

Ground Water Quality Characterization and Initial Trend Analysis for the Treasure Valley Shallow and Deep Hydrogeologic Subareas

by

Kenneth W. Neely and Janet K. Crockett

This report was published in 1998. The following sections are included on this web page: 1) Table of Contents, 2) Abstract, and 3) Some Examples of Graphics from the Treasure Valley ground water quality report. For a complete copy of the report, please contact Ken Neely or Janet Crockett

Table of Contents

I.	Abstract	1
II.	Introduction	3
	A. Statewide Ambient Program	3
	B. Program Objectives and Purpose of Report	4
	C. Well-Numbering System	4
	D. Acknowledgments	5
III.	Treasure Valley Shallow and Deep Hydrogeologic Subareas	7
	A. Location	7
	B. Geography	8
	C. Climate	8
	D. Demographics	9
	E. Land Use and Ground Water Vulnerability	9
	F. Previous and Current Investigations	11
	G. Hydrogeology	13
	i. Previous and Current Studies	13
	ii. Statewide Program	15
	I. Network Development	16
IV.	Ground Water Quality Characterization	20
	A. Network Design Verification	20
	B. Well Parameters and Field Measurements	21
	C. Major Ions	25
	D. Nutrients	33
	E. Trace Elements	38
	F. Radioactivity	40
	G. Volatile Organic Compounds	44
	H. Pesticides	46
	I. Bacteria	51

	J.	Characterization Summary	52
V.		Trend Monitoring	56
	A.	Program Approach	56
	B.	Initial Trend Results - TVS and TVD	56
		i. First Round to Second Round Comparisons	57
		ii. Results from Annual Sites	59
		iii. Sites with Multiple GC Pesticide Analyses	60
VI.		Ground Water Quality Concerns	62
	A.	Naturally Occurring	62
		i. Fluoride	62
		ii. Sulfate	63
		iii. Arsenic	63
		iv. Alpha Radiation, Uranium and Radium	63
		v. Beta Radiation	63
		vi. Radon	64
	B.	Human Activities	64
		i. Bacteria	64
		ii. Nitrate	64
		iii. Ammonia	65
		iv. Phosphorus	66
		v. Volatile Organic Compounds	67
		vi. Pesticides	67
VII.		Future Plans	68
VIII.		Recommendations	69
IX.		Summary and Conclusions	70
X.		References Cited	72
XI.		Appendices	76

List of Figures

Figure 1.	Well-numbering system	5
Figure 2.	Location of the Treasure Valley in Ada and Canyon counties	7
Figure 3.	Location of the Treasure Valley Shallow and Treasure Valley Deep Hydro-geologic Subareas	7
Figure 4.	Location of the Treasure Valley Shallow and Deep subareas and the Snake River Plain	8
Figure 5.	Subarea boundaries and aquifer types for the Treasure Valley Shallow and Deep subareas	9
Figure 6.	Profile showing the terraces adjacent to the Boise River (modified from Othberg, 1994)	10
Figure 7.	Precipitation contour map for the Treasure Valley and surrounding area	10
Figure 8.	Precipitation records for the Ourada Ranch and Boise Airport rain gauges	11
Figure 9.	Land uses in the Treasure Valley (modified from Kramber and others, 1997)	12
Figure 10.	Ground water vulnerability ratings for the Treasure Valley (modified from	

	Rupert and others, 1991)	13
Figure 11.	Generalized ground water flow directions for the Treasure Valley (modified from Newton, 1989)	15
Figure 12.	Stratigraphic relationships based on well log data for the Treasure Valley Shallow (TVS) and the Treasure Valley Deep (TVD) subareas	17
Figure 13.	Statewide Program monitoring sites for the Treasure Valley Shallow (TVS) subarea	18
Figure 14.	Statewide Program monitoring sites for the Treasure Valley Deep (TVD) subarea	19
Figure 15.	Well depths for TVS subarea monitoring sites	22
Figure 16.	Ground water temperatures for TVS subarea monitoring sites, 1991-1994	23
Figure 17.	Well depths for TVD subarea monitoring sites	24
Figure 18.	Ground water temperatures for TVD subarea monitoring sites, 1991-1994	25
Figure 19.	Scatterplot and Spearman's rho test results for temperature versus well depth for TVS and TVD monitoring sites, 1991-1994	27
Figure 20.	Scatterplot and Spearman's rho test results for pH versus well depth for TVS and TVD monitoring sites, 1991-1994	27
Figure 21.	Scatterplot and Spearman's rho test results for specific conductance versus well depth for TVS and TVD monitoring sites, 1991-1994	27
Figure 22.	Scatterplot and Spearman's rho test results for alkalinity versus well depth for TVS and TVD monitoring sites, 1991-1994	27
Figure 23.	Boxplots for field parameters versus subarea designation for Treasure Valley monitoring sites, 1991-1994	28
Figure 24.	Trilinear diagram plot for the Treasure Valley Shallow subarea, 1991-1994	29
Figure 25.	Trilinear diagram plot for the Treasure Valley Deep subarea, 1991-1994	30
Figure 26.	Boxplots for common ions versus subarea designation for Treasure Valley monitoring sites, 1991-1994	31
Figure 27.	TDS concentrations for the Treasure Valley Shallow subarea, 1991-1994	32
Figure 28.	Boxplots and Mann-Whitney rank-sum test results for TDS versus subarea designation for the Treasure Valley monitoring sites, 1991-1994	33
Figure 29.	Boxplots and Mann-Whitney rank-sum test results for hardness versus subarea designation for the Treasure Valley monitoring sites, 1991-1994	33
Figure 30.	Hardness concentrations for the Treasure Valley Shallow subarea, 1991-1994	34
Figure 31.	TDS concentrations for the Treasure Valley Deep subarea, 1991-1994	35
Figure 32.	Hardness concentrations for the Treasure Valley Deep subarea, 1991-1994	36
Figure 33.	Pie charts showing ranges of nitrate concentrations and associated percentages for TVS and TVD subareas, 1991-1994	37
Figure 34.	Boxplots and Mann-Whitney rank-sum test results for nitrate versus subarea designation for the Treasure Valley monitoring sites, 1991-1994	37
Figure 35.	Dissolved nitrate concentrations for the Treasure Valley Shallow subarea, 1991-1994	38
Figure 36.	Boxplots and Mann-Whitney rank-sum test results for nitrate concentrations at TVS sites (1991-1994) versus land use category	39
Figure 37.	Number of TVS sites with impacted nitrate levels (= or > 2.0 mg/l) and non-impacted nitrate levels (<2.0 mg/l) by land use category, 1991-1994	39

Figure 38.	Dissolved ammonia concentrations for the Treasure Valley Shallow and Deep subareas, 1991-1994	40
Figure 39.	Dissolved orthophosphorus concentrations for the Treasure Valley Shallow and Deep subareas, 1991-1994	41
Figure 40.	Dissolved nitrate concentrations for the Treasure Valley Deep subarea, 1991-1994	42
Figure 41.	Scatterplot and Spearman's rho test results for nitrate versus well depth for TVS and TVD monitoring sites, 1991-1994	42
Figure 42.	Scatterplot and Spearman's rho test results for nitrate versus TDS for TVS and TVD monitoring sites, 1991-1994	43
Figure 43.	Dissolved arsenic concentrations for the Treasure Valley Shallow and Deep subareas, 1991-1994	43
Figure 44.	Contour map for dissolved arsenic concentrations for the the Treasure Valley Shallow subarea, 1991-1994	44
Figure 45.	Contour map for dissolved arsenic concentrations for the Treasure Valley Deep subarea, 1991-1994	45
Figure 46.	Boxplots and Mann-Whitney rank-sum test results for total gross alpha versus subarea designation, 1991-1994	46
Figure 47.	Boxplots and Mann-Whitney rank-sum test results for total gross beta versus subarea designation, 1991-1994	46
Figure 48.	Adjusted gross alpha radioactivity concentrations for the Treasure Valley Shallow subarea, 1991-1994	47
Figure 49.	Adjusted gross alpha radioactivity concentrations for the Treasure Valley Deep subarea, 1991-1994	48
Figure 50.	Total uranium concentrations for the Treasure Valley Shallow and Deep subareas, 1991-1994	49
Figure 51.	Radon radioactivity concentrations for the Treasure Valley Shallow subarea, 1991-1994	50
Figure 52.	Detections of volatile organic compounds (VOCs) for the Treasure Valley Shallow and Deep subareas, 1991-1994	51
Figure 53.	Immunoassay pesticide test results for the Treasure Valley Shallow subarea, 1992-1995	52
Figure 54.	Immunoassay pesticide test results for the Treasure Valley Deep subarea, 1992-1995	53
Figure 55.	Gas chromatography pesticide test results for the Treasure Valley Shallow subarea, 1993, 1995, 1996 and 1997	54
Figure 56.	Fecal coliform bacteria detections for the Treasure Valley Shallow and Deep subareas, 1991-1994	55
Figure 57.	Pie graphs showing nitrate concentration percentages for the First and Second Round sampling for the Treasure Valley Shallow subarea	57
Figure 58.	Boxplots and Wilcoxon signed-rank test results for nitrate versus paired sampling years for the Treasure Valley Shallow subarea	58
Figure 59.	Boxplots of the differences in nitrate concentrations between paired samples versus years of sampling for the TVS subarea	58
Figure 60.	Annual sites for the Treasure Valley Shallow and Treasure Valley Deep subarea	59

Figure 61.	Four examples from Annual wells in the Treasure Valley showing nitrate concentrations versus time	60
Figure 62.	Human-induced ground water quality impacts and MCL exceedances for ammonia, bacteria, nitrate, pesticides, phosphorus and volatile organic compounds for the TVS subarea	65
Figure 63.	Human-induced ground water quality impacts and MCL exceedances for ammonia, bacteria, nitrate, pesticides, phosphorus and volatile organic compounds for the TVD subarea	66

List of Tables

Table 1.	Aquifer and layer delineations from selected hydrogeologic investigations for the Treasure Valley	14
Table 2.	Results of Mann-Whitney rank-sum tests for selected constituents and parameters versus subarea designation	26
Table 3.	Immunoassay results for the TVS and TVD subareas, 1992-1995	49
Table 4.	Results from three TVS subarea sites with GC pesticide detections in 1995, 1996 and 1997	61

List of Appendices

Appendix A	Constituent Percentiles for the TVS and TVD subareas	76
Appendix B	Source and Significance of Constituents	78
Appendix C	Quality Assurance	82
Appendix D	Summary of Statistic Tests used in this Report	83
Appendix E	Data Storage and Availability	84

Abstract

This report describes the ground water quality in the Treasure Valley Shallow (TVS) and Treasure Valley Deep (TVD) hydrogeologic subareas as determined from data collected through the Statewide Ambient Ground Water Quality Monitoring Program (Statewide Program). The Statewide Program is administered by the Idaho Department of Water Resources in cooperation with the United States Geological Survey-Water Resources Division. The TVS and TVD are two of the 20 subareas in the Statewide Program. The TVS and TVD subareas are located primarily in Ada and Canyon counties of southwestern Idaho. Ground water quality data were collected from 144 Statewide Program monitoring sites (existing wells) in the TVS subarea and 137 sites in the TVD subarea during the summer field seasons from 1991 through 1994. Data collection that occurred during these four years is referred to as First Round sampling. Second Round sampling began in 1995. Most of the sites sampled in 1991 through 1993 were re-sampled in 1995 through 1997, respectively. Ground water quality was characterized for the two subareas using First Round data. Initial trend analyses were conducted using Second Round data.

Aquifers in the TVS subarea occur in the unconsolidated gravels and coarse grained sands of the Snake River Group. Aquifers in the TVD subarea consist of the fine to medium grained

sands and occasional gravels that are often interbedded with thick clay layers. TVD aquifers occur primarily in the Idaho Group. The top of the TVD subarea was usually determined by the first occurrence of blue or gray clay in the well cuttings.

Characterization of the water quality data collected from 1991 through 1994 indicated that the dominant water types were calcium-bicarbonate and sodium-bicarbonate for both subareas. Trilinear plots showed that the overall water quality was more variable for the TVD subarea than for the TVS subarea. Results from Mann-Whitney rank-sum tests showed that there were significant differences in the median concentrations at the 95 percent confidence level between the two subareas for 18 of the 22 water quality constituents and parameters tested. Overall, ground waters of the TVS subarea were more mineralized than ground waters of the TVD subarea.

The ground water at most of the Statewide Program monitoring sites in the TVS and TVD subareas was suitable for human consumption and other beneficial uses. However, 49 of the 281 sites (17 percent) had one or more constituents with concentrations that exceeded the primary Maximum Contaminant Levels (MCLs) as established by the U.S. Environmental Protection Agency (EPA) for public drinking water supplies. The number of sites with detections above the MCLs was 33 for the TVS subarea (23 percent) and 16 for the TVD subarea (12 percent). Arsenic, bacteria, fluoride, gross alpha, gross beta, nitrate and volatile organic compounds were the constituents detected above existing primary MCLs. Sulfate, total dissolved solids and uranium had concentration levels above secondary MCLs or proposed primary MCLs.

Nitrate and pesticide data showed that impact to the ground water quality from human activities has occurred in the Treasure Valley, particularly in the TVS subarea. One hundred of the 144 TVS subarea sites (69 percent) had nitrate concentrations equal to or greater than 2.0 milligrams per liter (mg/l) which is the value used by the Statewide Program to distinguish between non-impacted and impacted nitrate levels. The number of sites with nitrate concentrations equal to or greater than 2.0 mg/l for the TVD subarea was 44 (32 percent). One or more pesticides were detected at 32 of 139 TVS sites (23 percent) analyzed by immunoassay methods with detection limits in the parts per billion range. Eighty-two of the 98 TVS sites (84 percent) analyzed by a gas chromatography (GC) method with detection limits in the parts per trillion range had one or more pesticide detections. All immunoassay and GC pesticide detections were below MCLs with most concentrations being at least one order of magnitude below MCLs.

Initial trend monitoring data showed that nitrate concentrations increased at 66 of the 92 TVS subarea sites (72 percent) sampled in the First Round and re-sampled in the Second Round. Individual nitrate increases ranged from 0.03 to 11.9 mg/l. The number of TVS sites with nitrate concentrations greater than the MCL of 10 mg/l increased from two (First Round) to seven (Second Round). Median nitrate values for the TVS subarea increased from 3.35 mg/l (First Round) to 3.87 mg/l (Second Round). Mann-Whitney signed-rank test results indicated that the increase in nitrate medians between the First and Second Rounds for the TVS subarea was significant at the 95 percent confidence level. Median nitrate values for the TVD subarea were 0.87 mg/l (First Round) and 0.69 mg/l (Second Round); these medians were not significantly different at the 95 percent confidence level.

Some Examples of Graphics From the Treasure Valley Ground Water Quality Report

Figure 35. Dissolved nitrate concentrations for the Treasure Valley Shallow subarea, 1991-1994.

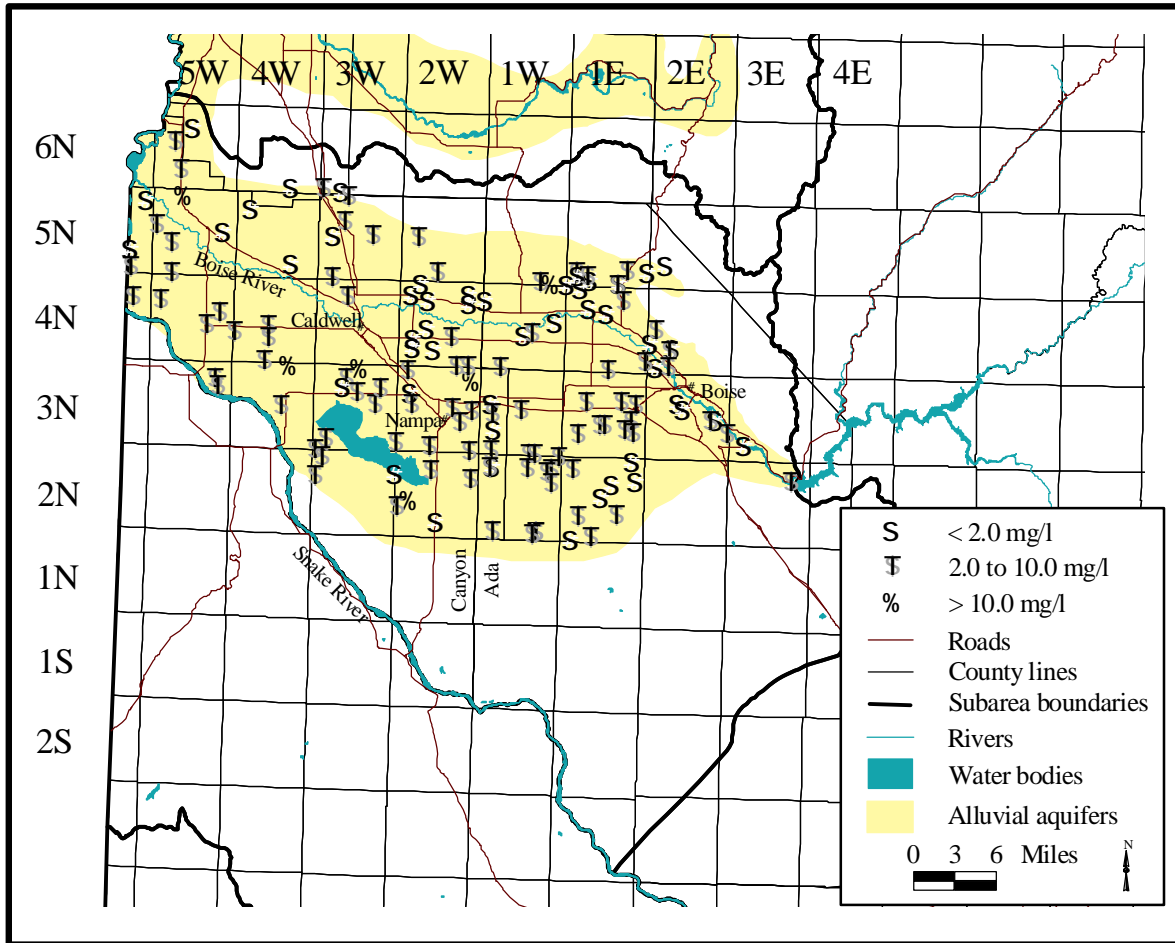


Figure 40. Dissolved nitrate concentrations for the Treasure Valley Deep subarea, 1991-1994.

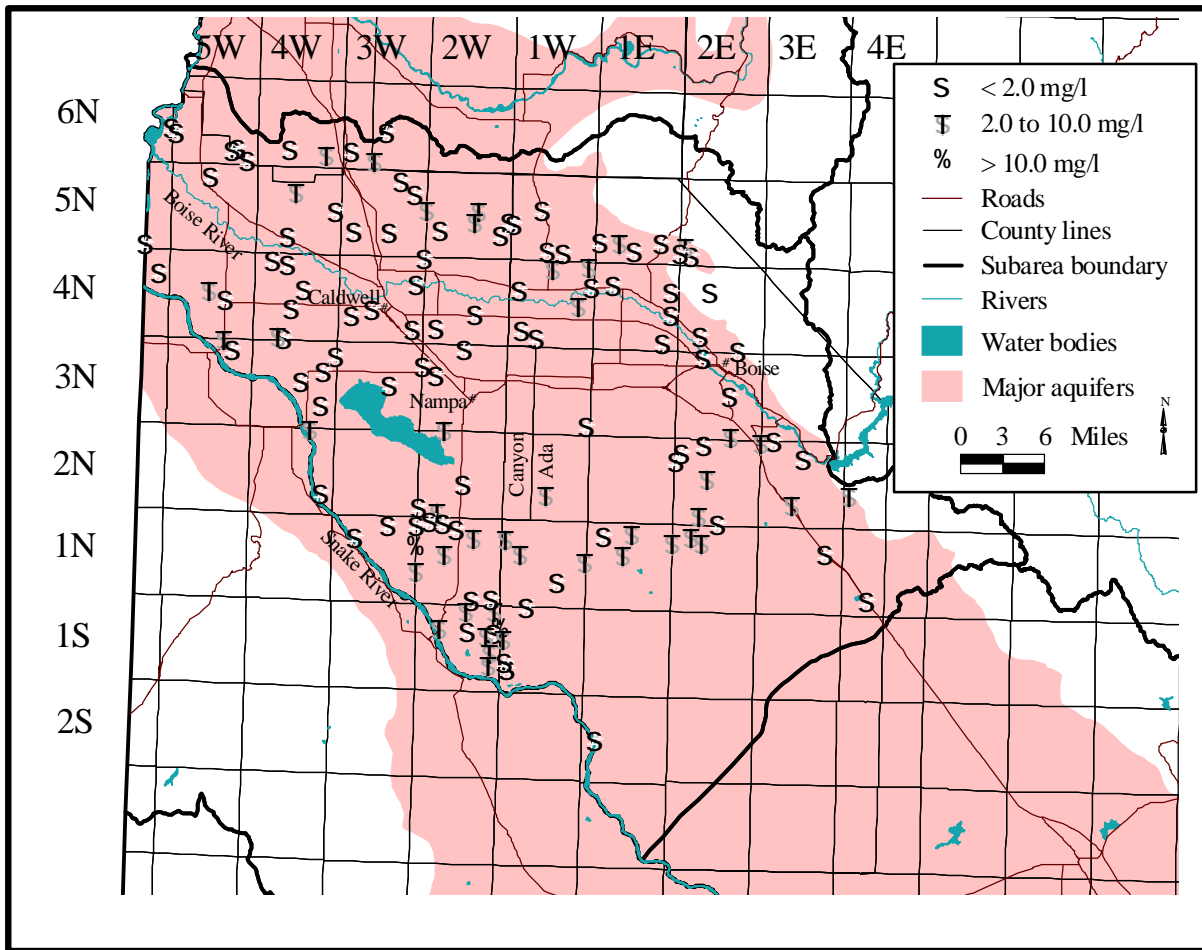


Figure 33. Pie charts showing ranges of nitrate concentrations and associated percentages for the TVS and TVD subareas, 1991-1994.

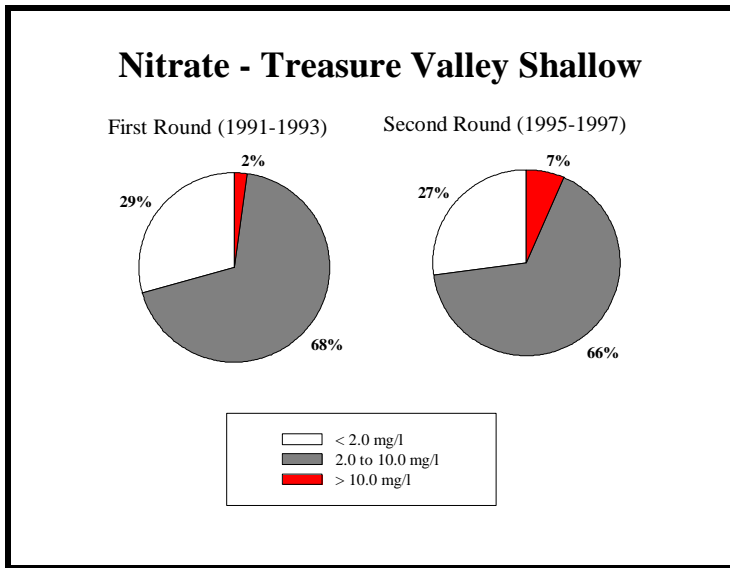
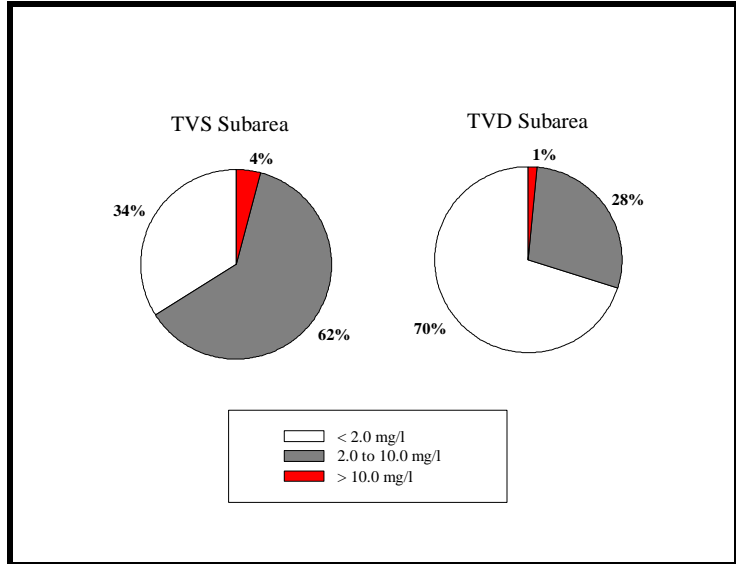


Figure 57. Pie graphs showing nitrate concentration percentages for the First and Second Round sampling for the Treasure Valley

Shallow subarea. (Note: the percentages for the Second Round shown here are slightly different than those shown in the report; the report is incorrect)

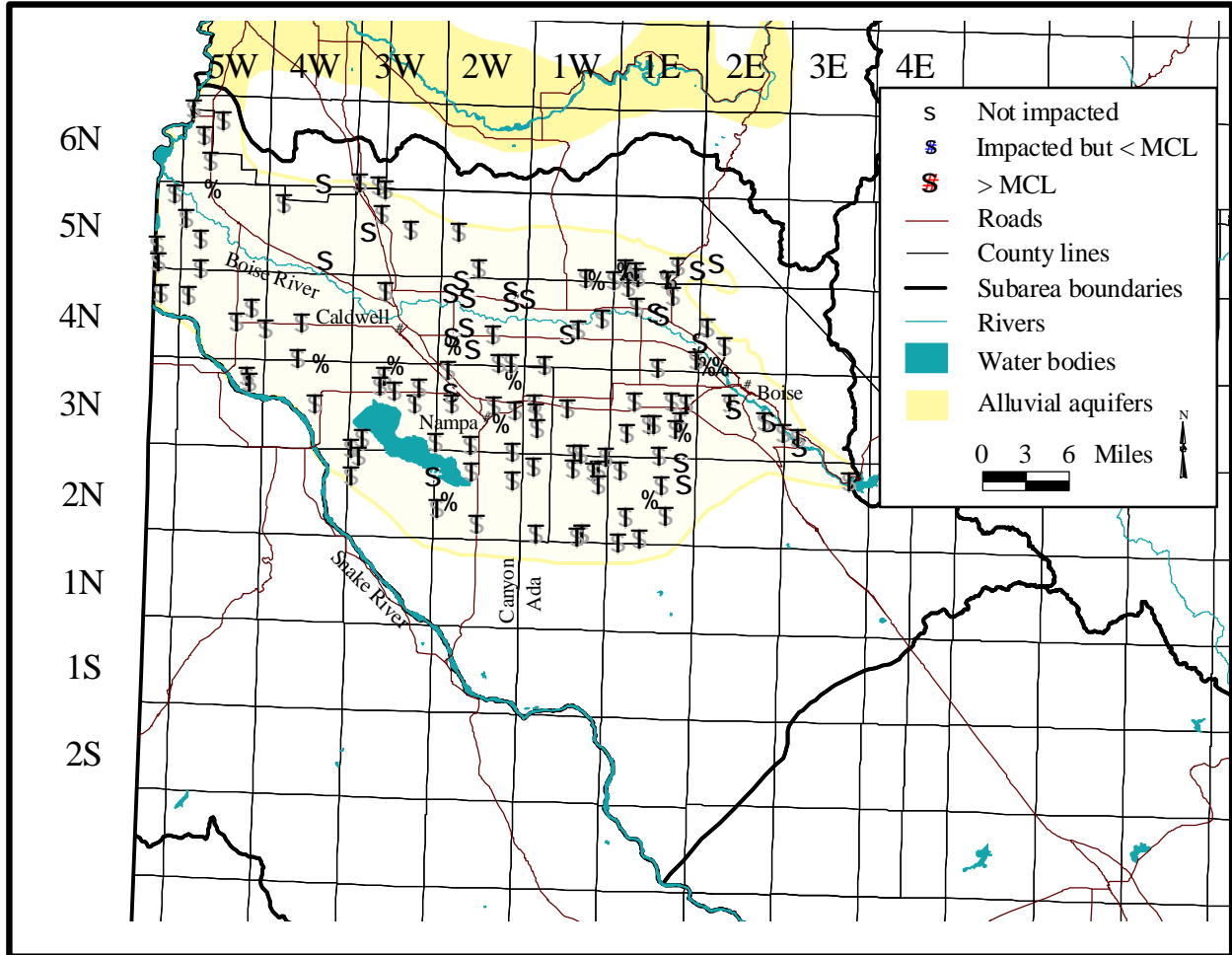


Figure 62. Human-induced ground water quality impacts and MCL exceedances for ammonia, bacteria, nitrate, pesticides, phosphorus and volatile organic compounds for the TVS subarea.