the results demonstrate that the rural areas north and west of Medford and north of Ashland likely have impacts from agricultural and/or septic system activity. The fact that only 3 sample results showed nitrate concentrations over 10 mg/L might indicate that only moderate inputs of nitrate are occurring across most of the area. Another explanation may be that clayey soils in the area have absorbed much of the nitrate inputs to the ground, preventing high levels of groundwater contamination.

Figure 12: Nitrate concentrations above 3 mg/L and greater than 7 mg/L are concentrated in the areas north and west of Medford and northwest of Ashland.



Geology and Nitrate Concentrations: Seventy-five percent of wells drawing from claystone aquifers showed moderate concentrations of nitrate (>3mg/L), followed by 43% of wells from sandstone aquifers and 41% of wells from alluvial aquifers. The lowest nitrate concentrations were present in wells drawing from basalt (20%) and granitic aquifers (16%). * (see note on page 41)

Well Depth and Nitrate Concentrations: In a comparison of well depth to nitrate concentrations, nitrate concentrations above 2 mg/L were detected in 52% (9 of 17) of the wells sampled which were less than 100 feet deep. This was not unexpected since nitrate contamination originates at or near the surface and many of the shallow wells had static water levels of 6 to 30 feet below grade. Nitrate applications at the surface (from animal manure, fertilizer or septic systems) would not have to infiltrate very deeply to impact groundwater quality in areas of shallow aquifers. Another, likely, pathway for nitrate contamination is poor well construction. Old wells, constructed without surface seals, or which have lost their caps or those that have been simply abandoned in place are all potential conduits to the groundwater for contaminants from the ground surface.

It was surprising, however, to discover that 2 of the 3 samples with the highest nitrate concentrations came from 142 and 200 feet deep wells, although both had shallow static water levels (31 and 60 feet below grade). Of the 9 deep wells with deep first water levels (indicating a deep aquifer), all had extremely low to non-detectable nitrate concentrations and only one had a nitrate concentration close to 1

mg/L. Of all 29 of the over 100 foot deep wells tested, 66% had no detectable nitrate or levels below 2 mg/L. Well log data was not available for 6 of the wells.

Agriculture and Nitrate Concentrations: The strongest data correlation was between high concentrations of nitrate and irrigated agriculture. It should be noted, however, that data regarding irrigation in the vicinity of the well was collected solely through Google Earth images, and therefore may contain inaccuracies.

Nitrate Concentrations Over Time: Of the four wells sampled in 2011 that had previously been sampled by DEQ in 1994, only one showed a significant change in concentration, from 3.9 mg/L to 5.9 mg/L (see Figure 13).

5.2 Arsenic Results

Arsenic was detected in 19 out of the 52 wells tested (17%). This is significant since arsenic is considered a carcinogen and a safe concentration for consumption has not been determined. Although EPA has set a drinking water standard (MCL) for public water systems at 10 ug/L, the MCL goal (MCLG) is 0. MCLs are generally set at concentrations that consider achievable levels of treatment by most public water supply systems.

In this study, three wells had arsenic levels above the drinking water standard of 10 ug/L: in Gold Hill (11.7), Grants Pass (18.1), and Jacksonville (32.1). Four wells had moderate arsenic levels, of greater than 2 ug/L (see Figure 14). Most samples showed very low concentrations, of less than the 2 ug/L (0.002 mg/L) LOQ, however.

Figure 13: This figure shows an increase in nitrate concentration at a Central Point well tested by DEQ in 1994, 1995 and 2011.

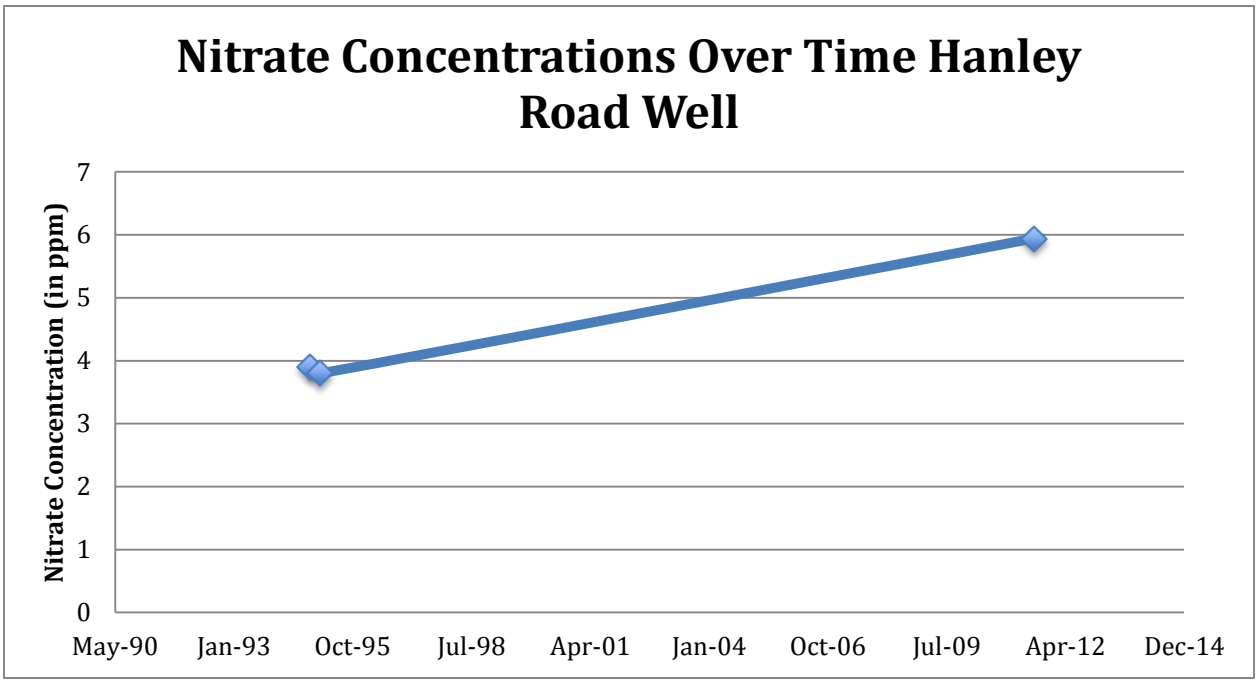


Figure 15 shows the distribution of arsenic at detectable and moderate concentrations in the basin. The highest percentage of arsenic detections was associated with basalt aquifers (including two of the highest concentrations recorded). The next highest percentages of detections were in claystone, sandstone, and alluvial aquifers, in that order. However, all of the detections in the alluvial aquifer were over 2 ug/L and one was 18 ug/L. No arsenic was detected in any of the 6 samples associated with granitic aquifers. *

Figure 14: Note that concentrations reading 0 ug/L in the graph above are actually less than the 2 ug/L LOQ.

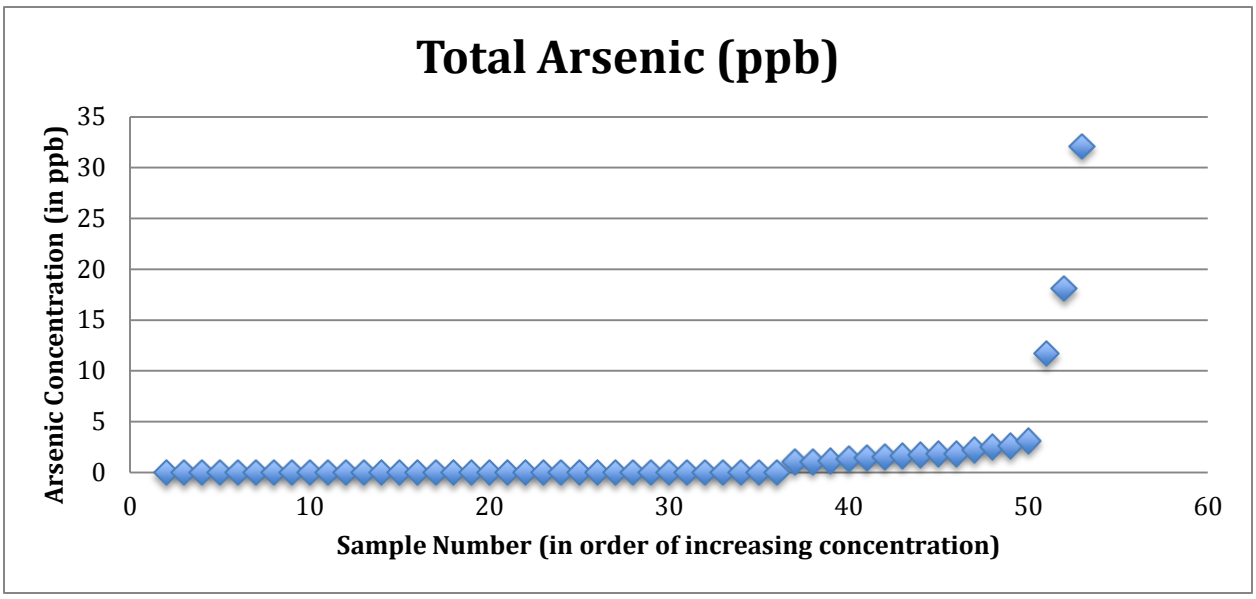
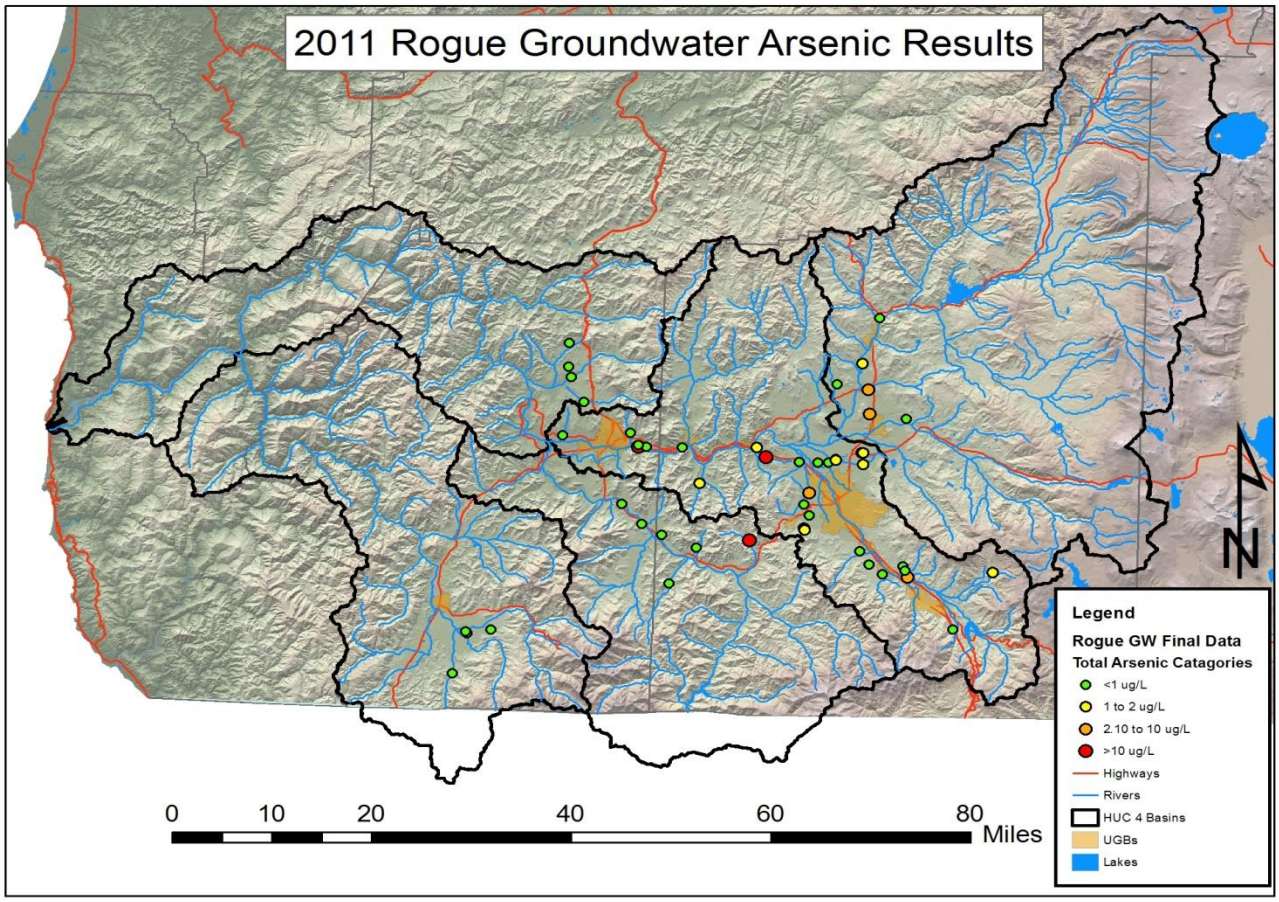


Figure 15: 2011 Rogue Groundwater Arsenic Results. Insufficient data points are available from this study to identify areas of extensive arsenic detection.

to identify areas of extensive arsenic detection.



5.3 Fluoride Results

Fluoride was detected in many of the wells in all sectors of the project study area except around Cave Junction, but most wells had very low, barely detectable levels (see Figure 16). Only one well had fluoride concentrations above the health advisory level of 2 mg/L, a well in Talent, surrounded by orchards. This well also had the highest boron levels detected in the study. A second well, located in a bend of the Rogue River near the city of Rogue River, had levels of 1.42 mg/L (Figure 17).

Geologic units in which fluoride was most consistently detected include granitic aquifers (6 of 6 samples had detections, 1>0.5 mg/L), basalt aquifers (9 of 10 samples had detections, 1>0.5 mg/L), and sandstone aquifers (5 of 7 samples had detections, 1>0.5 mg/L). *

Detections of fluoride above 0.5 mg/L were found in 2 wells supplied by alluvial aquifers, although only 5 of these 12 alluvial wells showed detectable fluoride. All wells tapping claystone aquifers had very low to non-detectable levels of fluoride. *

Figure 16: 2011 Rogue Groundwater Fluoride Results

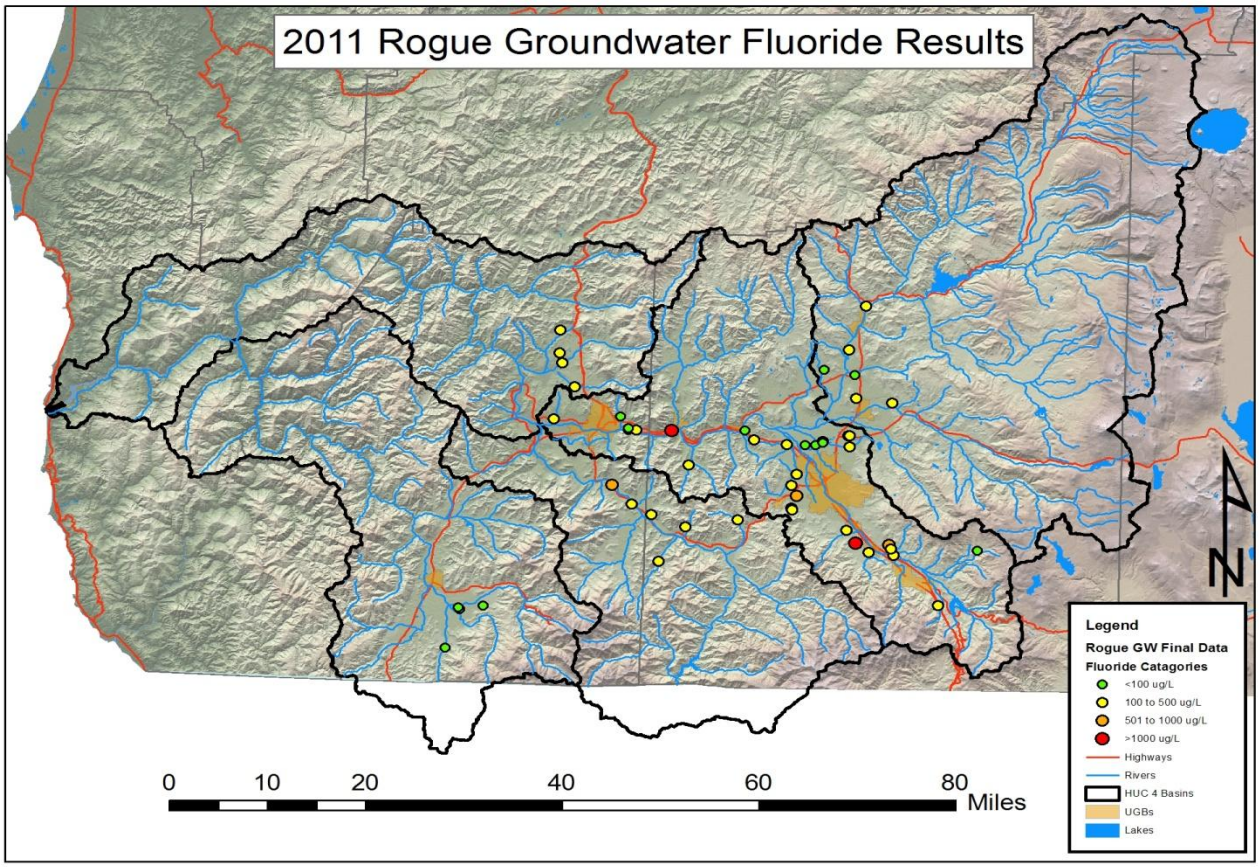
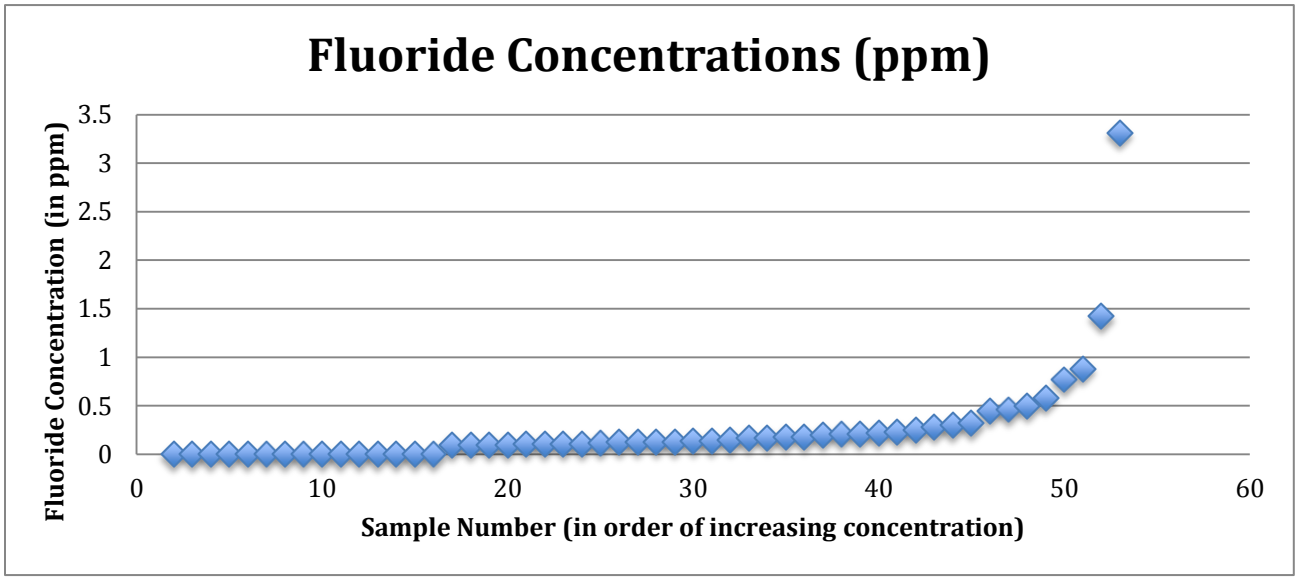


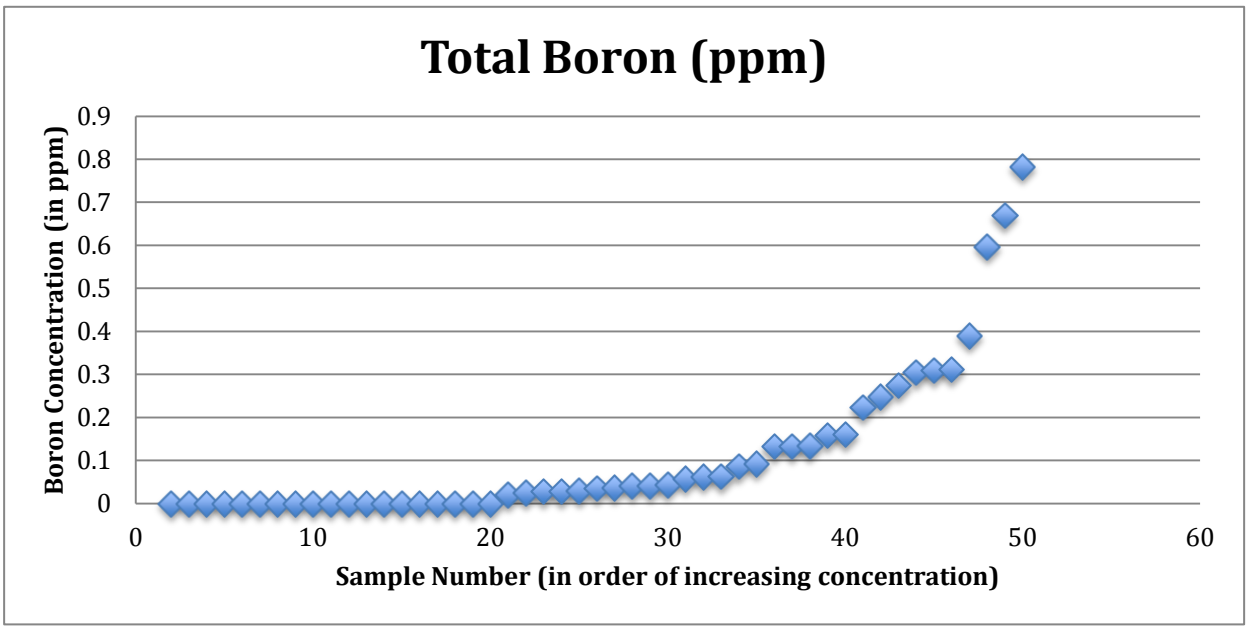
Figure 17: Most fluoride concentrations in the wells tested were below 1 mg/L. (Note that concentrations reading 0 mg/L in the graph above are actually <0.1 mg/L).



5.4 Boron Results

Boron levels above the One-Day and Ten-Day Health Advisory (3.0 mg/L) and the Longer Term Health Advisory (2.0 mg/L) for children were detected in only two wells in the study area. RV-069, in an area surrounded by orchards in Talent had the highest concentration of 6.64 mg/L. The other well, RV-022, at 2.53 mg/L, was located in Ashland in an irrigated agricultural area with orchards and other crops. Only one other well had boron levels above 1 mg/L (RV-071, in Phoenix) and most other wells (see Figure 18, below) had levels less than 0.5 mg/L.

Figure 18: This figure illustrates that a majority of the sample results for boron had concentrations below 0.1 mg/L. 18 samples had results over 0.1 (the three samples with the highest concentrations (1.1, 2.5, and 6.6) are not shown on this graph). Note that concentrations reading 0 mg/L in the graph above are actually <0.02 mg/L.



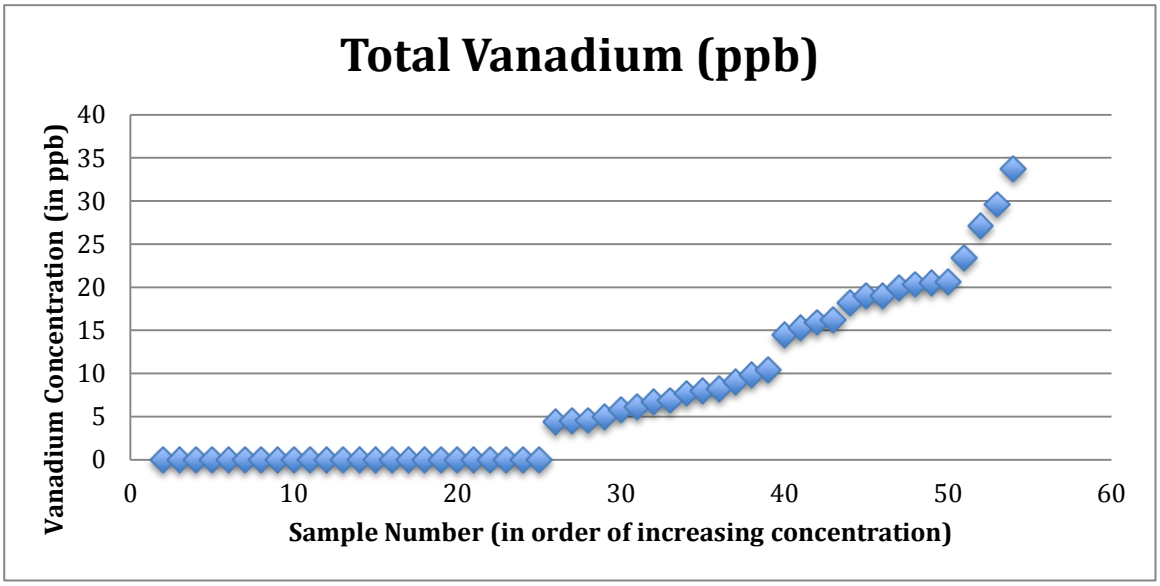
The highest percentages of boron detections were found in wells drawing from sandstone and claystone aquifers. Two of the highest concentrations were found in wells with sandstone water sources. The well with the highest boron concentration did not have a well log and therefore the aquifer unit was indeterminate. The fewest boron detections were found in wells tapping basalt aquifers. *

5.5 Vanadium Results

Vanadium was not a parameter that was expected as part of this study. Vanadium has not previously been detected in the area primarily because laboratory analyses used previously could only detect vanadium concentrations above 30 ug/L. The analyses were conducted simply because it was part of a metals analysis used to detect arsenic, lead, zinc and other metal concentrations in water. While the concentrations of vanadium in groundwater were not high, they were fairly pervasive at low levels. This is not unusual as vanadium is a ubiquitous element in nature and commonly found in volcanic rocks such as those present in the Rogue Basin. A 2010 USGS study of 8400 samples in California found a correlation of high vanadium concentrations with oxic or alkaline groundwater and mafic or andesitic rocks. In that study, high vanadium was considered to be greater than or equal to 50 ug/L and moderate concentrations to be between 25 and 49 ug/L (Wright, 2010). Several other states have developed public information about vanadium in drinking water in response to detections of vanadium in their state's groundwater supplies.

Approximately 56% of the wells tested (29 of 52) had some detectable level of vanadium in the water. Twenty of the wells (37%) had vanadium concentrations above the Arizona Drinking Water Guidelines of 7 ug/L and 15 of the wells (29%) had detections at or above the proposed California "notification level" of 15 ug/L for long-term consumption. None of the wells had concentrations above the proposed EPA Action Level, or the Minnesota Department of Health Risk Limit, of 50 ug/L. The highest concentration detected was 33.7 ug/L (see Figure 19). Since state guidelines appear to vary widely as to the acceptable concentration of vanadium in drinking water, and the EPA has not yet issued a drinking water guideline for the constituent, it is not clear whether these concentrations are a public health concern or not.

19: More than half of the wells tested showed some detection of vanadium. Note that concentrations reading 0 ug/L in the graph above are actually <4.0 ug/L

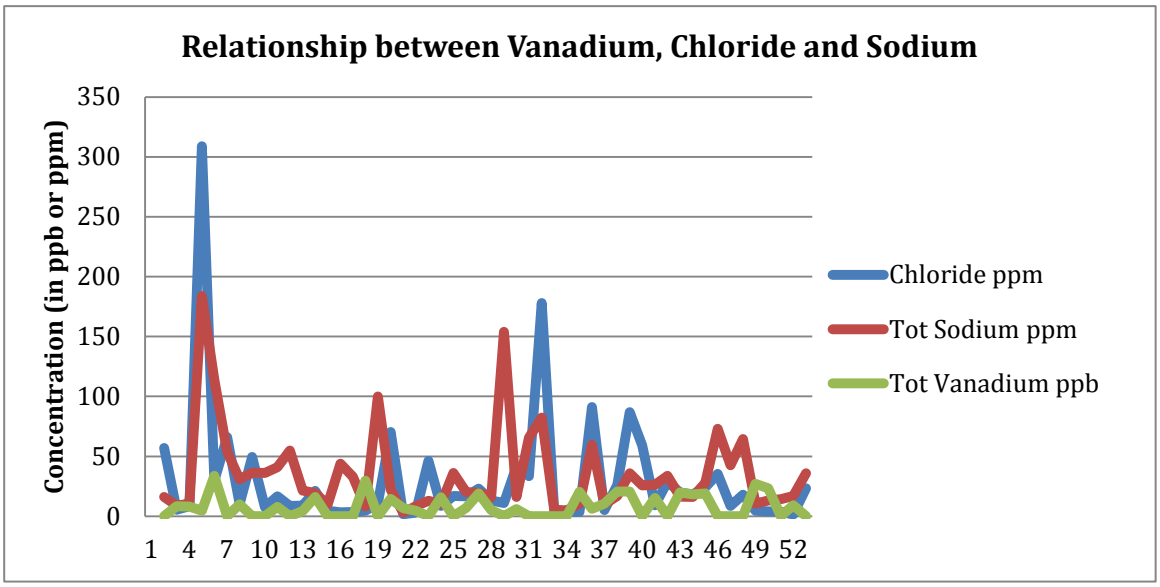


Since vanadium oxide is used by industry to make steel, it is possible that the vanadium detections are not necessarily indicative of area-wide groundwater quality, but may instead be the result of well or water pipe corrosion or possibly even of steel pump corrosion. Ion exchange is a treatment methodology that has been shown to reduce vanadium concentrations in drinking water (WaterTech Online.com, 2011).

Vanadium is known as a metal that binds with oxygen, sodium, sulfur or chloride (Irwin, 1997). Figure 20 examines the relationship between vanadium, dissolved chloride and sodium concentrations in the samples tested. There did not appear to be a consistent relationship in all samples.

*Note: All information about aquifer type associated with the wells in this study was collected from driller's well logs recorded on the Water Resources Department website. In some situations, the well log considered to be associated with the sampled well may possibly be associated with another, nearby well. In addition, the geologic expertise and exactitude of reporting of geologic units encountered by drillers varies widely. Therefore, it is possible that information recorded on a well log (and therefore analyses in this report based on aquifer type) may be inaccurate or misleading.

Figure 20: There does not appear to be a consistent relationship between vanadium, dissolved chloride and sodium concentrations in the samples tested.



6. Conclusions

There are distinct areas in the Rogue Basin where nitrate from anthropogenic sources has contaminated groundwater. The results of the July 2011 groundwater sampling in the Rogue Basin indicate that the percentage of wells impacted by nitrate contamination of groundwater has not definitively increased or decreased over the past seven decades.

Table 10 presents a summary of groundwater study results from 1971 to 2011, showing that in combined county results, the percentage of wells tested that had nitrate concentrations above 3 mg/L went up, from 31% (in the USGS 1971-73 studies which included data from 1951 to 1970) to 33% (in the combined 1992-1994 DEQ studies), to 35% in the 2011 DEQ study. Of note, however, is a decrease in wells with nitrate concentrations above the drinking water standard in the combined studies. This percentage was 13% in the USGS studies, 7% in DEQ's 1992-1994 studies, and 6% in the 2011 study. This may indicate that the severity of nitrate contamination in Jackson County has been reduced. The results may, however, be solely a reflection of the individual wells selected for the various studies. The best indication of actual groundwater quality conditions may be provided by the much larger sample volume of the Real Estate Transaction data base although that data does not represent the same quality control of a DEQ or USGS study.

All study results indicate that the areas of nitrate contamination in the basin are largely centered around Central Point, west Medford, North Ashland, and various other points in rural areas of both Jackson and Josephine Counties. The strongest data correlation was between high concentrations of nitrate and irrigated agriculture.

In Josephine County, the percentage of wells with elevated nitrate concentrations is consistently lower than in Jackson County. The USGS 1973 study detected nitrate above 3 mg/L in 10% of wells tested, DEQ detected nitrate above 3 mg/L in 35% of wells in 1994, and only 6% in 2011. More evaluation is necessary to determine if this represents a trend of reduced nitrate.

Table 10: Summary of Groundwater Study Results 1971-2011

	1971-1972 USGS Studies	1973 USGS Study	1971-1973 USGS Studies	1992 DEQ Study	1994 DEQ Study	1994 DEQ Study	1992-1994 DEQ Studies	2011 DEQ Study	2011 DEQ Study	2011 DEQ Study
	Jackson County	Josephine County	Combined	Jackson County	Jackson County	Josephine County	Combined	Jackson County	Josephine County	Combined
Number of Wells Tested	92	14		27	20	20	67	36	16	52
Nitrate >3 mg/L	34%	10%	31%	7%	65%	32%	33%	47%	6%	35%
Nitrate>10 mg/L	14%	0%	13%	0%	15%	10%	7%	8%	0%	6%
Max Nitrate (mg/L)	41	4.2	41	6.7	13	14	14	19.3	4.37	19.3
Wells tested for N	76	10	86							
Arsenic detection	N/A	0%		7%	5%	5%		44%	6%	17%
Max Arsenic (ug/L)		ND		26	16	13		32.1	18.1	32.1
Fluoride >2 mg/L	9%	0%		4%	0%			3%	0%	2%
Fluoride >4 mg/L	7%	0%		4%	0%			3%	0%	2%
Fluoride detection	97%	7%		37%	70%	N/A		78%	56%	71%
Max Fluoride (mg/L)	12	0.5		11	0.7			3.31	0.77	3.3
Boron > 2mg/L	16%	29%		15%	0%	0%		5%	0%	4%
Boron detection	93%	100%		96%	75%	40%		69%	50%	63%
Max Boron (mg/L)	20	4.3		14	0.99	0.32		6.64	0.305	6.64
Vanadium detection	N/A	N/A		0%	0%	0%		56%	56%	56%
Max Vanadium (ug/L)				<30	<30	<30		33.7	29.6	33.7
Pesticides	N/A	N/A		0%	10%	0%		N/A	N/A	N/A
VOCs	N/A	N/A		4%	10%	20%		N/A	N/A	N/A

N/A = Not Tested
ND = Not Detected

Trend data are available for a number of specific wells in the Grants Pass area for the 2 years that DEQ conducted quarterly monitoring in 1990 and 1991 but is generally inconclusive. Attempts were made in 1994 and 2011 to re-sample wells from previous studies with limited success. Some increases and some decreases in nitrate concentrations were observed.

Of greatest concern is the detection of measurable arsenic in 44% of wells tested in Jackson County in the 2011 DEQ study. Even though very few of the wells had concentrations above the current drinking water standard for arsenic, there are recent studies suggesting potential human health impacts from arsenic at concentrations well below the current drinking water standard of 10 ug/L.

The finding that 29% of the wells sampled have vanadium concentrations above the 15 ug/L notification level proposed by the State of California indicates a potential concern. EPA has yet to set a drinking water standard for vanadium, however, and no concentrations were found above the current EPA Action Level of 50 ug/L.

7. Recommendations

Further define the extent of area-wide arsenic, fluoride, and boron concentrations in the Rogue Basin by collecting more data. Improving the delineation of naturally occurring arsenic, fluoride, and boron would allow targeted education efforts to rural homeowners in areas with suspected elevated concentrations.

Re-visit the 1995-1997 Jackson County well ordinance and attempt to implement a similar ordinance to aid in the collection of more, local, information about groundwater quality.

Secure funding to create maps of arsenic, boron, and fluoride data already available in a database available through the Oregon Health Authority (OHA). Data from the USGS, WRD, OHA and DEQ should be mapped together to allow better visualization of distribution of these parameters. In addition, funding will be required to allow adequate analysis of this large volume of data.

Conduct an investigation of potential concerns associated with wide-spread vanadium concentrations in drinking water wells.

Evaluate correlations between irrigated agriculture, and eventually, specific agricultural practices, and nitrate contamination of groundwater supplies in order to target public education efforts. Potential correlations between the presence of septic systems and areas with nitrate contamination should also be evaluated.

Evaluate the correlation between rock type of the water-bearing aquifer and the presence of arsenic, fluoride and boron. This will allow a better understanding of the distribution of arsenic, fluoride and boron in basin groundwater supplies.

Develop a Groundwater Quality Education program, including the dissemination of information about current groundwater quality conditions to local agencies and organizations, and to the public through those organizations. Education should include flyers to dentists regarding fluoride in groundwater, and presentations to inform the public, local agencies and organizations about groundwater quality conditions. Local water quality laboratories could assist education efforts by suggesting analyte lists to their clients. Real estate professionals should be informed about potential water quality concerns in the Basin and the Real Estate Transaction testing requirements. In addition real estate agents could distribute technical assistance documents and agency contacts to new well owners. Education is an important next step to assist rural homeowners in protecting their health.

Provide local agencies such as the Jackson and Josephine County Soil Water Conservation Districts, OSU Extension, and County Health Departments, and environmental organizations such as watershed councils with relevant pamphlets and training to provide technical assistance to well owners in addition to the technical assistance they already provide to reduce nonpoint sources of contamination. Increased awareness by these agencies that nonpoint sources of contamination to groundwater sometimes differ from those sources to surface water, as do the prevention strategies for contamination from those sources, would also be helpful.

Evaluate a potential declaration of an “Area of Groundwater Concern” under ORS 468B.175 since there are distinct areas in the Rogue Basin where nitrate from anthropogenic sources has contaminated groundwater or ORS 448.271 through the Oregon Health Authority (OHA) since elevated nitrate, arsenic and fluoride can constitute a public health concern. This declaration would raise the prioritization of the area for funding by grants and agency resource and focus a local committee on addressing the issue.

8. Bibliography

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Appendix A: Glossary of Terms

California Proposed Notification Level - Notification Levels are health-based advisory levels for chemicals in drinking water that are established for chemicals for which there are no formal regulatory standards (Maximum Contaminant Levels, or MCLs). Notification Levels may be established by the California Department of Public Health Division of Drinking Water and Environmental Management (DDWEM) when a chemical is found in or threatens drinking water sources. Upon request by DDWEM, the California Office of Environmental Health Hazard Assessment performs a risk assessment of the chemical using standard risk and exposure assumptions and proposes a health-protective level. A notification level is then established by DDWEM, and amended as necessary as conditions or risk assessment methods change.

Drinking Water Equivalent Level (DWEL) – A drinking water lifetime exposure level, assuming 100% exposure from that medium, at which adverse, noncarcinogenic health effects would not be expected to occur. (2012 DWS doc)

Drinking Water Standard (DWS) – A U.S. Environmental Protection Agency National Primary Drinking Water Regulations (NPDWRs or primary standards). These are legally enforceable standards that apply to public water systems. They are not legally enforceable in private wells. The primary standards protect public health by establishing an allowable limit of contaminant concentration in drinking water.

EPA Action Level – A term used to identify the level of contaminant concentration high enough to warrant remedial action.

EPA Contaminant Candidate List 3 – CCL 3 is a list of contaminants that are currently not subject to any proposed or promulgated national primary drinking water regulations, that are known or anticipated to occur in public water systems, and which may require regulation under the Safe Drinking Water Act (SDWA). The list includes, among others, pesticides, disinfection byproducts, chemicals used in commerce, waterborne pathogens, pharmaceuticals, and biological toxins. The Agency considered the best available data and information on health effects and occurrence to evaluate thousands of unregulated contaminants. EPA used a multi-step process to select 116 candidates for the final CCL 3.

Federal Standard – A maximum contaminant level, a national primary drinking water regulation, or an interim drinking water regulation adopted by the US EPA pursuant to the federal Safe Drinking Water Act (ORS 536.137) [OAR 340-40-100(6)].

Health Advisory Level (HA) – An estimate of acceptable drinking water concentrations for a chemical substance based on human health effects information. Health Advisories are not legally enforceable but provide technical guidance based on non-cancer health effects for different durations of exposure (e.g., one-day, ten-day, and lifetime). They are provided for unregulated drinking water contaminants.

Lifetime HA - The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure. Based on exposute of a 70 kg (154 lb) adult consuming 2 liters of water per day.

Maximum Contaminant Level (MCL) – The maximum permissible level of a contaminant in water delivered to users of a public water system (*enforceable* drinking water standards). These are set as

close to MCLGs as feasible using best available analytical and treatment technologies and taking cost into consideration. Term is used interchangeably with Drinking Water Standard.

Maximum Contaminant Level Goal (MCLG) – A *non-enforceable* health benchmark goal which is set at a level at which no known or anticipated adverse effect on the health of persons is expected to occur and which allows an adequate margin of safety.

Maximum Measurable Level (MML) - The maximum allowable concentration of a contaminant or substance of concern that is established by the Environmental Quality Commission to by used by DEQ to initiate the process of designating "Groundwater Management Areas" within the state of Oregon where necessary to preserve groundwater quality (ORS 468.691). [OAR 340-40-100 (7)]. The interim MML [from OAR 340-40-090 Table 4 (1991)] for Arsenic is 0.05 ppm, for Nitrate is 10 ppm, and for Fluoride is 4 ppm.

Minnesota Health Risk Limit – A concentration of a substance or chemical adopted by rule of the Minnesota commissioner of health that is a potential drinking water contaminant because of a systemic or carcinogenic toxicological result from consumption.

One Day HA – The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to one day of exposure. Intended to protect a 10 kg (22 lb) child who is consuming 1 liter of water per day.

Reference Dose (RfD) – An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Source: epa.gov/drink/standards/hascience.cfm

Secondary Drinking Water Regulations (SDWR) – Non-enforceable Federal guidelines regarding cosmetic effects (such as tooth or skin discoloration) or aesthetic effects (such as taste, odor, or color) of drinking water.

Secondary Maximum Contaminant Level (SMCL) – Used interchangeably with Secondary Drinking Water Regulations (SDWR).

Substance of Concern – A contaminant confirmed in groundwater in Oregon as a result of actual or suspected nonpoint source activities. [OAR 340-40-100(9)].

Ten Day HA – The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to ten days of exposure. Intended to protect a 10 kg child who is consuming 1 liter of water per day.

10-4 Cancer Risk HA – The concentration of a chemical contaminant in drinking water that is associated with a specific probability of cancer. This HA is provided to assist in cancer risk reduction evaluations. *The Office of Water also advises consideration of more conservative cancer risk levels of 10-5 and 10-6 found in the IRIS or OPP RED source documents for exposure-specific risk assessment.*

Appendix B: 1988 – 1993 DEQ Statewide Monitoring Data from Rogue Basin Wells

Sample Date / Time	Station Identifier	Nitrate / nitrite as N (mg/L)	Dissolved Boron (mg/L)	Dissolved Arsenic (mg/L)	Total Recoverable Arsenic (mg/L)	Chloride (mg/L)	Dissolved Manganese (mg/L)	Total Recoverable Maganese (mg/L)	Dissolved Lead (mg/L)	Total Recoverable Lead (mg/L)
3/28/1989 14:15	14836	0.66	<0.03		7.0	0.07				
6/27/1989 11:45		0.67	<0.03		3.9	<0.02				
9/12/1989 15:50		0.72	<0.03		4	<0.02				
11/29/1988 11:35	14837	0.31			2					
3/28/1989 14:30		0.32	<0.03		2	<0.02				
6/28/1989 9:20		0.3	<0.03		2.2	<0.02				
9/13/1989 8:25		0.31	<0.03		2	<0.02				
1/24/1990 10:25		0.39	<0.03		1.7	<0.02				
5/8/1990 15:25		0.31	<0.03		2.1	<0.02				
8/14/1990 8:50		0.34	<0.03		1.8	<0.02				
11/15/1990 8:50		0.35	<0.03		1.6	<0.01				
9/11/1991 12:35		0.35	<0.03		1.5	<0.01				
7/13/1988 17:25	14838	<0.02			9	<0.05				
7/13/1988 17:25		<0.02			9.1	<0.05				
3/28/1989 16:30		0.04	<0.03		3	<0.02				
6/28/1989 14:00		0.02	<0.03		3	<0.02				
9/13/1989 14:41		0.04	<0.03		3.4	<0.02				
1/24/1990 9:35		0.07	<0.03		3.2	<0.02				
7/13/1988 16:10	14839	<0.02			570	1.8				
7/13/1988 16:10		<0.02			570	1.5				
11/29/1988 14:25		<0.02			560 Est					
3/29/1989 8:50		<0.02	0.08		560	1.7				
6/28/1989 8:20		<0.02	0.07		550	1.8				
6/28/1989 15:00			<0.03							
9/13/1989 10:45										
9/13/1989 11:10		<0.02	0.04		360	2.1				
1/24/1990 8:30		<0.02	0.08		550	1.4				
6/7/1993 20:00		<0.02	0.07		440	0.94	0.94			
3/19/1989 11:30	14840	<0.02	<0.03		1.7	0.05				
6/28/1989 13:25		0.02	<0.03		1.5	0.05				
9/13/1989 12:30		0.02	<0.03		1.5	0.05				
1/23/1990 14:30		0.02	<0.03		1.5	0.05				
5/9/1990 11:20		0.03	<0.03		1.5	0.04				
8/14/1990 14:20		0.03	<0.03		1.5	0.05				
11/15/1990 10:40		<0.02	<0.03		1.5	0.02				
9/11/1991 14:00		0.05	<0.03		1.5	0.06				
7/13/1988 19:43	14841	<0.02			3	<0.05				
7/13/1988 19:43		<0.02			2.6	<0.05				
11/29/1988 16:35		0.04			2					
3/29/1989 16:00		0.04	<0.03		2.1	<0.02				
6/28/1989 10:30		0.04	<0.03		2.1	<0.02				
9/12/1989 15:20		0.05	<0.03		2.1	<0.02				
1/23/1990 15:15		0.05	<0.03		2.1	<0.02				
7/13/1988 12:10	14842	0.05			3	<0.05				
7/13/1988 12:10		0.05			3.1	<0.05				
3/29/1989 13:00		0.07	<0.03		2.6	<0.02				
6/27/1989 16:20		0.08	<0.03		2.7	<0.02				
9/12/1989 14:30		0.08	<0.03		2.8	<0.02				
1/23/1990 13:50		0.1	<0.03		3	<0.02				
7/13/1988 11:25	14843	<0.02			74	<0.05				
7/13/1988 11:25		<0.02			74	<0.05				
7/13/1988 11:38		<0.02			67	<0.05				
9/29/1989 13:45		<0.02	0.19		75	<0.02				
6/27/1989 15:25		0.02	0.19		72	<0.02				
9/12/1989 13:50		0.02	0.21		70	<0.02				
1/23/1990 13:10		<0.02	0.19		94	<0.02				

Sample Date / Time	Station Identifier	Nitrate / nitrite as N (mg/L)	Dissolved Boron (mg/L)	Dissolved Arsenic (mg/L)	Total Recoverable Arsenic (mg/L)	Chloride (mg/L)	Dissolved Manganese (mg/L)	Total Recoverable Maganese (mg/L)	Dissolved Lead (mg/L)	Total Recoverable Lead (mg/L)
7/12/1988 16:33	14844	0.18				7	<0.05			
7/12/1988 16:33		0.18				7	<0.05			
7/12/1988 16:47		0.23				8	<0.05			
3/27/1989 14:10		0.21	<0.03			4.3	<0.02			
6/26/1989 14:15		0.2	<0.03			5	<0.02			
9/11/1989 14:45		0.25	<0.03			4.9	<0.02			
1/22/1990 14:15		0.28	<0.03	<0.005		7.6	<0.02			
7/12/1988 17:50	14845	0.25				6	0.35			
7/12/1988 17:50		.025				5.6	0.35			
3/27/1989 12:55		0.59	<0.03			4.5	<0.02			
6/26/1989 13:45		0.3	<0.03			4.5	<0.02			
9/11/1989 14:15		0.3	<0.03			4.3	<0.02			
1/22/1990 13:40		1.2	<0.03	<0.005		4.5	<0.02			
3/27/1989 15:10	14846	0.05	0.06			150	<0.02			
6/26/1989 14:55		0.06	0.05			150	<0.02			
9/11/1989 15:35		0.07	0.05			150	<0.02			
1/22/1990 14:50		0.06	<0.03	<0.005		120	<0.02			
5/7/1990 13:45		0.04	0.22			130	<0.02			
8/13/1990 14:30		0.05	0.04			140	<0.02			
11/13/1990 13:45		0.05	0.06			140	<0.01			
9/10/1991 8:30		0.05	0.05			130	<0.01			
7/12/1988 12:35	14847	0.16				1300	<0.05			
7/12/1988 12:35		0.16				1300	<0.05			
3/28/1989 9:30		.015	0.16			1500	<0.02			
6/27/1989 8:00		0.16	0.14			1300	<0.02			
9/12/1989 9:10		0.07	0.13			1100	0.18			
1/23/1990 8:40		0.26	0.15			1200	0.02			
6/7/1993 15:21		0.11	0.29			1900 Est	<0.01	<0.01		
7/12/1988 14:00	14848	0.18				2	<0.05			
7/12/1988 14:00		0.18				2.4	<0.05			
3/27/1989 15:55		0.13	<0.03			2.2	<0.02			
6/26/1989 15:50		0.17	<0.03			2.4	<0.02			
9/11/1989 16:10		0.15	<0.03			2.3	<0.02			
1/23/1990 9:25		0.16	<0.03			2.6	<0.02			
7/14/1988 9:10	14849	1.3				3	<0.05			
7/14/1988 9:30		1.3				3.2	<0.05			
3/27/1989 16:45		1.9	<0.03			3.3	<0.02			
6/26/1989 16:45		1.8	<0.03			3.1	<0.02			
9/11/1989 16:50		1.9	<0.03			3.1	<0.02			
1/23/1990 7:50		2	<0.03			3.2	<0.02			
5/7/1990 15:55		1.3	<0.03			2.7	<0.02			
8/15/1990 12:15		1.2	<0.03			2.7	<0.02			
11/14/1990 9:15		2.4	<0.03			3.6	<0.01			
9/10/1991 10:45		1.6	<0.03			2.9	<0.01			
1/23/1989 11:50	14852									
3/28/1989 12:10		0.95	<0.03			5.1	<0.02			
6/27/1989 10:35		1.1	<0.03			4.6	<0.02			
9/12/1989 11:25		0.93	<0.03			4.7	<0.02			
1/23/1990 11:50		0.94	<0.03			4.6	<0.02			
9/13/1989 9:30	14853									
9/13/1989 10:00		0.04	<0.03			1.6	<0.02			
5/7/1990 14:15	14854	9.8	0.22			81	<0.02			
8/13/1990 15:15		10	0.21			81	<0.02			
11/13/1990 14:20		9.7	0.22			82	<0.01			
9/10/1991 9:15		9.9	0.21			83	<0.01			
2/17/1994 10:36		12	0.2	<0.005	<0.005	84	<0.01	<0.01	<0.005	<0.005
4/21/1994 9:48		11								

Sample Date / Time	Station Identifier	Nitrate / nitrite as N (mg/L)	Dissolved Boron (mg/L)	Dissolved Arsenic (mg/L)	Total Recoverable Arsenic (mg/L)	Chloride (mg/L)	Dissolved Manganese (mg/L)	Total Recoverable Maganese (mg/L)	Dissolved Lead (mg/L)	Total Recoverable Lead (mg/L)
5/7/1990 14:40	14855	7.2	0.05			47	<0.02			
8/15/1990 14:30		6.2	0.05			47	<0.02			
11/13/1990 14:50		6.7	0.06			47	<0.01			
9/10/1991 9:30		6.3	0.06			45	<0.01			
5/7/1990 15:20	14856	0.69	<0.03			5.3	<0.02			
8/13/1990 16:10		0.7	<0.03			5.4	<0.02			
8/15/1990 12:53										
11/13/1990 15:30		0.7	<0.03			5.4	<0.01			
9/10/1991 10:00		.65	<0.03			5.4	<0.01			
5/7/1990 16:30	14857	2	<0.03			5.4	<0.02			
5/8/1990 16:15		<0.02	<0.03			5.4	<0.02			
8/15/1990 13:40		2	<0.03			5.5	<0.02			
11/14/1990 8:45		2	<0.03			5.4	<0.01			
9/10/1991 11:30		2.2	<0.03			5.4	<0.01			
2/16/1994 13:28		2.40 Est	<0.03	<0.05	<0.005	5.8	<0.01	<0.01	<0.005	<0.005
4/21/1994 8:00		26								
5/8/1990 9:20	14859	0.19	<0.03			2.2	<0.02			
8/15/1990 7:45		0.19	<0.03			2.7	<0.02			
11/14/1990 11:15		0.19	<0.03			2.2	<0.01			
9/11/1991 8:15		0.19	<0.03			2.8 Est	<0.01			
5/8/1990 9:58	14860	<0.02	0.19			140	<0.02			
8/15/1990 10:15		<0.02	0.21			150	<0.02			
11/14/1990 13:20		<0.02	0.18			120	<0.01			
9/11/1991 9:15		<0.02	0.19			120	<0.01			
5/8/1990 10:56	14861	0.05	<0.03			3	<0.02			
8/15/1990 8:55		0.02	<0.03			2.8	<0.02			
11/14/1990 14:10		<0.02	<0.03			2.3	0.01			
9/11/1991 8:40		0.02	<0.03			2.9	0.1			
5/8/1990 12:55	14862	0.48	<0.03			3.3	<0.02			
8/15/1990 15:45		0.52	<0.03			3.6	<0.02			
11/14/1990 15:20		0.53	<0.03			3.4	0.01			
9/11/1991 11:00		0.89	<0.03			4.7	<0.01			
5/8/1990 13:50	14863	0.32	<0.03			1.8	<0.02			
8/14/1990 10:00		0.19	<0.03			2.8	<0.02			
5/8/1990 14:25		0.14	<0.03			2.7	<0.02			
8/14/1990 10:30		0.26	<0.03			2.1	<0.02			
5/9/1990 8:55	14865	0.24	0.08			40	<0.02			
8/16/1990		0.37	0.09			40	<0.02			
11/15/1990 9:55		0.24	0.07			44	<0.01			
9/11/1991 13:15		0.38	0.07			31	<0.01			
6/8/1993 10:50		0.22	0.08			47	<0.01	<0.01		
5/9/1990 9:25	14866	2.3	<0.03			9.7	<0.02			
8/14/1990 12:55		2.2	<0.03			9.7	<0.02			
11/15/1990 12:30		3	<0.03			13	<0.01			
9/11/1991 15:50		2.6	<0.03			11	<0.01			
6/7/1993 17:00		2.3	<0.03			12	<0.01	<0.01		
5/9/1990 10:10	14867	<0.02	<0.03			320	0.05			
8/14/1990 13:35		<0.02	<0.03			250	0.04			
11/15/1990 11:35		<0.02	<0.03			170	0.04			
9/11/1991 15:00		<0.02	<0.03			210	0.04			
6/8/1993 10:15		<0.02	<0.03			140	0.03	0.03		
5/9/1990 10:38	14868	2.1	<0.03			4.5	<0.02			
8/14/1990 15:20		2	<0.03			5	<0.02			
11/15/1990 11:00		2.2	<0.03			5.8	<0.01			
9/11/1991 14:30		1.4	<0.03			4.1	<0.01			
11/14/1990 12:00	14869	2.1	<0.03			6	<0.01			
9/10/1991 14:50		2.3	<0.03			6	<0.01			

Sample Date / Time	Station Identifier	Nitrate / nitrite as N (mg/L)	Dissolved Boron (mg/L)	Dissolved Arsenic (mg/L)	Total Recoverable Arsenic (mg/L)	Chloride (mg/L)	Dissolved Manganese (mg/L)	Total Recoverable Maganese (mg/L)	Dissolved Lead (mg/L)	Total Recoverable Lead (mg/L)
11/14/1990 13:40	14870	<0.02	<0.03			3.2	0.55			
9/11/1991 9:40		0.02	<0.03			5.4	0.57			
11/15/1990 11:45	14871	0.02	<0.03			8.5	<0.01			
9/11/1991 15:20		<0.02	<0.03			33	0.2			
1/30/1992 15:15	15653	0.15	0.04		<0.005	3.9	<0.01	<0.01		
1/30/1992 16:00	15654	<0.02	0.43		<0.005	960	0.18	0.19		
1/30/1992 16:55	15655	0.06	<0.03		<0.005	1.1	<0.01			
2/15/1994 9:00	15657	490 Est	0.03	<0.005	<0.005	25	0.02	0.02	<0.005	<0.005
4/20/1994 15:33		4.6								
2/15/1994 9:50	15658	16 Est	<0.03	<0.005	<0.005	27	<0.01	<0.01	<0.005	<0.005
4/20/1994 15:48		14								
2/15/1994 11:00	15659	8.10 Est	<0.03	<0.005	<0.005	10	<0.01	<0.01	<0.005	0.007
4/20/1994 16:10		7.4								
2/15/1994 11:40	15660	0.21 Est	0.05	<0.005	<0.005	7.9	<0.01	<0.01	<0.005	<0.005
4/20/1994 16:30		0.03								
2/15/1994 12:15	15661	5.40 Est	<0.03	<0.005	<0.005	11	<0.01	<0.01	<0.005	<0.005
4/20/1994 16:54		6.8								
2/15/1994 13:00	15662	0.21 Est	0.25	<0.005	<0.005	410	<0.01	<0.01	<0.005	<0.005
4/21/1994 10:42		0.1								
2/15/1994 13:40	15663	<0.02 Est	0.32	<0.005	<0.005	480	<0.01	<0.01	<0.005	<0.005
4/21/1994 11:03		<0.02								
2/15/1994 15:50	15664	0.06 Est	0.03	<0.005	<0.005	43	<0.01	<0.01	<0.005	<0.005
4/21/1994 11:40		0.08								
2/16/1994 8:30	15665	0.03 Est	0.06	<0.005	<0.005	34	1	1	<0.005	<0.005
4/20/1994 14:40		0.08								
2/16/1994 9:07	15666	0.10 Est	<0.03	<0.005	<0.005	8.4	<0.01	<0.01	<0.005	<0.005
4/20/1994 15:00		0.11								
2/16/1994 9:37	15667	0.64 Est	0.21	<0.005	<0.005	72	<0.01	<0.01	<0.005	<0.005
4/20/1994 15:15		0.64								
2/16/1994 10:20	15668	1.20 Est	<0.03	<0.005	<0.005	4.5	0.02	0.02	<0.005	<0.005
4/21/1994 9:04		1.3								
2/16/1994 10:55	15669	0.1	<0.03	0.013	0.011	5.5	<0.01	<0.01	<0.005	<0.005
4/21/1994 8:41		0.05								
2/16/1994 12:15	15670	0.93	<0.03	<0.005	<0.005	3.8	<0.01	<0.01	<0.005	<0.005
4/21/1994 8:23		0.91								
2/16/1994 14:40	15672	3.60 Est	<0.03	<0.005	<0.005	5.8	<0.01	<0.01	<0.005	<0.005
4/21/1994 9:28		4.2								
2/17/1994 9:00	15673	4.9	<0.03	<0.005	<0.005	5.7	<0.01	<0.01	<0.005	<0.005
2/17/1994 9:25	15674	1.6	<0.03	<0.005	<0.005	3.6	<0.01	<0.01	<0.005	<0.005
2/17/1994 10:00	15675	1.6	0.16	<0.005	<0.005	280	<0.01	<0.01	<0.005	<0.005

Appendix C:
Free Nitrate Testing of Private Well Water Care and Feeding of Your Well and Spetic System Classes Spring 2011

All meetings were held in Community Meeting Rooms at Libraries except the Rogue River meeting.

- March 10 – Medford 5:30-6:30 – 21 attendees, 14 samples
- March 19 – Ruch – 1-2 pm- ~20 attendees, ~14 samples

- April 7 – Central Pt – 5:30 pm – >75 attendees, >70 samples
- April 9 – Applegate – 11 am- ~20attendees, 14 samples
- April 11 – Gold Hill – 5 pm - 14 attendees, 12 samples
- April 23 – Ashland –1:30 pm – 44 attendees, 27 samples

- May 7-8 – Master Gardener's Spring Fair (J Co Fairgrounds) – 30 participants, 40 samples
- May 11 – Shady Cove - 6pm – 32 attendees, 20 samples
- May 19 – Rogue River – 6 pm – 23 attendees, 20 samples
- May 21 – Eagle Point – 1pm – ~30 attendees, ~20 samples
- May 31 – Grants Pass - >70 attendees, ~65 samples

- June 8 – Cave Junction – 5:30 pm - ~22 attendees, ~15 samples

Summary for presentation series: Twelve free nitrate sampling and public education events were held during the spring of 2011. Approximately 400 well owners attended, approximately 330 samples were analyzed, 118 well owners gave permission to sample their private well.

Appendix D: Well Information for Sampled Wells

Rouge Basin Grouwater Study RV-XXX	LASAR	City	Google Earth Latitude	Google Earth Longitude	Source	County	Well Log #
Rogue Basin Grouwater Study RV-001	36492	Cental Point	42.408382°	-122.954687°	Class	Jack	31143
Rogue Basin Grouwater Study RV-002	15670	Grants Pass	42.425840°	-123.272183°	DEQ GP 94	Jose	12848
Rogue Basin Grouwater Study RV-003	14857	Grants Pass	42.427496°	-123.272190°	DEQ GP 94	Jose	12847
Rogue Basin Grouwater Study RV-004	15669	Grants Pass	42.424033°	-123.271144°	DEQ GP 94	Jose	?
Rogue Basin Grouwater Study RV-005	15663	Grants Pass	42.437282°	-123.418319°	DEQ GP 94	Jose	15704
Rogue Basin Grouwater Study RV-006	15690	Central Point	42.359997°	-122.930174°	DEQ GP 93	Jack	12942
Rogue Basin Grouwater Study RV-007	15689	Cental Point	42.339990°	-122.943747°	DEQ GP 93	Jack	13494
Rogue Basin Grouwater Study RV-008	36493	Medford	42.323985°	-122.931997°	DEQ GP 93	Jack	13412
Rogue Basin Grouwater Study RV-009	36564	White City	42.425535°	-122.832986°	DEQ GP 93	Jack	855
Rogue Basin Grouwater Study RV-010	36495	Eagle Point	42.567123°	-122.737241°	Class	Jack	51019
Rogue Basin Grouwater Study RV-011	36496	Shady Cove	42.640021°	-122.805460°	Class	Jack	32524
Rogue Basin Grouwater Study RV-012	36498	White City	42.597414°	-122.937496°	Class	Jack	56718
Rogue Basin Grouwater Study RV-013	36499	Eagle Point	42.525896°	-122.824200°	Class	Jack	57270
Rogue Basin Grouwater Study RV-014	36500	Eagle Point	42.487847°	-122.819315°	Class	Jack	3094
Rogue Basin Grouwater Study RV-015	36501	Eagle Point	42.480685°	-122.746898°	Class	Jack	19204
Rogue Basin Grouwater Study RV-016	36502	Central Point	42.408405°	-122.917559°	Class	Jack	152853
Rogue Basin Grouwater Study RV-017	36503	Gold Hill	42.414503°	-123.020131°	Class	Jack	32543
Rogue Basin Grouwater Study RV-018	36504	Rogue River	42.425806°	-123.184531°	Class	Jack	24487
Rogue Basin Grouwater Study RV-019	36505	Grants Pass	42.424994°	-123.255207°	Class	Jose	16136
Rogue Basin Grouwater Study RV-020	36506	Gold Hill	42.369949°	-123.148566°	Class	Jack	14335
Rogue Basin Grouwater Study RV-021	36507	Gold Hill	42.360495°	-123.147698°	Class		57374
Rogue Basin Grouwater Study RV-022 – Shallow	36511	Ashland	42.246155°	-122.745044°	Class		19789
Rogue Basin Grouwater Study RV-023 – Deep	36512	Ashland	42.246155°	-122.745044°	Class		19788
Rogue Basin Grouwater Study RV-024	36513	Ashland	42.229307°	-122.735437°	Class		31885
Rogue Basin Grouwater Study RV-025	36514	Medford	42.265782°	-122.809216°	Class		14852
Rogue Basin Grouwater Study RV-027	36515	Cave Junction	42.055832°	-123.616233°	Class	Jose	54582
Rogue Basin Grouwater Study RV-028	36516	Applegate	42.209674°	-123.201427°	Class		18462
Rogue Basin Grouwater Study RV-029	36517	Applegate	42.285970°	-123.218418°	Class		17601
Rogue Basin Grouwater Study RV-031	36518	Jacksonville	42.236146°	-123.057363°	Class?		17349
Rogue Basin Grouwater Study RV-032	36519	Talent	42.232877°	-122.784618°	Class?		15382
Rogue Basin Grouwater Study RV-033	36520	White City	42.533638°	-122.884689°	Y Jack CO WM		55776
Rogue Basin Grouwater Study RV-034	36521	Ashland	42.233748°	-122.728344°	M Jack CO WM		19893
Rogue Basin Grouwater Study RV-035	36522	Ashland	42.166371°	-122.658409°	Y Jack CO WM		20515
Rogue Basin Grouwater Study RV-036	36523	Central Point	42.491079°	-122.953710°	M Jack CO WM		34195
Rogue Basin Grouwater Study RV-037	36525	Central Point	42.341207°	-122.942654°	Jack CO MW		53563
Rogue Basin Grouwater Study RV-038	36526	Central Point	42.408804°	-122.897583°	Jack CO MW		3434
Rogue Basin Grouwater Study RV-039	36527	Medford	42.300300°	-122.936830°	Jack CO MW		16055

Rouge Basin Grouwater Study RV-XXX	LASAR	City	Google Earth Latitude	Google Earth Longitude	Source	County	Well Log #
Rogue Basin Grouwater Study RV-040	36529	Medford	42.298634°	-122.900681°	Jack CO MW	Jack	16064
Rogue Basin Grouwater Study RV-041	36530	Medford	42.302774°	-122.940649°	Jack CO MW	Jack	16073
Rogue Basin Grouwater Study RV-042	36531	Medford	42.304998°	-122.919716°	Jack CO MW	Jack	16075
Rogue Basin Grouwater Study RV-043	36532	Medford	42.297484°	-122.931003°	Jack CO MW	Jack	30214
Rogue Basin Grouwater Study RV-044	36533	Medford	42.300013°	-122.940173°	Jack CO MW	Jack	51098
Rogue Basin Grouwater Study RV-045	36538	Medford	42.422348°	-122.958770°	Jack CO MW	Jack	52479
Rogue Basin Grouwater Study RV-046	36539	Medford	42.299049°	-122.941276°	Jack CO MW	Jack	55681
Rogue Basin Grouwater Study RV-047	36540	Grants Pass	42.446396°	-123.287665°	JoCo WM	Jose	514
Rogue Basin Grouwater Study RV-048	36541	Grants Pass	42.410885°	-123.401689°	JoCo WM	Jose	13885
Rogue Basin Grouwater Study RV-049	36542	Grants Pass	42.432093°	-123.333983°	JoCo WM	Jose	19047
Rogue Basin Grouwater Study RV-050	36543	Grants Pass	42.361518°	-123.372174°	JoCo WM	Jose	6290
Rogue Basin Grouwater Study RV-051	36544	Grants Pass	42.333435°	-123.299126°	JoCo WM	Jose	7378
Rogue Basin Grouwater Study RV-052	36545	Cave Junction	42.127374°	-123.545521°	JoCo WM	Jose	6091
Rogue Basin Grouwater Study RV-053	36546	Cave Junction	42.120274°	-123.591850°	JoCo WM	Jose	13049
Rogue Basin Grouwater Study RV-054	36547	Cave Junction	42.122987°	-123.594312°	JoCo WM	Jose	53826
Rogue Basin Grouwater Study RV-055	36548	Grants Pass	42.586515°	-123.413366°	Class – Found Log	Jose	2425
Rogue Basin Grouwater Study RV-056	36549	Merlin	42.532041°	-123.407464°	Class – No Log	Jose	
Rogue Basin Grouwater Study RV-057	36550	Grants Pass	42.493130°	-123.381313°	Class – No Log	Jose	
Rogue Basin Grouwater Study RV-058	36551	Grants Pass	42.502636°	-123.387640°	Class – No Log	Jose	
Rogue Basin Grouwater Study RV-059	36552	Central Point	42.412381°	-122.883575°	Class – No Log	Jack	
Rogue Basin Grouwater Study RV-060	15659	Grants Pass	42.439278°	-123.379419°	Class – No Log	Jose	
Rogue Basin Grouwater Study RV-061	36553	Cental Point	42.429276°	-123.038897°	Class – No Log	Jack	
Rogue Basin Grouwater Study RV-063	36554	Ashland	42.240230°	-122.741599°	Class – No Log	Jack	
Rogue Basin Grouwater Study RV-064	15682	White City	42.425509°	-122.830719°	Neighbor	Jack	Do with #9
Rogue Basin Grouwater Study RV-065	36561	Ashland	42.239696°	-122.741587°	Neighbor	Jack	Do with #63
Rogue Basin Grouwater Study RV-066	36562	Central Point	42.413230°	-122.883579°	Neighbor	Jack	52545
Rogue Basin Grouwater Study RV-067	36563	Central Point	42.414332°	-122.883583°	Neighbor	Jack	

Appendix E: Laboratory Reports for 2011 Groundwater Quality Investigation