State of Oregon
Department of Environmental Quality

SOUTHERN WILLAMETTE VALLEY GROUNDWATER ASSESSMENT 2000-2001 NITRATE STUDY

Final Report

February 2003

Greg Aitken, R.G.
Jack Arendt, R.G.
Audrey Eldridge, R.G.
Groundwater Quality Protection Program
Water Quality Division

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ATTACHMENTS

A	**Real Estate Information**
B	**Mailer**
C	**1993 Statewide Groundwater Monitoring Master Plan**
D	**2000-2001 Data**

1.0 INTRODUCTION

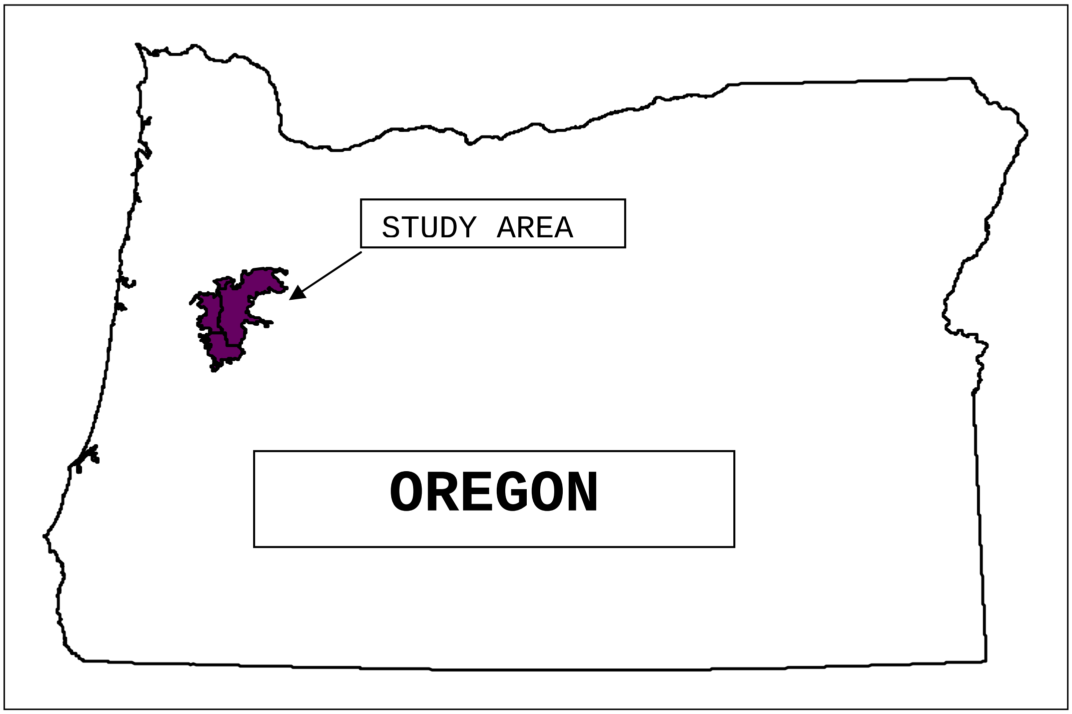
This report describes the work undertaken by the Department of Environmental Quality (DEQ) Groundwater Protection Program between Fall 2000 and Summer 2001 to study the current magnitude and extent of nitrate pollution of shallow groundwater in the Southern Willamette Valley. The Southern Willamette Valley is considered by DEQ to be a priority area for groundwater assessment and protection for three primary reasons: 1) severity and extent of nonpoint source groundwater contamination documented in past studies; 2) vulnerability of shallow groundwater to adverse impacts from population growth in the Willamette Valley; and 3) need for integration of groundwater quality protection strategies with other ongoing high-priority water quality improvement efforts in the Willamette Valley (i.e., Total Maximum Daily Loads [TMDLs]). DEQ will use the results of this evaluation to consider groundwater protection strategies, including the assessment of designating a Groundwater Management Area(s) or Area(s) of Groundwater Concern in the Valley, consistent with Sections 468B.175 and 468B.180 of the Groundwater Quality Protection Act.

The Groundwater Quality Protection Act is a critical component in Oregon's overall water quality protection and management strategy. The goal of DEQ's Groundwater Program is to ensure that Oregon's groundwater is protected as a resource for all present and future beneficial uses. The protection strategy begins with monitoring and assessment to identify groundwater quality problems. Where nonpoint sources of groundwater contamination are identified, groundwater management committees comprised of local stakeholders may be formed to develop groundwater management plans, in collaboration with state government agencies. Public education, research and demonstration projects are established to increase public awareness. These plans include development and implementation of best management practices to address groundwater contamination and protection.

DEQ has performed 45 regional groundwater studies in Oregon since the mid-1980s. Some evidence of 'non-point' groundwater contamination has been detected in 35 of the 45 areas studied. Non-point refers to the potential that the contamination is coming from an area, rather than from the end of a pipe, such as the discharge from a waste water treatment system. The most common contaminant found in these studies was nitrate, followed by pesticides, volatile organic compounds, and bacteria. Some of these areas, including the Southern Willamette Valley, have a high percentage of wells exceeding the drinking water standard for nitrates. In some cases pollutants occur in private water supply wells at concentrations exceeding safe exposure levels, thus posing threats to public health.

Groundwater from private and public wells is the principal source of drinking and irrigation water supply for a large number of residents in the Southern Willamette Valley. Portions of this area are already very populated, and this area is forecasted to be one of the fastest growing parts of the state. Demands for abundant, high quality

FIGURE 1: LOCATION OF THE STUDY AREA IN OREGON .



groundwater will rise with the increases in population. Left unchecked, nonpoint sources of groundwater contamination will increasingly compromise this water supply. When groundwater is contaminated from non-point sources at levels that exceed standards detailed in the Groundwater Quality Protection Act, DEQ is authorized to declare a "Groundwater Management Area." Once such a declaration is made, responsible agencies and the local communities will work together to develop an Action Plan with a focus on restoring groundwater quality. Through the development of an Action Plan, State government can play a key role in helping local governments, residents, and other stakeholders increase their awareness of groundwater quality concerns and mobilize them to take actions leading to groundwater protection and restoration of the water quality of this valuable resource.

2.0 PURPOSE AND SCOPE OF THE 2000-2001 STUDY

The purpose of this study was to confirm and supplement data collected in the past by DEQ and other agencies characterizing the occurrence of nitrate in shallow groundwater in the alluvial aquifers of the Southern Willamette Valley. Shallow groundwater (less than 75 feet below ground surface) in alluvium was targeted for sampling in this study because water-supply data (Hinkle, 1997) indicate that more than 80% of the groundwater used in the Willamette Valley is pumped from the alluvium. Shallow groundwater in the uppermost aquifer is assumed to be the groundwater resource most likely affected by anthropogenic activities.

DEQ's 2000-2001 study was limited to evaluating nitrate as a groundwater contaminant for three reasons: 1) nitrate sample collection and analysis is economical and could be completed in a timely fashion; 2) a considerable amount of nitrate data was already available from past studies, for use as a baseline for planning sampling targets; and 3) nitrate is a useful indicator of groundwater vulnerability, including the likelihood indicating a potential for of impacts from other contaminants like pesticides.

Nitrate in groundwater may originate 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 2-3 mg/L generally indicate anthropogenic contributions of nitrate (Madison and Brunett, 1985). In the Southern Willamette Valley where nitrate concentrations are commonly reported to be less than 1 mg/L, it is likely that "background" (non-anthropogenic) concentrations of nitrate approach the method detection limit of 0.05 ppm.

The health-based federal drinking water standard (MCL) for nitrate in drinking water is 10 mg/L. Consistent with the Safe Drinking Water Act, this regulatory standard applies exclusively to public drinking water systems and not to private water supplies. The epidemiological basis for the 10 mg/L drinking water standard is controversial, and recent studies have indicated there may be adverse human health effects at levels less than the 10 mg/L standard.

The results of this groundwater assessment may lead to an expanded investigation by DEQ for other contaminants (e.g., pesticides, volatile organic compounds, and/or arsenic) which are of interest both in terms of their potential impact on drinking water quality and degradation of surface water upon discharge of polluted groundwater to wetlands, lakes, streams, and rivers.

2.1 Objective

The primary objective of this study was to determine the magnitude and extent of nitrate contamination in the shallow alluvial aquifer from nonpoint sources in the Southern Willamette Valley. An important secondary objective was to perform outreach to local stakeholders (i.e., rural residents, farmers, and local government officials) about groundwater quality and protection from nonpoint sources in the Valley.

2.2 Project Organization and Responsibilities

This groundwater assessment was undertaken as a DEQ Water Quality Program initiative, in consultation with Oregon Health Division, Oregon Water Resources Division, Oregon State University Extension Service, Oregon Department of Agriculture, and the United States Geological Survey. DEQ staff responsible for undertaking this groundwater assessment are identified below in Table 1:

Table 1
2000-2001 Project Roles and Responsibilities

Role	Name and Location	Responsibilities	Contact Phone Number
Project Coordinator	Kerri Nelson, Eugene	Ensured coordination and consistency of project with other Water Quality Program and Western Region initiatives	541.686.7838 ext. 226
Project Advisor & Laboratory Coordinator	Greg Pettit, Eugene	Advised project team on: project scope; data collection methods, analysis, and interpretation; GW Protection Act interpretation. Coordinated project field work with Laboratory priorities and workload.	541.686.7838 ext. 253
Project Manager	Greg Aitken, Eugene	Developed, coordinated, and managed project implementation, including technical and public participation components	541.686.7838 ext. 252
Project Scientist	Jack Arendt, Salem	Coordinated collection and interpretation of project technical data	503.378.8240 ext. 240
Field Sampling Management	Rich Myzak, Portland	Implemented sampling plan and coordinated field operations with DEQ Laboratory Division	503.229.5983 ext.270
Field Sampling	Michael Tichenor, Portland	Collected field samples and performed public outreach	503.229.5983 ext.315
Laboratory Data Quality Assurance	Raeann Haynes, Portland	Coordinated Laboratory quality assurance and control activities, including management of laboratory analytical data (i.e., LASAR)	503.229.5983 ext.227
Sample Tracker	Bob McCoy	Tracked samples and data through the Laboratory	503.229.5983 ext.238
Communications & Outreach	Jennifer Boudin, Eugene	Coordinated media communications and assisted with public outreach	541.686.7838 ext. 235
Address/Mailing List Coordinator	Kathy Jacobsen, Eugene	Maintained project mailing lists, coordinated distribution of written communications to stakeholders	541.686.7838 ext. 0
Data Management – Laboratory	Won Kim, Portland	Maintained LASAR database for project analytical data	503.229.5360
Data Management – Western Region	Mary Camarata, Eugene	Developed and maintained databases for project data, coordinated with Laboratory data manager	541.686.7838 ext. 259
Data Management – Western Region	Mindy English Eugene	Data entry and maintenance of databases for project data, field sampling	541.686.7838 ext. 269

2.3 Location and Extent of Study Area

The area of this investigation encompasses the lowlands in the southern portion of the Willamette Valley, extending from Eugene to Albany in Lane, Linn, and Benton Counties (see Figure 2). Areas inside the urban growth boundaries of Eugene, Corvallis, Albany, and Lebanon are excluded because of this study's emphasis on groundwater quality issues affecting non-regulated rural water supplies. The boundary of the study area approximately coincides with the limits of shallow alluvium aquifer within the Southern Willamette Valley, known to include a shallow sensitive aquifer. It is bounded on the east by the Cascade Range, to the west by the Oregon Coast Range, to the north by the Salem Hills, and to the South by the city of Eugene's urban growth boundary. The study area encompasses approximately 780 square miles.

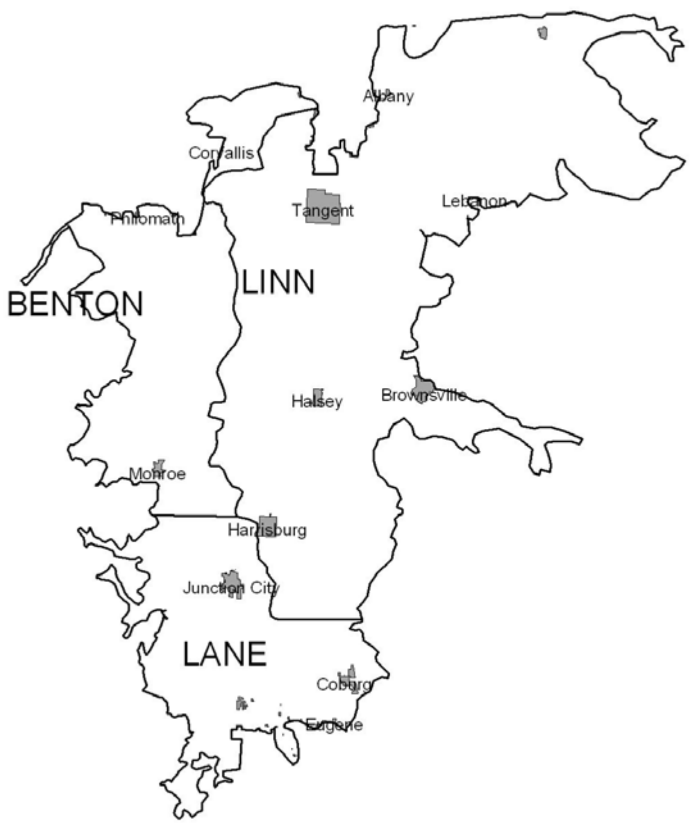


FIGURE 2

Southern Willamette Valley Study area

2.4 Land Uses

Land uses in the study area are predominantly agricultural (see Figure 3), including a diversity of crops (field crops, such as grains, hay, mint and hops; seed crops such as grass and vegetable seeds; and vegetable fruit, nut, and nursery crops) and pasture. Many of these crops are irrigated. Commercial livestock production occurs in the study area, including 33 confined animal feeding operations (CAFOs) permitted by the Oregon Department of Agriculture (Figure 4). Non-agricultural uses include rural residential, commercial, industrial, and natural habitat enhancement.

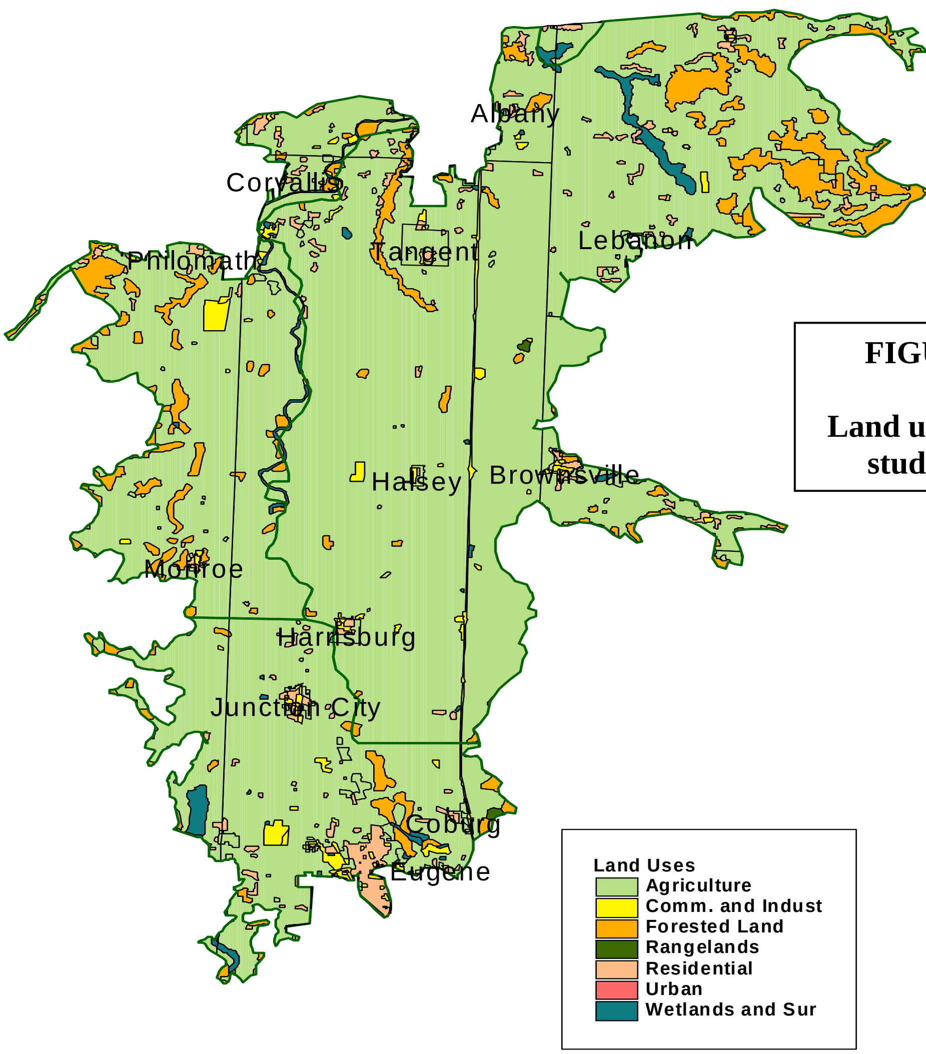


FIGURE 3

Land uses of the study area

2.5 Groundwater Resources

Based on information available in databases maintained by the Water Resources Division and Oregon Health Division (OHD), groundwater within the study area has multiple beneficial uses, including public and private water supply. Groundwater is also used extensively for irrigation. Other beneficial uses include recharge of surface water bodies that include rivers and wetlands.

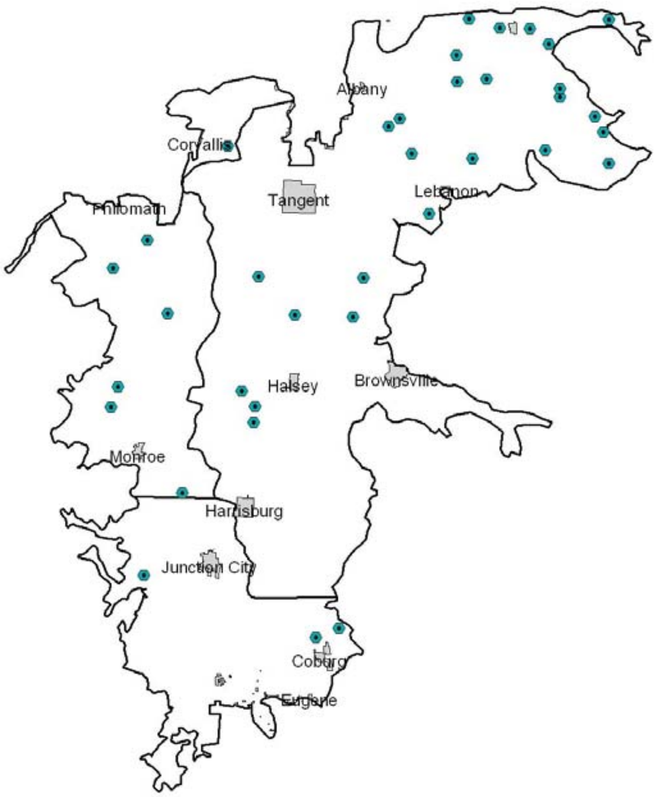


FIGURE 4

Locations of confined animal feeding operations

3.0 GEOLOGY AND HYDROGEOLOGY

The Willamette Valley is a broad, north-south trending alluvial plain in northwestern Oregon. The valley is flanked on the west by early Tertiary marine sedimentary and volcanic rocks of the Coast Range and on the east by Tertiary and Quaternary volcanic and volcaniclastic rocks of the Cascade Range. The Willamette Valley is an extensive lowland, typically 10 to 15 miles wide. The valley is sub-divided into four separate structural basins by local bedrock uplands. From north to south, the Portland Basin (Oregon and Washington), Tualatin Basin, central Willamette Valley, and southern Willamette Valley, each have decidedly different hydrologic properties. The valley lowlands are constricted midway between Portland and Eugene by the Salem-Eola Ridge, a northwest-southeast, cross-valley trending upland. The Southern Willamette Valley Groundwater Study Area, located south of the Salem-Eola Ridge, encompasses approximately 780 square miles.

The extent and thickness of major Quaternary age deposits control a majority of the regional groundwater systems within the Willamette River Basin.

3.1 Geology

Based on previous work conducted by state and federal agencies (Gamnett and Caldwell, 1998; Orzol et al, 2000), the Willamette Valley has been a topographic low for at least 15 million years. Subsequent uplift of the Coast Range and Cascade Range has further defined the basin along the north-south axis of a regional down-warp or trough. The sustained subsidence over time has resulted in the consistent filling of the lowlands from Cascade and Coast Range sources.

The lowlands and tributary valleys of the Willamette Valley are underlain by Quaternary-age, fluvial derived materials that were deposited during four major sedimentary episodes. These episodes can be subdivided into seven surficial geologic units. By their positions and internal stratigraphy, each of these units record major geologic and environmental events within the Willamette Valley. The character and distribution of these deposits also exert substantial control on current topography, soil characteristics, and groundwater properties.

As the major streams enter the valley lowlands from the surrounding mountains, large alluvial fans of coarse sand and gravel are deposited. These fans are thickest along the eastern margins and thin to broad braided deposits toward the west. Sediment particle sizes grade distally (westward) and with depth to finer-grained sediments. Consequently, within the lowlands, the upper 30 to150 feet of alluvial fill is made up of materials deposited by braided channel systems. The fill is primarily composed of sand and gravel deposited in sub-horizontal sheets, 6 to 30 feet thick. Across the valley, these deposits grade to fans greater than 300 feet thick where the Santiam and McKenzie rivers enter the lowlands. These two fans are partly responsible for the Willamette River's current position along the west side of the valley. The fan deposits can also be traced further upstream as much thinner valley trains of coarse gravel outwash flanking the major Cascade Range tributaries.

The two most recent periods of deposition culminated about 23,000 and 12,000 years ago, respectively. These two units represent long phases of fan deposition that occurred during the late Pleistocene. The young sedimentary units represent the latest phase of the braided stream-alluvial fan depositional system. Mapped exposures only represent the visible part of much thicker sand and gravel deposits. These pulses produced separate mapable units that likely represent episodes of elevated sediment production from the Cascade Range.

Between 15,000 and 12,000 years ago, filling of the Willamette lowlands by sediment from Cascade and Coast Range sources was repeatedly and cataclysmically interrupted by multiple floods from Glacial Lake Missoula. These floods left over 40 beds of sand, silt, and clay known locally as the Willamette Silt. The silts were derived primarily from the upper Columbia Basin. Total thickness in the southern Willamette Basin seldom exceeds 20 feet at lower altitudes near Albany. The silt quickly tapers to a feathered edge at altitudes of 300 to 360 feet above sea level on the margins and higher plains of the basin. South of Harrisburg, the silts are too thin to be mapped as a distinct unit.

About 12,000 years ago, there was a profound change in sediment and flow regimes of the Willamette River and its major tributaries. A transition from braided stream-alluvial fan deposition to modern incised meandering stream system began to occur. The Pleistocene braided river systems that had been forming significant outwash plains of sand and gravel evolved to incised and meandering systems that are developing today's Holocene floodplains. Today's modern floodplains are typically 2 to 4 miles wide, are covered by cumulic soils with varying amounts of organic matter and ability to drain, and have been historically flooded several times. Underlying the Holocene floodplains, the interbedded sequences of channel facies that form belts of highly permeable sand and gravel are separated by over-bank facies of less permeable fine sand, silt, and clay.

3.2 Hydrogeology

One of the objectives of the Southern Willamette Valley Groundwater Study was to develop a better understanding of the factors that control the fate and transport of contaminants in shallow groundwater environments. Based on data collected during subsequent phases of the investigation, groundwater models of the Willamette Valley can be created to simulate future water quality conditions.

The Quaternary units within the Willamette Basin have unique hydrogeologic properties due to their (1) grain size characteristics, (2) degrees of weathering, compaction, and cementation, and (3) internal faces architecture. Although geologically, each lithologic unit can be distinctly different, hydrogeologic units are based on porosity and permeability and, therefore, can often overlap between lithologic boundaries. As such, there are five major hydrogeologic units that represent the dozen geologic units mapped in the Willamette Valley.

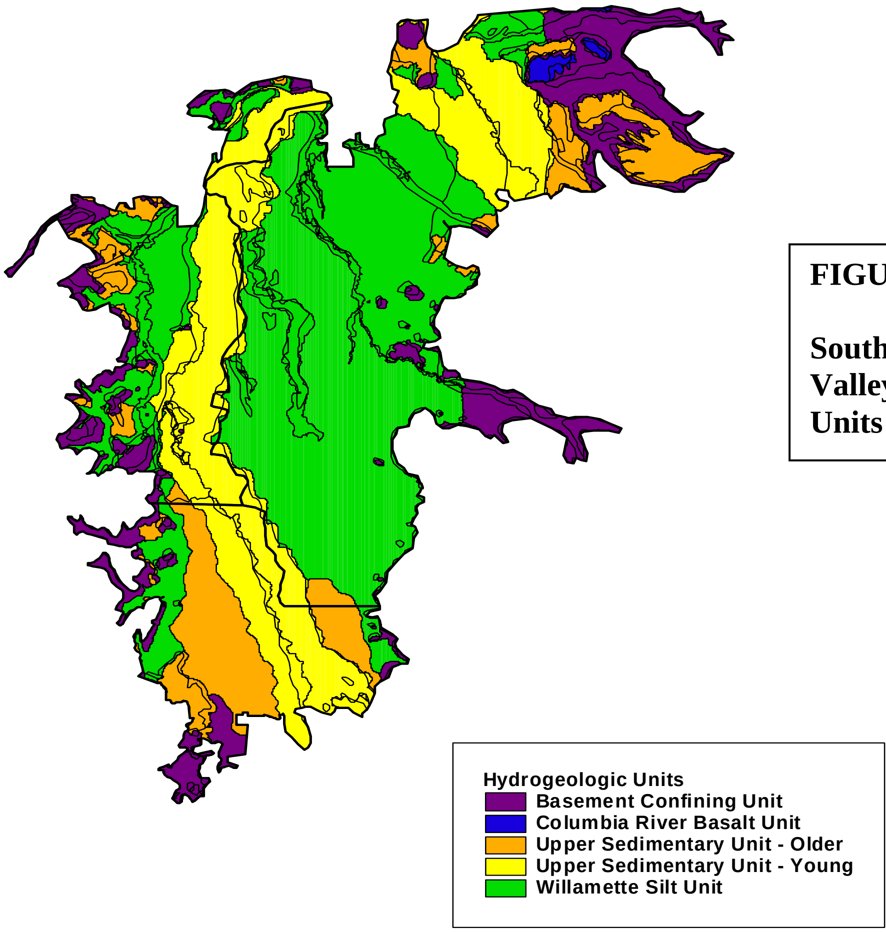


FIGURE 5

Southern Willamette Valley Hydrogeologic Units

Previous work in the Willamette Valley conducted by the US Geological Survey (USGS) and the Water Resources Department (WRD) has defined five regional hydrogeologic units. These regional units are (1) the Basement Confining unit, (2) the Columbia River Basalt unit, (3) the Willamette Confining unit [not shown as it underlies various units and does not surface in the study area], (4) the Willamette Aquifer [depicted as the Older and Younger Upper Sedimentary Unit], and (5) the Willamette Silt unit. In the southern part of the Southern Willamette Valley, the contact between the Basement and Willamette confining units is sometimes difficult to distinguish through well log assessment. As a result, some areas of the basin may not be as deep as initially interpreted. The Columbia River Basalt hydrogeologic unit outcrops as a small window located in the northeast corner of the study area; however, none of the study wells encountered these isolated basalt occurrences.

Based on their similar hydrogeologic properties, Holocene floodplain deposits of the Willamette

River and major tributaries (Figure 5, Younger Upper Sedimentary Units), late Pleistocene sands and gravels (Figure 5, Older Upper Sedimentary Units) that post-date the Missoula flood deposits, and late Tertiary fluvial sands and gravels that underlie terraces flanking the margins of lowlands and tributary valleys are group together as one hydrogeologic unit. This unit, referred to as the Willamette Aquifer, is more permeable and susceptible to contaminant impacts than other basin deposits. The Willamette Aquifer is generally much looser and less cemented than the older, Tertiary marine rocks and Cascade volcanic units in the basin. The Holocene sands and gravels of the modern floodplain are a major source of groundwater and generally have higher yields in the valley than other geologic units. The overall groundwater flow direction of the shallow alluvial aquifers is towards the Willamette River. Groundwater in the close proximity of the Willamette River will tend to flow in the direction of the river drainage.

In the study area, groundwater in the younger, upper part of the Willamette aquifer generally occurs under unconfined conditions. Regionally, groundwater flows to the major streams, indicating that base flow of these streams is sustained by groundwater discharge. The hydraulic gradient of the Willamette aquifer ranges between 2 and 60 feet per mile, depending on the location in the valley. Based on average values of the hydraulic gradient and other hydrogeologic characteristics of the Willamette aquifer, the velocity of water moving through the aquifer ranges between 3 and 30 feet per day which is typical for sand and gravel aquifers.

In areas where the water-table is near the ground surface, a considerable volume of groundwater in the Willamette Basin is removed through evapotranspiration from soil root zones. Based on cross-sectional groundwater flow models, about 15 or 16 inches of evapotranspiration per year is supported by the aquifer system.

An analysis of bank deposits and driller's well logs shows that the meandering winding and anastomosing rivers of the Holocene have left meandering ribbons of well-sorted gravels and sand. These highly permeable sediments are separated horizontally and vertically by fine-grained overbank deposits. Similar to a typical river section of today, the course-grained channel facies in the subsurface can characteristically be 30 to 100 feet wide and three to ten feet thick. Fine-grained overbank deposits of silt and clay typically underlie most of the floodplain. These deposits will often restrict the flow between individual ribbons of coarse-grained, channel facies deposits.

Generally, on a basin-wide scale, the younger Holocene sands and gravels are considered to be a homogenous unit. On a more local floodplain scale, facies variations between and within channel and overbank deposits will likely control groundwater flow patterns. Changes in channel facies can control processes such as solute transport and hyporheic flow, as well as provide avenues for interactions between surface water and groundwater. Locations where subsurface channel facies intersect active river channels are likely to be zones of substantial exchange between ground and surface water.

4.0 BACKGROUND INFORMATION

The overall approach used to collect, assemble, and analyze data for this report is described in this section. First, a description of the sources of historical data is given, followed by a description of the sampling design for 2000-2001 project data. In Section 4 and 5 of this report, approaches used to define the quality of both historical and 2000-2001 project data are discussed, as are the collection and analytical methods used for project data.

4.1 Historical Data

Assessment of historic nitrate data from previous groundwater investigations was the starting point for planning the sampling targets for this study. DEQ reviewed existing nitrate concentration data available from several sources, including various state and federal government programs that have monitored Valley groundwater quality in the past. This data review formed the basis for the project study design, by providing an indication of where nitrate pollution of groundwater has already been documented, and where data gaps exist.

4.1.1 Data Sources

The sources of nitrate concentration data reviewed by DEQ are included in Table 2, including information about their geographic focus, sampling extent, and a generalization about the level of data quality. Brief summaries of sample results from these studies are described in the sections that follow.

4.1.1.1 1985-1987 Oregon DEQ Studies

As part of a statewide assessment of shallow groundwater for contamination from agricultural chemicals (including nitrates), DEQ collaborated with local, state, and federal agencies in the mid 1980s in sampling groundwater from 45 shallow wells in Lane and Linn
Counties (DEQ, 1988). The nitrate data from this study are known to have a high level of quality control including strict field sampling techniques by experience professionals and laboratory analysis using EPA-specified protocols and a rigorous Quality Assurance/Quality Control program.

Of the 16 wells tested in the Coburg Area, 9 wells had nitrate concentrations ranging between 3 and 7 mg/L. The remaining Coburg wells had nitrate levels lower than 3 mg/L. Of the 29 wells were sampled for nitrate in the North Albany area, samples from 8 wells had an exceedance of 5 mg/L. None of the samples exceeded the 10 mg/L MCL.

Table 2
Southern Willamette Valley Groundwater Assessments

Organization	Sampling Program	Geographic Focus	# of Sample Points in Southern Willamette	Sampling Period	Quality Control Level[1]
Oregon DEQ	Groundwater Assessments	Statewide	15	1985-1987	High
Oregon DEQ	Groundwater Assessments	Coburg, Junction City, Albany-Lebanon	61	1993-1994	High
Oregon DEQ	Voluntary Nitrate Testing	Statewide	34	1992-1993	Low
Oregon State University Agricultural Extension	Volunteer Nitrate Testing	Junction City and Coburg	271	1997	Low
Oregon Health Division	Real Estate Transaction Testing	Statewide	963	1989-1996[2]	Low
Oregon Health Division	Public Water Supply System Testing	Statewide	144	1979 through present[3]	Low/High
United States Geological Survey	NAQWA	Nationwide	30	1993	High

4.1.1.2 1993-1994 Oregon DEQ Studies

DEQ initiated the Statewide Groundwater Quality Monitoring Program in 1993 (DEQ, 1993b) to assess the impact of nonpoint sources on the quality of Oregon's groundwater resources. Based on known or suspected area-wide contamination and concerns about groundwater vulnerability, DEQ prioritized 32 areas within the state for assessment, including three areas (DEQ 1993c,

1 High quality Control attributed to adherence to strict protocols for field sampling and laboratory analysis by trained regulatory agency personnel; Low quality control designated when protocols for sampling and analysis are not documented, or when colorimetric analytical methods are used.

2 Electronic summaries of OHD's real estate transaction groundwater testing data are not available after 1996.

3 Data reviewed by DEQ do not include sampling events in the year 2000. "Low/High" rating due to the that sampling may not be done by trained personnel, but the analysis does follow EPA protocols.

1994a, and 1994 b) within the Southern Willamette Valley (Coburg, Junction City, and the Albany-Lebanon Plain). Between 1993 and 1994, 61 wells were sampled for nitrate as part of these three assessments. These data are known to have a high level of quality control, including strict well selection, field sampling, and laboratory analysis protocols.

The nitrate data obtained from DEQ's Coburg, Junction City, and Albany-Lebanon groundwater assessments are presented in Figure 6 and Table 3 (end of this Chapter).

- ***1994 Coburg Area Study***

In June 1994, DEQ collected samples from 20 domestic wells in the Coburg area (Figure 6), in which nitrate results ranged up to 15 mg/l. Nitrate concentrations exceeded 3 mg/L in 12 wells, and exceeded the 10 mg/L MCL in 4 wells. The higher concentrations of nitrate tended to occur in wells near the Coburg Bottom Loop Road, Pioneer Estates, and Lanes Turn Road areas.

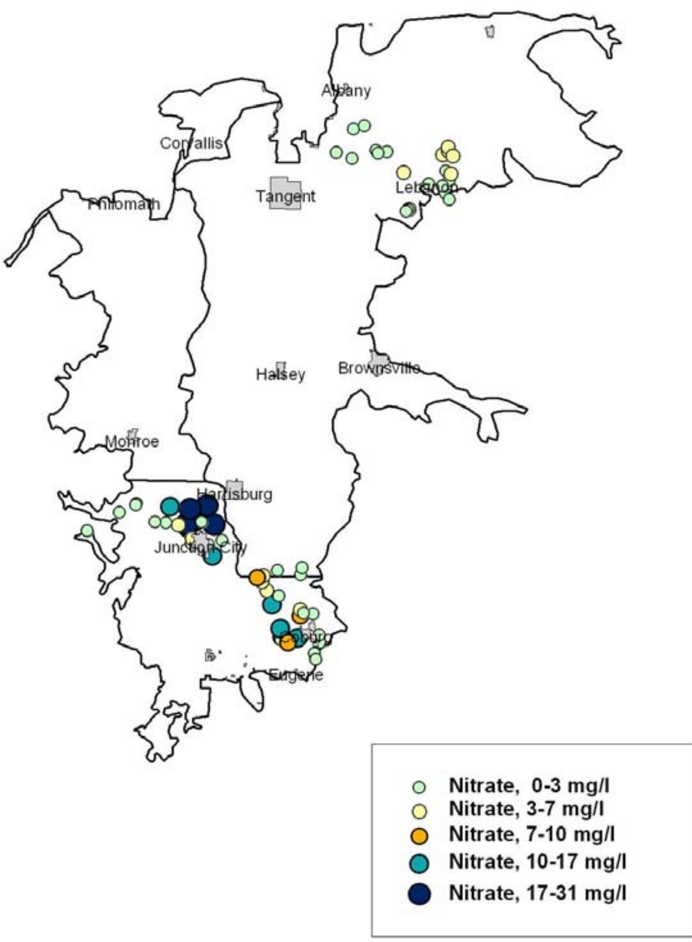


FIGURE 6

Nitrate results DEQ groundwater 1993-94 investigations

- ***1994 Coburg Area Study***

In June 1994, DEQ collected samples from 20 domestic wells in the Coburg area (Figure 6), in which nitrate results ranged up to 15 mg/l. Nitrate concentrations exceeded 3 mg/L in 12 wells, and exceeded the 10 mg/L MCL in 4 wells. The higher concentrations of nitrate tended to occur in wells near the Coburg Bottom Loop Road, Pioneer Estates, and Lanes Turn Road areas.

- ***1993 Junction City Area Study***

In April 1993, DEQ collected samples from 21 domestic wells in the Junction City area (Figure 6), in which nitrate results ranged up to 31 mg/L. Nitrate concentrations exceeded 3 mg/L in 11 wells, and exceeded the 10 mg/L MCL in 8 wells, primarily in an area north of Junction City.

- ***1993 Albany-Lebanon Plain Study***

In August 1993, DEQ collected samples from 21 domestic wells in Albany-Lebanon Plain area (Figure 6), in which nitrate ranged up to 6.5 mg/L. Nitrate concentrations exceeded 3 mg/L in seven of the 21 wells, primarily in the South Santiam River floodplain near Tennessee and Tennessee School Roads. The 10 mg/L MCL was not exceeded in any of the 21 wells.

4.1.1.3 Oregon State University Extension Volunteer Testing

Staff of the Lane County office of the Oregon State University (OSU) Extension Service surveyed approximately 500 domestic well owners in northern Lane County (including Junction City and Coburg areas) during 1995-1997 to increase awareness about groundwaterquality protection and to accumulate nitrate screening data as a measure of groundwater quality. The nitrate screening data were collected using a Hach kit for colorimetric analysis of well water samples. DEQ considers these samples to have a lower level of quality control when compared to samples collected by experience professionals and laboratory analysis conducted using EPA-specified protocols and a rigorous laboratory Quality Assurance/Quality Control program. These data are nonetheless valuable in showing the approximate distribution of elevated nitrate concentrations.

OSU Extension data available to DEQ include nitrate results from 469 domestic wells scattered in rural areas between Harrisburg and Eugene (Figure 7). Nitrate concentrations generally ranged up to 34 mg/L, and one sample had nitrate at 233 mg/L. There were exceedances of the 10 mg/L MCL in 167 wells. Nitrate concentrations ranged between 3 and 10 mg/L in 191 wells.

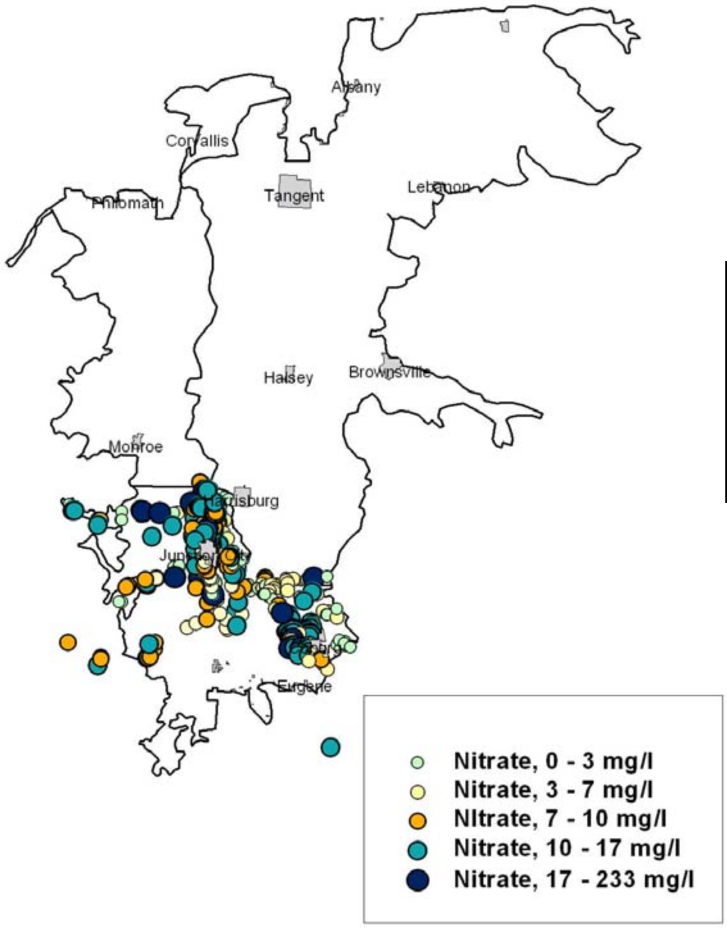


FIGURE 7
1995-97 OSU Extension Volunteer Testing – in Junction City & Coburg areas

Wells with elevated nitrate tended to be located near Coburg and Junction City, and within the younger alluvium near the Willamette River between these two cities. Another significant number of wells with high nitrate levels occurred west of Harrisburg, including the floodplain of Ferguson Creek.

4.1.1.4 Oregon Health Division Real Estate Transaction Testing

Since 1989, Oregon Revised Statutes 448.271 has required sellers of residential property with domestic wells to sample for nitrate and bacteria. Nitrate testing data are routinely submitted to the Oregon Health Division (OHD) by property sellers, but data submitted more recently than 1996 are not organized or easily available due to staff resource limitations at Oregon Health Division. Laboratory sample results from 964 wells sampled between 1989 and 1996 in the

Counties of Linn, Lane and Benton have been reported to OHD as a result of this program. DEQ considers these data have a low level of quality control, in the absence of strict field sampling or laboratory analysis protocols. Once again, these data are still valuable in showing the approximate distribution of elevated nitrate concentrations.

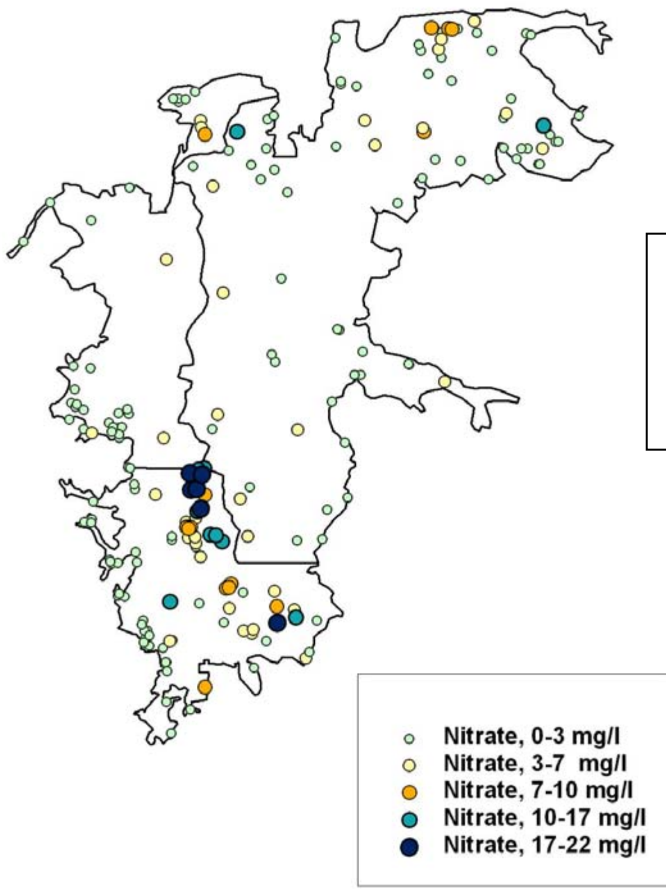


FIGURE 8

Nitrate results from real estate transactions

Only a portion of the 964 domestic wells in these three Counties were actually in the Southern Willamette Valley study area. Of this group, 564 wells had addresses that were recognized by the ArcView mapping program. The nitrate results from those recognizable addresses sampled in the project study area between 1989 and 1996 are presented in Figure 8 and described below:

- Nitrate exceeded the 10 mg/L MCL in 34 wells. The majority of these wells occurred in the Junction City area (19), north Eugene –Coburg area (4), and the Albany – Lebanon Plain (7).

- Nitrate ranged between 3 and 10 mg/L in 175 domestic wells. Many of these wells occurred in the Albany-Lebanon Plain area (47), Corvallis (23), north Eugene-Coburg (27), Harrisburg (7), Junction City (39), and Scio (14).

4. 1.1.5 Oregon Health Division Public Drinking Water Supply Data

Consistent with the Safe Drinking Water Act, OHD requires testing of public drinking water supplies including restaurants, hotels, mobile home parks, and any drinking water supply regularly accessible to the public. DEQ staff reviewed OHD records and found at least 112 permitted public water supply systems dependent on a groundwater source within the study area. These systems are required to monitor water quality on a routine basis, including laboratory analysis for nitrate. Data are considered to have a mixed level of quality control, when compared to samples collected by experience professionals and laboratory analysis conducted using EPA-specified protocols and a rigorous laboratory Quality Assurance/Quality Control program. Samples may have been collected by untrained individuals (such as the homeowner) but the analyses are required to be completed by a laboratory certified for drinking water samples.

Figure 9 shows the approximate locations of public water supply systems found in the project study area, including an indication of one or more incidences of elevated nitrate concentrations detected at any time during historic routine monitoring. Nitrate levels of 3-10 mg/L were reported at least once in 27 systems, predominantly east of Corvallis, Tangent, Albany-Lebanon Plain area, Scio, Halsey, Harrisburg, and Junction City areas. Exceedances of the 10 mg/L MCL were reported at least once in 8 systems within the project study area, near Junction City, Harrisburg, Coburg, Brownsville, Corvallis and Tangent.

Figure 9 shows the approximate locations of public water supply systems found in the project study area, including an indication of one or more incidences of elevated nitrate concentrations detected at any time during historic routine monitoring. Nitrate levels of 3-10 mg/L were reported at least once in 27 systems, predominantly east of Corvallis, Tangent, Albany-Lebanon Plain area, Scio, Halsey, Harrisburg, and Junction City areas. Exceedances of the 10 mg/L MCL were reported at least once in 8 systems within the project study area, near Junction City, Harrisburg, Coburg, Brownsville, Corvallis and Tangent.

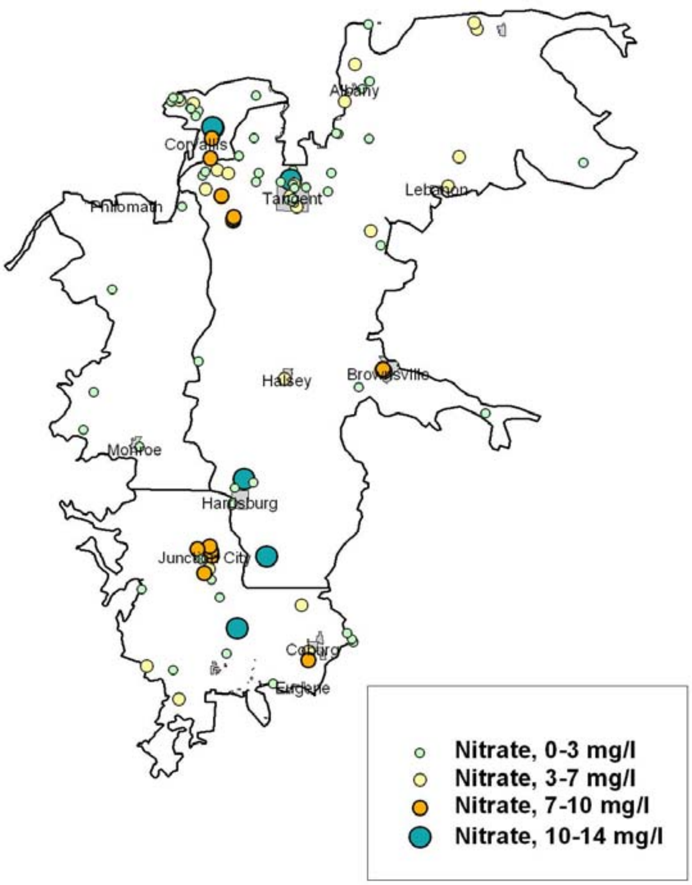


FIGURE 9

Historical highest nitrate value for individual public water supplies

Nitrate data available to DEQ for these public water supply systems are not reliable indicators of general shallow groundwater quality for the following reasons:

- water samples are collected at the "entry point" to the water supply system, which often includes water pumped from more than one well;
- any exceedances of the nitrate MCL will generally trigger immediate corrective action, including abandonment of the source or reduction of contaminant levels by dilution of water from other sources;
- once a system violation is corrected, documentation of violation details (e.g., specific nitrate MCL exceedances) may not be consistently available;
- public water supply wells (particularly newer ones) tend to be relatively deep and extend below

the shallow vulnerable aquifers.

Because of the above information, DEQ believes that the available public water supply system monitoring data is likely to be biased towards underreporting of elevated nitrate levels actually be present in shallow groundwater. This nitrate information is presented for informational purposes, but not intended to be used for comparison with the shallow domestic well data.

4.1.1.6 United States Geological Survey Willamette Valley Groundwater Assessment

The USGS studied groundwater quality in the Willamette Valley (Hinkle, 1997), including laboratory analyses of nitrate in samples collected in 1993 from 30 water supply wells distributed broadly across the project study area. These data are known to have a high level of quality control, including strict well selection, field sampling, and laboratory analysis protocols.

Figure 10 includes locations and nitrate concentration ranges for these 30 wells. Nitrate concentrations ranging from 3-10 mg/L occurred in 6 wells, and exceedances of the nitrate MCL (10 mg/L) occurred in 4 wells. The limited number of wells sampled in this study and their wide spatial distribution across the study area makes it difficult to determine any general patterns in nitrate distribution. However, these data are consistent with the data from other studies showing elevated nitrate concentrations near Junction City, Harrisburg, and Coburg.

4.1.1.7 Oregon DEQ Voluntary Nitrate Testing

DEQ sponsored a voluntary nitrate testing program between 1992 and 1993, enabling the screening of groundwater from 34 domestic wells in the Coburg area for nitrate. Testing results from this program are considered to have a low level of quality control in the absence of strict field sampling or analysis protocols. Samples were collected by well owners and analyzed for nitrate by DEQ staff using a Hach field kit for colorimetric analysis. The results of this testing indicated that a majority of the 34 wells had nitrate concentration exceeding 3 mg/L, and six wells exceeded the 10 mg/L MCL.

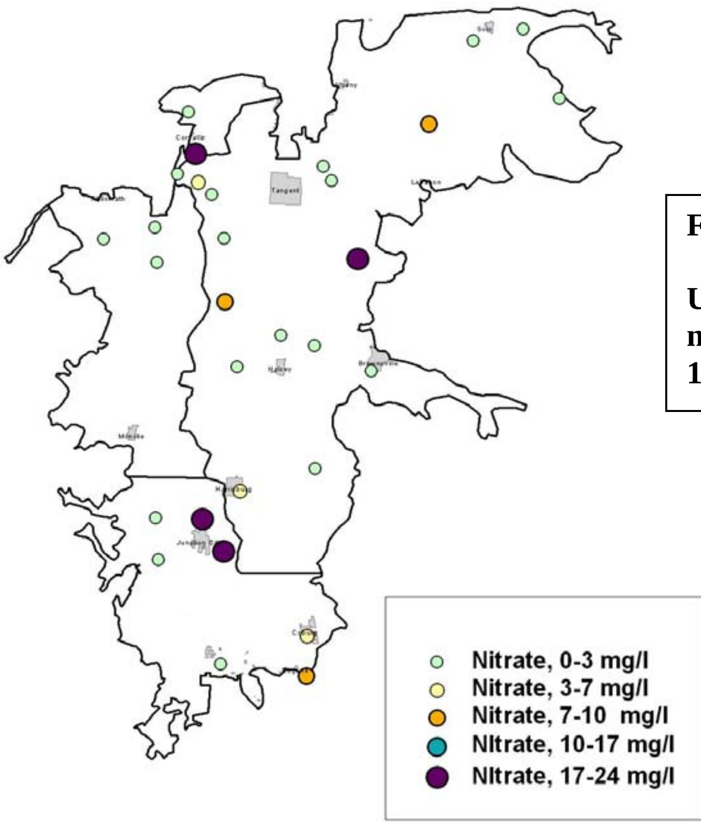


FIGURE 10

USGS NAQWA study of nitrate in groundwater 1991 & 1993

4.1.2 Historic Data Summary & Data Gaps

Nitrate data from the previous cited studies and data sources indicate regional concentration trends, despite their variable quality and their biased spatial distribution within the project study area. Elevated nitrate concentrations (greater than 3 mg/L) tended to occur in the following general areas: Albany-Lebanon Plain (especially north of Lebanon); rural area between Albany and Corvallis; and areas near Harrisburg, Junction City, and Coburg. In addition, public water supply system data suggest that elevated nitrate concentrations occur in groundwater near Tangent, Halsey, and Scio.

Despite the useful data available from these seven studies, they were not sufficient in quality and/or quantity for regional interpretations of nitrate distribution in groundwater within most of the project study area. The portions of the study area with little or no historic data include areas near Alvadore (east of Fern Ridge Reservoir), Monroe, Halsey, Brownsville, Corvallis-Albany, Tangent, Millersburg, and Scio.

Table 3
Nitrate Results
1993-1994 DEQ Studies

Sample Date	Laser Number	General Location	Nitrate, mg/L
06/27/1994	16643	Pauite, Coburg	7.1
06/27/1994	16644	Coburg Rd. Coburg	8.9
06/27/1994	16641	Coburg Rd. N. Coburg	4.2
06/27/1994	16642	Indian Dr. Coburg	2.3
06/27/1994	16646	Coburg Rd. Coburg	2.6
06/28/1994	16647	Coburg Rd. Coburg	13.0
06/28/1994	16648	Coburg Rd. Coburg	3.3
06/28/1994	16649	Lanes Turn Rd. Coburg	5.9
06/29/1994	16655	Cross Rd.Ln. Coburg	3.4
06/29/1994	16656	Coburg Bottom Loop Coburg	11.0
06/28/1994	16650	Cross Rd. Ln. Coburg	8.4
06/28/1994	16651	Powerline Rd. Coburg	1.8
06/28/1994	16652	Herman Rd. Coburg	0.6
06/28/1994	16653	Coburg Rd.N. Coburg	0.7
06/29/1994	16658	Coburg Bottom Loop Coburg	15.0
06/29/1994	16659	Knox Rd. Coburg	2.0
06/29/1994	16660	Coburg Bottom Loop Coburg	13.0
04/20/1993	16534	Oaklea Dr. Junction City	17.0
04/20/1993	16535	Hw. 99W Junction City	31.0
04/20/1993	16538	Love Lake Rd. Junction City	21.0
04/20/1993	16539	Lingo Ln, JC.	19.0
04/21/1993	16540	Oaklea Dr. Junction City	19.0
04/20/1993	16537	Hwy. 99W Junction City	18.0
04/21/1993	16541	6Th Ave. Junction City	5.1
04/19/1993	16545	Ferguson Rd. Junction City	12.0
04/20/1993	16543	Love Lake Rd. Junction City	0.0
04/21/1993	16544	Spruce Junction City	3.5
04/20/1993	16546	Teritorial Rd. Junction City	0.0
04/19/1993	16547	Washburne Ln. Junction City	2.2
04/21/1993	16551	Cox Butte Rd. Junction City	3.7
04/21/1993	16553	Strome Ln. Junction City	14.0
08/09/1993	16582	Kgal Dr. Lebanon	0.9
08/10/1993	16583	W. Oak Dr. Lebanon	3.8
08/09/1993	16577	Tennessee School Rd. Lebanon	5.1
08/09/1993	16578	Tennessee Rd. Lebanon	6.5
08/10/1993	16584	W. Oak Dr. Lebanon	0.7
08/10/1993	16588	Spicer Dr. Lebanon	0.5
08/10/1993	16590	Muller Dr. S.E. Albany	0.0
08/10/1993	16591	Stutzman Dr. S.E. Albany	1.1
08/09/1993	16579	Tennessee Rd. Lebanon	6.4
08/09/1993	16580	Tennessee Rd. Lebanon	4.5
08/10/1993	16585	36232 W. Oak Dr. Lebanon	0.3

08/10/1993	16587	Langmack Rd. Lebanon	3.9
Sample Date	**Laser Number**	**General Location**	**Nitrate, mg/L**
08/10/1993	16592	Red Bridge Rd. S.E. Albany	0.8
08/11/1993	16594	Penny Ln. Lebanon	0.2
08/11/1993	16597	Fry Rd. S.E. Albany	1.2
04/19/1993	16536	Link Ridge Dr. Junction City	ND
04/19/1993	16536	Link Ridge Dr. Junction City	ND
04/19/1993	16542	Alder Junction City	ND
04/19/1993	16548	Cox Butte Rd. Junction City	ND
04/19/1993	16549	Ferguson Rd. Junction City	ND
04/19/1993	16550	Territorial Rd. Junction City	ND
08/10/1993	16589	Spicer Dr. S.E. Albany	ND
08/11/1993	16596	Midway Dr. S.E. Albany	ND
08/11/1993	16593	Wheeler Lp. Lebanon	ND
06/27/1994	16645	Powerline Rd. Coburg	1.7
06/29/1994	16657	Smith Ln. Coburg	10.0
06/28/1994	16654	Coburg Rd. Coburg	1.2
08/09/1993	16581	Tennessee Rd. Lebanon	3.3
08/10/1993	16586	Gore Dr. Lebanon	0.7
04/21/1993	16552	Prairie Rd. Junction City	ND
08/11/1993	16595	Honah Lea Dr. Lebanon	ND

5.0 PROJECT DESIGN AND METHODS

5.1 Sampling Design for Project Data

Design of a sampling plan for DEQ's 2000-2001 groundwater assessment included two main criteria for selecting sampling targets. Firstly, DEQ sampled groundwater from private water supply wells broadly distributed across the Valley to fill gaps in the spatial distribution of the historical data. Secondly, DEQ focused collection of groundwater samples in three areas within the Valley previously sampled by DEQ in the mid-1990s (Coburg, Junction City, and Lebanon-Albany plain areas). Within these three areas, 61 wells that were previously sampled were re-sampled. Additional wells with no previous sampling history were also sampled in these areas, to further define the nature and extent of nitrate contamination apparent from the historical data.

5.2 Project Sample Collection Methods

Groundwater samples were collected from hose-bibs or taps plumbed directly to water supply wells, consistent with the DEQ Laboratory Field Sampling Reference Guide (DEQ, 1993a). Sample documentation and chain-of-custody procedures outlined in the Master Plan and Reference Guide were followed. Samples were shipped to the DEQ Laboratory by field staff within 5 days of collection.

The following breakdown characterizes the current use of the 476 project wells sampled for evaluation of spatial distribution of nitrate:

- 437 wells used for private domestic water supply
- 29 wells used for public water supply systems
- 10 wells used for irrigation or livestock

To expedite sample collection and project completion, field staff limited sampling to wells that were actively being used by their owners and readily accessible to DEQ field staff. The winter season in which sampling took place precluded access to many shallow irrigation wells that are not typically operational outside the dry irrigation season.

Because the wells targeted for sampling were typically being pumped by their owners as an active water supply, samples were collected from the wells after a purge time of about 1 minute. Longer purge times, characteristic of most other DEQ groundwater studies, were deemed unnecessary for actively used wells in this project because these wells experienced a degree of regular purging from their frequent use.

5.3 Project Analytical Methods

Samples were analyzed for Laboratory analyses included Nitrate/Nitrite – Nitrogen (NO_3+NO_2-N), consistent with U.S. EPA Methods 353.2. Nitrate analyses were done at the DEQ Laboratory in Portland using the lead-cadmium reduction method. The analytical minimum reporting level

(MRL) was 0.05 mg/l for these analyses.

5.4 Quality Control and Quality Assurance

The data generated by this sampling event met the data quality objectives set for this project. This was determined by analyzing duplicate, field blank, and transfer blank samples for 10% of the samples collected.

5.5 Comparisons with Water-Quality Criteria and Nitrate Health Risks

The USEPA drinking current drinking water maximum contaminant level (MCL) for nitrate (as nitrogen) of 10 mg/L nitrate was used as a benchmark to conduct data comparison. The MCL is the maximum concentration of a contaminant allowed in public water systems as regulated by the federal Safe Drinking Water Act. The MCL is not enforceable for private water supply systems. Water with a nitrate (as nitrogen) concentration below the MCL of 10 mg/L is not necessarily free of health risks.

Infants and developing fetuses are especially vulnerable to health problems from drinking water with nitrate levels above 10 ppm. Nitrate can interfere with the ability of the blood to carry oxygen to vital tissues of the body in infants of six months old or younger. The result is called methemoglobinemia, or "blue baby syndrome". Infants may also receive greater exposure than others in the same household because of their smaller body weight and the higher proportion of water in their diets. Concentrations less that 10 ppm nitrate may have adverse, but non-lethal, health effects on infants due to nitrates converting to nitrites in the blood, and limiting the ability to efficiently transfer O2.

Many adults are also susceptible to nitrate effects. Some older children and adults are genetically susceptible to methemoglobinemia, and a large number of adults are exposed to chemicals in their workplaces, or in medications that put them at increased risk for harm from nitrate.

Little is known about the long-term effects of drinking water with elevated nitrate levels. Some ongoing research (Weyer et al, 2001) indicates that nitrate at levels as low as 3.0 mg/l in drinking water may have other negative health effects, including increased risk of certain cancers and spontaneous miscarriages. To date, scientific research results are not conclusive about these possible effects.

5.6 Reporting of Data to Well Owners

In May 2001, nitrate data, sampling date(s), and geographic coordinates were sent to each owner of wells sampled by DEQ as part of this study. A fact sheet describing nitrate health risks and a customer service questionnaire were also included with the laboratory results. A sample of this mailer is included in Attachment B. Of the 518 mailers, eight were returned. as undeliverable due to an incorrect address.

6.0 DATA MANAGEMENT

For data validation and user accessibility, project data was entered into two separate database management systems.

6.1 LASAR

DEQ Laboratory staff entered all project analytical data into the Laboratory Analytical Storage and Retrieval (LASAR) system, which is designed to hold all analytical data generated by the Laboratory. Metadata for sampling stations (wells) and equipment are associated with each data point, including a single point latitude/longitude geographic coordinate. LASAR data is available agency-wide and can also be accessed publicly through DEQ's internet web site. The LASAR web site link is: http://www.deq.state.or.us/wq/lasar/LasarHome.htm.

6.2 Project ACCESS™ database

DEQ Western Region staff entered both analytical and non-analytical data into an ACCESS™ database, hosted on DEQ's Eugene local area network in Attachment D of this report.

6.3 Geographic Information System

ArcView™ (v. 3.2) software was used as a geographic information system (GIS) tool for evaluating historic and current project groundwater data as a function of land use, hydrogeology, demographics, permitted point sources, and surface water quality. ArcView was also used to display and map this information.

7.0 WELL DATA

7.1 Methods of Identifying Well locations

All wells discussed in this report have been assigned a unique identifier designated as the LASAR Station Number by DEQ. LASAR numbers previously assigned to the wells sampled by DEQ in the mid-1990s were maintained, and new LASAR numbers were assigned to wells sampled for the first time by DEQ in this study. Each LASAR number is linked electronically to information about well ownership, use, street address, and geographic coordinates.

DEQ also used a handheld GPS unit for obtaining latitude and longitude coordinates at each sample locality.

7.2 Well Selection

Water supply wells in the Valley were selected for sampling and nitrate analysis if they intercepted the uppermost subsurface water-bearing zone, because of the high vulnerability of shallow groundwater to impacts from non-point sources. Generally, these shallow wells were less than 75 feet deep, and in many cases were less than 50 feet deep.

Water supply wells were also targeted for sampling if they met one or more of the following criteria:

Criterion No. 1: Wells previously sampled by DEQ

Of the 61 wells that were previously sampled by DEQ during 1993 and 1994 in portions of Coburg, Junction City, and the Albany-North Lebanon area (see Table 43), DEQ was successful in accessing 12 of these wells and collected samples in December 2000. The 1993-1994 set of wells was originally selected by DEQ based on land use patterns (e.g., agriculture, high density rural residential), proximity to potential nitrate contaminant sources (e.g., large onsite septic systems, CAFOs) and indications of nitrate contamination from existing data (including OHD's real estate transaction testing). Field staff attempted to access these wells by calling well owners listed in previous DEQ reports, and visits to the current occupant of the property with a known well location.

Criterion No. 2: Shallow wells in areas with documented nitrate contamination

DEQ field staff sought additional shallow water supply wells (less than 75 feet deep) to sample in each of the three areas previously sampled in the mid-1990s (Coburg, Junction City, and the Albany-Lebanon Plain). Numerous "cold call" inquiries were made by field staff to identify accessible shallow wells and seek permission to sample from property owners. Typically, these are wells that have no documented sampling history.

Criterion No. 3: Shallow wells in areas of the Valley with no documentation about nitrate contamination

Little is known about nitrate levels in shallow groundwater within large areas of the Willamette

Valley, outside of the Coburg, Junction City, and Albany-North Lebanon areas. DEQ field staff made numerous “cold call” inquiries about accessing shallow wells owned by rural residents near the following communities in the Southern Willamette Valley: Alvadore, Cheshire, Lancaster, Bear Creek, Harrisburg, Brownsville, Halsey, Shedd, Tangent, Oakville, Granger, Riverside, Orleans, Pirtle, Scio, Grand Prairie, and Crabtree. These are wells that have no documented sampling history other than a possible analysis for nitrate and bacteria as part of a property transfer.

Criterion No. 4: Public requests for shallow well sampling

In a number of cases, DEQ staff received unsolicited requests by rural residents for well sampling. As a public service, these requests were honored if the well was determined to be shallow (less than 75 feet deep) and located within the study area.

7.3 Documentation of Well Depth

DEQ staff sought documentation about geology and well construction details (i.e., WRD water well reports and interviews with well drillers) for all wells sampled in this study to facilitate the interpretation of sample results. However, a significant number of the available shallow irrigation and domestic farm wells were drilled or dug without conventional documentation (i.e., WRD Water Well Report). Of the 476 wells sampled in this assessment, Water Well Reports were successfully retrieved for only a small fraction less than half of these wells. Additional labor-intensive record searching is likely to yield additional Water Well Reports. However, DEQ staff predict it is not likely that significant documentation will not be found or that many well reports will be confidently matched to with a large number of the wells sampled in this assessment because shallow wells in the Valley tend to be drilled more than 20 years ago. Many of, and most of these wells drilled before the 1980’s were not documented with WRD well water reports.

Due to the screening nature of this assessment and the large number of wells sampled in the Valley, DEQ staff chose to rely largely on anecdotal information provided by the well owner regarding well depth.

Wells without corresponding documentation of installation were selected for sampling at the discretion of the project staff when in the event that conventionally documented wells were not available in an area targeted for sampling. In those cases, project staff took extra measures to interview the well owner (and well constructor when known) about construction details, sound the well depth when possible, and inspect the wellhead for seal defects.

7.4 Protocol for Contacting and Communicating with Well Owners

Once a particular well had been tentatively identified as meeting the selection criteria or by field reconnaissance, prospective well owners were identified, informed about the project, and asked for permission to sample their wells. DEQ staff used these opportunities to inform, educate, and solicit input from well owners, consistent with the public participation requirements of the Groundwater

Quality Protection Act and the project objective of increasing public awareness and collaboration in protecting groundwater resources.

DEQ field sampling staff used the following general protocol for communicating with prospective well owners:

- To the extent possible, telephone contact was made before making personal contact with well owners. Telephone numbers were obtained for specific street addresses through reverse telephone directories available on the internet, or data available electronically from county tax assessors. The telephone contact included a personal introduction, brief information about project objectives, and a request for an opportunity to inspect the wellhead and sample the well. Project staff conveyed the benefits gained by well owners who allow their wells to be sampled.

- Personal field contacts with well owners followed-up on the telephone conversation, and additional information was provided about the project objectives, groundwater quality protection, and the purpose for DEQ's interest in sampling private wells. Field staff also sought information, comments, and advice from well owners. Such feedback was recorded as part of the field documentation.

- Written materials were offered to well owners during these contacts, including the following documentation: 1) DEQ staff business card; 2) a DEQ Introductory Letter; and 3) OHD's Nitrate Fact Sheet. If the well owner was not at home, this package of information was inserted into a plastic pocket wands left in an accessible location, inserted into a plastic pocket. Project staff was prepared to graciously accept refusal from well owners to access their private well. Such refusals were documented so that in these cases the owners will not be contacted again for future project sampling efforts.

8.0 FIELD SAMPLING LOGISTICS AND LABORATORY ANALYSES

Technical staff from both the DEQ Laboratory and DEQ's Western Region performed the field sampling. The DEQ Laboratory performed all laboratory analyses.

Field sampling and laboratory analyses were conducted according to the standard procedures outlined in Section 5.0 and 6.0 of the September 1993 Statewide Groundwater Monitoring Program Master Plan (Plan). This Plan is presented in Appendix C, including sampling procedures, sample documentation and custody, sample transport, health and safety, laboratory data QC/QA, equipment calibration and maintenance, data reduction/validation/maintenance, performance audits, data assessment, corrective action, and confirmatory sampling requirements.

The following sections represent amendments to portions of the September 1993 Statewide Groundwater Monitoring Program Master Plan, consistent with the specific needs of this project.

8.1 Data Management, Analysis, & Reporting

DEQ Laboratory staff entered and managed all laboratory analytical data in LASAR, while non-analytical data were entered and managed by DEQ Water Quality Program staff in an ACCESS™ database. GIS tools (ArcView™) were used to evaluate the groundwater data as a function of land use, hydrogeology, demographics, permitted point sources, and surface water quality. DEQ also used hand held GPS units in order to collect adequate information to view well locations in ArcView.

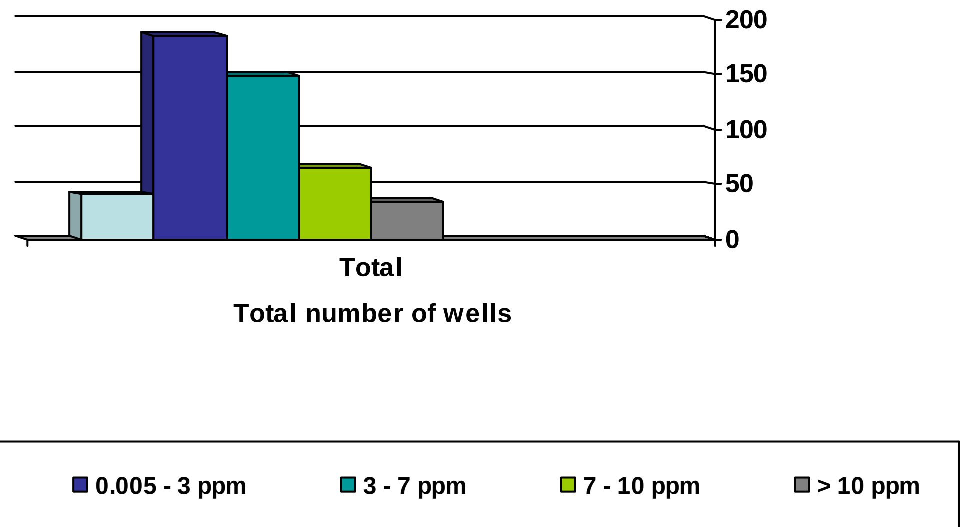
A separate database with both analytical and non-analytical data was created in the DEQ Eugene office, and is housed on the Eugene shared directory.

9.0 DISTRIBUTION OF NITRATE

The distribution of nitrate in groundwater in the Southern Willamette Valley can be discussed in terms of spatial variability. Consideration of temporal variability (evaluation of differences in nitrate concentrations over time) is difficult due to the limited number of wells that have available nitrate data for a period of time. Approximately 100 wells were in the subset of wells that both for this project and DEQ's previous assessment work done in the mid-1990s, but all of the 2000-2001 samples were collected within a 5 month period of time.

The nitrate-N levels measured in the 476 wells sampled for this project range from non-detectable (method reporting limit of 0.05 mg/l) to 231.0 mg/L. The results are summarized presented in Table 4 and shown in Figure 12. A histogram of these data is shown in Fig. 11.

Figure 11
Histogram of 2000-2001 Nitrate Results



To facilitate data interpretation, the number of wells sampled is compared with 5 groupings of Nitrate-N levels, as follows:

TABLE 4

Concentration Range (mg/l)	Characterization	Number of Wells	% of total wells sampled
Non-detectable	Absent	41	8.61
0.5 – 3	Low	186	39.08
3 – 7	Moderate	149	31.30
7 – 10	High	65	13.66
Above 10	very high	35	7.35

The 476 samples were not randomly distributed throughout the Valley. Because some of the project data were collected to investigate previously identified nitrate problems (e.g.,

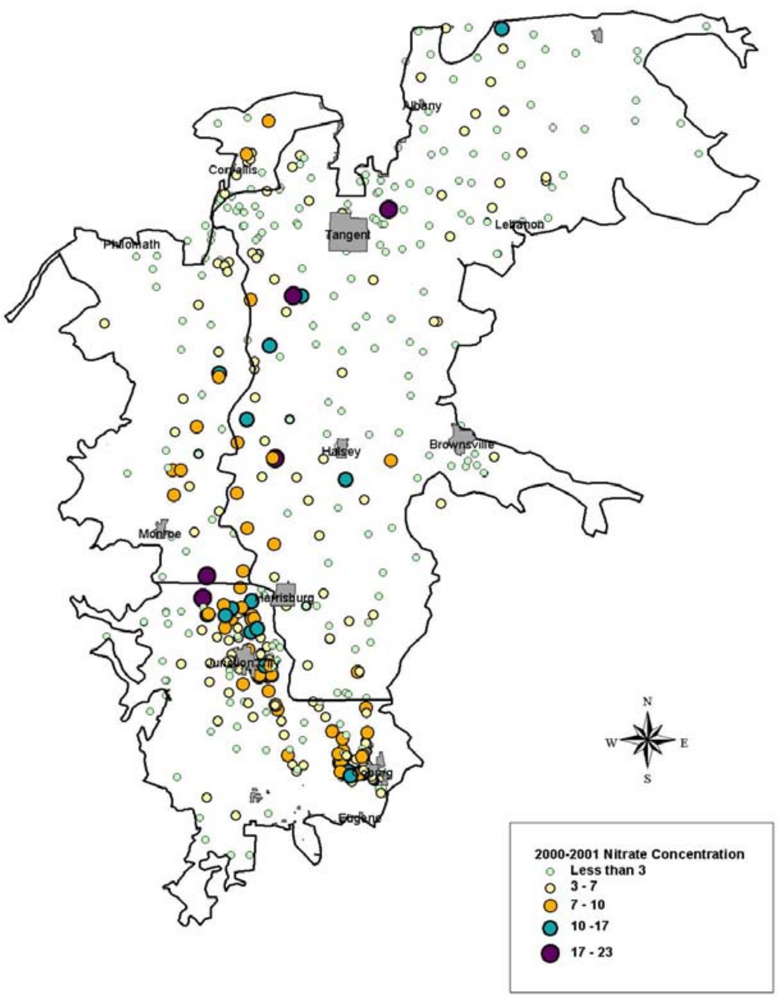


FIGURE 12

Highest nitrate value from wells sampled during 2000-2001 study

Coburg Bottom Loop Road area), the cumulative data set may contain a bias towards high nitrate concentrations. The data do, however, indicate the existence of extensive bodies of high nitrate groundwater in the Valley.

Depth data were available for only some of the 476 sites. The 476 samples were not randomly distributed throughout the Valley. Because some of the project data were collected to investigate previously identified nitrate problems (e.g., Coburg Bottom Loop Road area), the collective data sets may contain a bias towards high nitrate concentrations. The data do, however, indicate the existence of extensive areas of groundwater with high nitrate concentrations in the Valley.

Examining the group of samples that were above 7 mg/L and contrasting the sample locations with the hydrogeologic units, it is clear that the higher values of nitrate are present in mainly one feature. All but 5 of the wells with greater than 10 mg/L of nitrate are present in the Younger Upper Sedimentary Unit (reworked floodplain deposits of the Willamette River and major tributaries). There are 6 wells with nitrate values between 7-10 mg/L that are significantly outside of the Younger Upper Sedimentary Unit, and 6 other 7-10 mg/L wells that are not mapped in this Unit, but are adjacent to it. This relationship is presented in Figure 13 below, with the Younger Upper Sedimentary Unit represented in black.

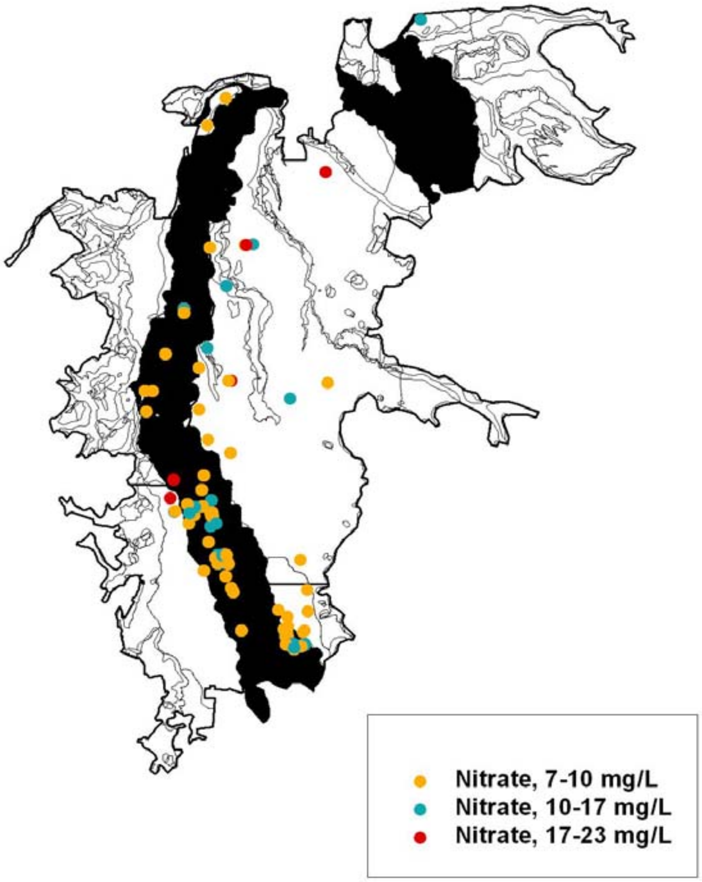


FIGURE 13

Higher nitrate values relative to the Upper Sedimentary Unit (Younger)

10.0 CONCLUSIONS

Based upon the information gathered during this investigation, combined with data available from other sources and previous studies, there is sufficient evidence to indicate adverse impacts to the groundwater from anthropogenic activities. More than 20% of the 476 wells sampled during this study contained nitrate at concentrations greater than 7 mg/L.

Approximately 89% of the wells sampled with values greater than 7 mg/L appear to be located in or relatively adjacent to the sand and gravel deposits associated with the Willamette River and its tributaries. This hydrogeologic Unit contains very permeable material and there is relatively little overlying silt or clay to buffer the impacts from land uses.

The Groundwater Quality Protection Act has established 7 mg/L as the criteria that must be exceeded before the DEQ can designate an area as a Groundwater Management Area. This study provides the documentation needed that nitrate has exceeded the limit needed to consider a declaration of a Groundwater Management Area. Important questions that could be answered by the Groundwater Advisory Committee would include:

1. What are the sources of nitrate to the groundwater;
2. How are nitrate values changing over time; and,
3. Are the best management practices currently employed adequate to protect the groundwater resource?

DEQ should evaluate the information provided in this report, and should network with other agencies, local governments and the residents of this area. Any future steps taken must reflect the best interests of public health, safety and the environment.

REFERENCES

DEQ, 1986. "Mode of Operations Manual for the Water Quality Monitoring Section." Laboratories and Applied Research Division, Oregon Department of Environmental Quality.

DEQ, 1988. “Assessment of Oregon’s Groundwater for Agricultural Chemicals.” Laboratories and Applied Research Division, Oregon Department of Environmental Quality

DEQ, 1993a. "DEQ Laboratory Field Sampling Reference Guide." Revision 3.0, Oregon Department of Environmental Quality, Portland, Oregon.

DEQ, 1993b. "Statewide Groundwater Monitoring Program-Master Plan." Oregon Department of Environmental Quality, Water Quality Division, Portland, Oregon.

DEQ, 1993c. "Statewide Groundwater Monitoring Program, 1993 Junction City Groundwater Investigation." Oregon Department of Environmental Quality, Groundwater Section, Water Quality Division, Portland, Oregon.

DEQ, 1994a. "Statewide Groundwater Monitoring Program, 1994 Albany-Lebanon Plain Area Groundwater Investigation." Oregon Department of Environmental Quality, Groundwater Section, Water Quality Division, Portland, Oregon.

DEQ, 1994b. "Statewide Groundwater Monitoring Program, 1994 Coburg Area Groundwater Investigation." Oregon Department of Environmental Quality, Groundwater Section, Water Quality Division, Portland, Oregon.

Gannett, Marshall, W. and Caldwell, Rodney R.; 1998; Geologic Framework of the Willamette Lowland Aquifer System, Oregon and Washington; USGS Professional Paper 1424-A

Hinkle, S.R., 1997. Quality of shallow groundwater in alluvial aquifers of the Willamette Basin, Oregon 1993-1995; U.S. Geological Survey Water-Resources Investigative Report 97-4082-B.

Lee, Karl K. and Risley, John C.; 2002; Estimates of Ground-Water Recharge, Base Flow, and Stream Reach Gains and Losses in the Willamette River Basin, Oregon; USGS Water Resources Investigations Report 01-4215

Madison, R.J., and Brunett, J.O., 1985. Overview of the occurrence of nitrate in groundwater of the United States: U.S.Geological Survey Water-Supply Paper 2275.

O’Connor, Jim E.; Sarna-Wojcicki, Andrei; Wozniak, Karl C.; et. al.; 2001; Origin, Extent, and Thickness of Quaternary Geologic Units in the Willamette Valley, Oregon; USGS Professional Paper 1620

Orzol, Leonard L.; Wozniak, Karl C.; Meissner, Tiffany R.; and Lee, Douglas B.; 2000; Groundwater and Water-Chemistry Data for the Willamette Basin, Oregon; USGS Water Resources Investigations Report 99-4036

State of Oregon, 1989. Groundwater Quality Protection Act of 1989. House Bill 3515, Sections 17 Through 66. (Oregon Revised Statutes 468B.150 through 468B.185)

Weyer, P.J., et. al., 2001. Municipal Drinking Water Nitrate Level and Cancer Risk in Older Women: The Iowa Women's Health Study; Epidemiology, Vol. 11, No. 3

Woodward, D.G., et. al., 1998. Hydrogeologic framework of the Willamette Lowland Aquifer System, Oregon and Washington. USGS Professional Paper 1424-A.