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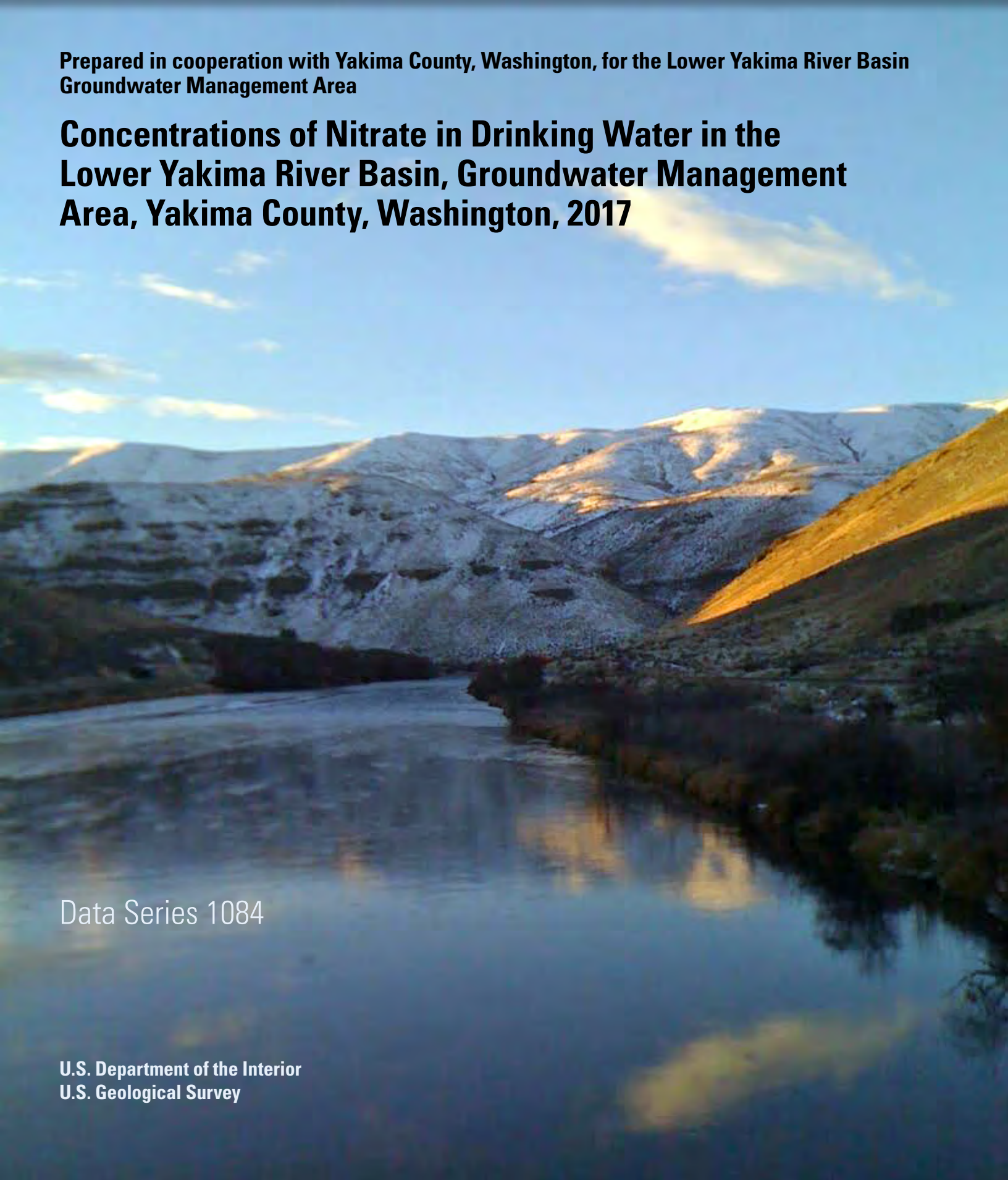
Prepared in cooperation with Yakima County, Washington, for the Lower Yakima River Basin Groundwater Management Area

Concentrations of Nitrate in Drinking Water in the Lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, 2017



Data Series 1084

U.S. Department of the Interior
U.S. Geological Survey

Cover: Yakama area drain site, Yakima River at Umantum, Washington (12484500), December 18, 2012. Photograph by Gabe Landrum, U.S. Geological Survey.

Concentrations of Nitrate in Drinking Water in the Lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, 2017

By Raegan L. Huffman

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U.S. Department of the Interior
RYAN K. ZINKE, Secretary

U.S. Geological Survey
James F. Reilly II, Director

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Conversion Factors

U.S. Customary Units to International System of Units

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.004047	square kilometer (km^2)
section (640 acres or 1 square mile)	259.0	square hectometer (hm^2)
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
acre-foot (acre-ft)	1,233	cubic meter (m^3)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)
	Flow rate	
acre-foot per year (acre-ft/yr)	0.001233	cubic hectometer per year (hm^3/yr)

Datums

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

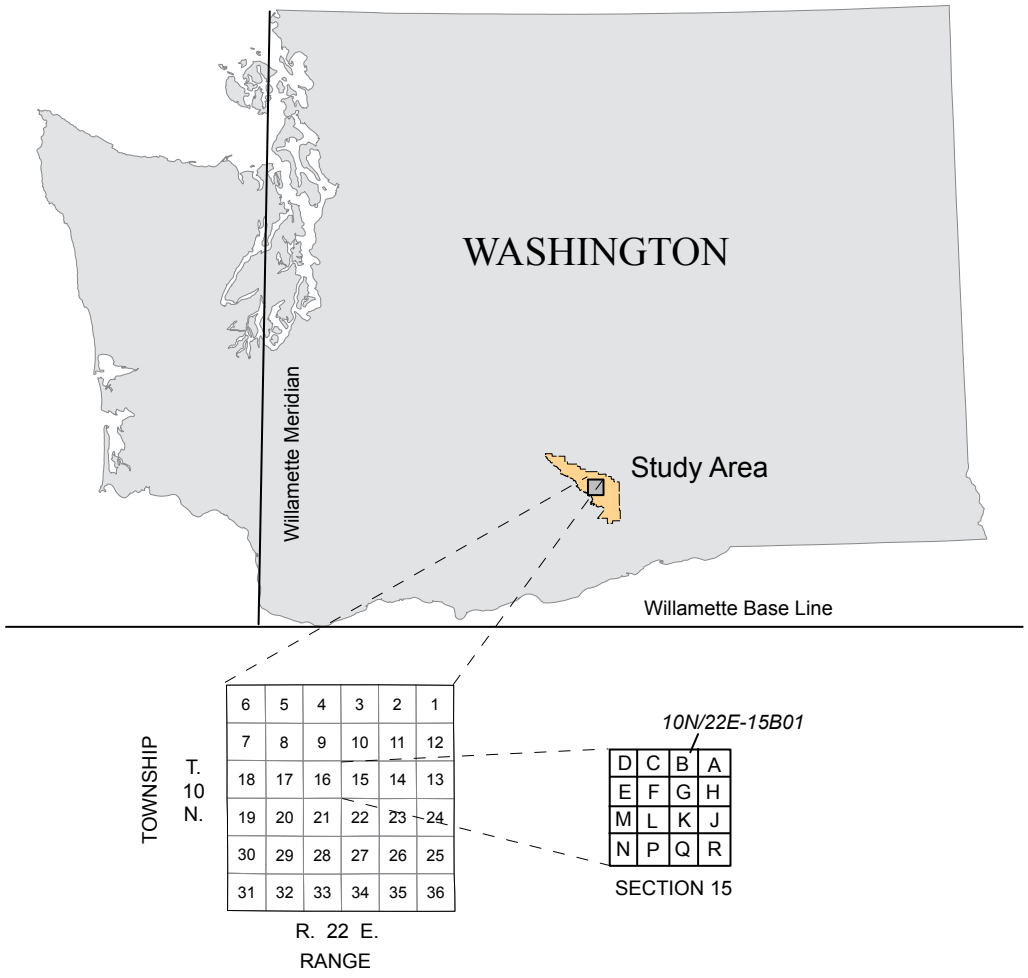
Supplemental Information

Concentrations of chemical constituents in water are given in either milligrams per liter (mg/L) or micrograms per liter (µg/L).

Activities for radioactive constituents in water are given in picocuries per liter (pCi/L)

Well-Numbering System

In the State of Washington, wells and springs are assigned numbers that identify their location within a township, range, section, and 40-acre tract. For example, local well number 10N/22E-15B01 indicates that the well is in township 10 north and range 22 east, north and east of the Willamette Base Line and Meridian, respectively. The numbers immediately following the hyphen indicate the section (15) within the township; the letter (B) following the section gives the 40-acre tract of the section. The two-digit sequence number (01) following the letter indicates that the well was the first one inventoried by U.S. Geological Survey personnel in that 40-acre tract. An “S,” “D,” or “P” following the sequence number indicates that the site is a spring, deepened well, or piezometer in a well, respectively. In the figures of this report, wells and springs are identified individually by only the section and 40-acre tract, such as 15B01; township and range are shown on the map borders.



Concentrations of Nitrate in Drinking Water in the Lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, 2017

By Raegan L. Huffman

Abstract

The U.S. Geological Survey, in cooperation with the lower Yakima River Basin Groundwater Management Area (GWMA) group, conducted an intensive groundwater sampling collection effort of collecting nitrate concentration data in drinking water to provide a baseline for future nitrate assessments within the GWMA. About every 6 weeks from April through December 2017, a total of 1,059 samples were collected from 156 wells and 24 surface-water drains. The domestic wells were selected based on known location, completion depth, ability to collect a sample prior to treatment or filtration, and distribution across the GWMA. The drains were pre-selected by the GWMA group, and further assessed based on ability to access sites and obtain a representative sample.

More than 20 percent of samples from the domestic wells and 12.8 percent of drain samples had nitrate concentrations that exceeded the maximum contaminant level (MCL) of 10 milligrams per liter established by the U.S. Environmental Protection Agency. At least one nitrate concentration above the MCL was detected in 26 percent of wells and 33 percent of drains sampled. Nitrate was not detected in 13 percent of all samples collected.

Introduction

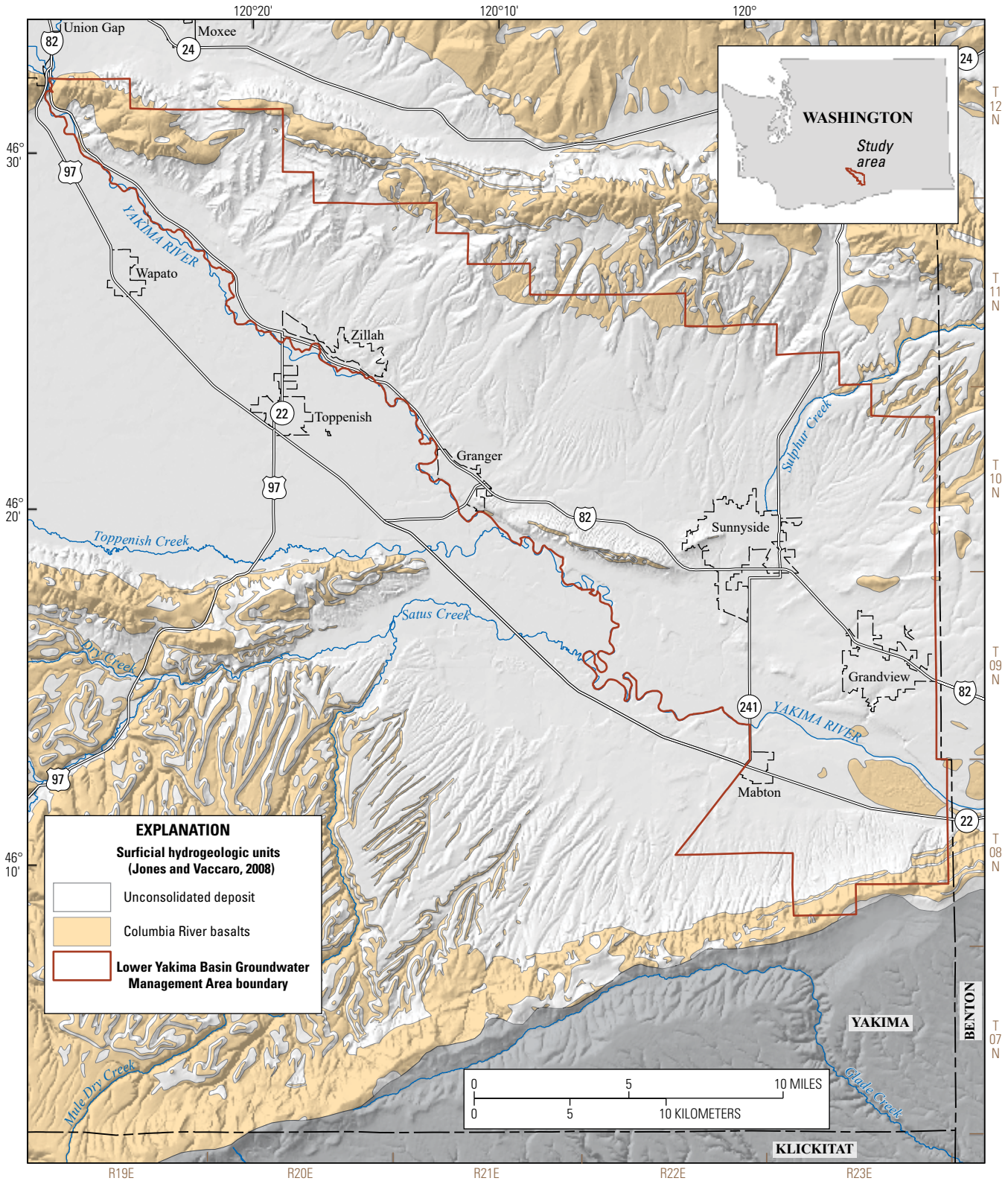
In the lower Yakima River Basin in central Washington State, 12–21 percent of private drinking-water wells have nitrate levels above the U.S. Environmental Protection Agency (EPA) Drinking Water Standard of 10 milligrams per liter (mg/L) (summarized in U.S. Environmental Protection Agency, 2012; and Washington State Department of Ecology 2010). The contaminated wells tend to be shallow and are primarily used to supply private residences.

Elevated levels of nitrate in drinking water in the lower Yakima River Basin are a high priority concern for a variety of governmental agencies and private groups, many of which are involved in the lower Yakima River Basin Groundwater Management Area (GWMA; fig. 1). The GWMA was formed in 2012 to identify ways to reduce nitrate concentrations in groundwater. In support of this goal, the GWMA has pursued a variety of approaches including public education campaigns to inform people about the problem of elevated nitrate levels, soil sampling to help farmers apply nutrients at agronomic rates, and the collection of groundwater nitrate samples to document the extent of the problem and provide a baseline against which future improvements can be measured.

However, the full extent of the problem has not been well documented. No systematic assessment of nitrate concentrations across the GWMA has been performed, complicating the interpretation of localized monitoring efforts that may indicate nitrate from distant or local sources, and making long-term trend analysis difficult.

Groundwater in many areas of the GWMA has not been sampled for nitrate, creating gaps in the understanding of nitrate concentrations in aquifers tapped for drinking water. The nitrate data that do exist were not necessarily collected for the purpose of comparison to previous nitrate concentrations to determine if levels are increasing or decreasing over long time scales. The existing data also were not collected with the goal of determining the seasonal variation of nitrate concentrations in groundwater, which is likely to indicate agricultural practices such as tillage, fertilization, and irrigation.

The purpose of this data collection effort is to collect sufficient nitrate concentration data from the lower Yakima River Basin GWMA to fill identified critical gaps in the current groundwater nitrate inventory. The data collected will assist in documenting the GWMA's current nitrate conditions and provide a baseline against which future nitrate assessments can be compared, and will provide insight into the design and sampling frequency of a long-term monitoring program. This report describes the results of this data collection effort.



Base map from USGS and other digital data, various years and scales. Projection: Lambert Conformal Conic, State Plane Washington South. Horizontal datum is North American Datum of 1983

Figure 1. Location of the Groundwater Management Area and surficial hydrogeologic units, lower Yakima River Basin, Yakima County, Washington.

Description of Study Area

The Yakima River Basin extends from the Cascade Mountains east to the Columbia River. Streamflow averages 4.1 million acre-feet per year (acre-ft/yr), and is intensively managed using five storage reservoirs and irrigation diversions of about 2.8 million acre-ft/yr (Ely and others, 2011). East-west trending ridges separate the Yakima River Basin into several broad valleys (subbasins) that slope gently toward the Yakima River, and contain most of the population and economic activity in the basin. The Toppenish/Benton subbasin, the largest and most southerly of the five subbasins, encompasses almost 1,500 mi^2 between Ahtanum Ridge and Rattlesnake Hills on the north and Toppenish Ridge and the Horse Heaven Hills on the south. The lower Yakima River Basin GWMA (fig. 1) is within this subbasin.

The Toppenish/Benton subbasin is largely filled with deposits of alluvial fan, loess, dune sand, alluvial terrace, continental sedimentary, and Touchet Formation and Ellensburg Formation deposits. These sediments are more than 1,200-ft thick west of the town of Toppenish and gradually thin to zero thickness at the northern end of the subbasin where the underlying basalt outcrops. The unconsolidated sediments remain about 1,000-ft thick south of the Yakima River (and the GWMA) until the basin abruptly ends against the steep Toppenish Ridge (Jones and others, 2006).

Irrigated cropland is the major land use activity within the subbasin, encompassing 70–80 percent of the area. The primary crop types within the subbasin include orchards, vegetables, hay, mint, and hops (Washington State Department of Ecology, 2010). Dairy and animal feeding operations are also prevalent within the subbasin near the cities of Sunnyside, Granger, Mabton, and Grandview (Washington State Department of Ecology, 2010). Substantial amounts of nitrogen have been applied to the land surface in the lower Yakima River Basin for decades, primarily as fertilizer for row crops, but also in recent years as animal waste (manure) (Washington State Department of Ecology, 2010).

About one-third of the basin population is not served by public supply systems and instead relies on private wells (Washington State Department of Ecology, 2010). Residential drinking-water wells in the GWMA are typically shallow, with some as shallow as 10-ft deep. Wells that typically require a high flow rate are more likely to be drilled through the entire thickness of basin sediments to penetrate the Wanapum or Saddle Mountain basalts that underlie the subbasin.

Sample Collection Design and Methods

Sites Selection

Groundwater samples were collected from 156 existing wells (table 1). Well selection was based on the following criteria: known and documented location and completion depth or open interval (drillers' log), the ability to collect a sample prior to any treatment or filtration, and spatial distribution across the GWMA (table 1, fig. 2). Candidate domestic wells for this study consisted of those listed in the USGS National Water Information System database, Washington State Department of Ecology well log database, and from a well assessment survey conducted by Yakima County in 2015 and 2016. Further screening of candidate wells took place in the field, based on owner permission and ability to collect a representative sample. Groundwater samples were collected about every 6 weeks (a total of 6 times) from April to December 2017.

Surface water, in agricultural drains, was sampled from 24 sites, spatially distributed across the GWMA (table 2, fig. 2). Drain sites were pre-selected by the GWMA. Suitability of a site was determined during field reconnaissance based on the ability to gain access to the site, and the ability to obtain a representative grab (dip) sample. Each site was sampled about once every 6 weeks for a total of 7 times between April and December 2017.

Sample Collection

All sample collection, processing, and field analyses were in accordance with applicable USGS procedures as described in the National Field Manual (U.S. Geological Survey, variously dated). Groundwater samples were collected prior to any filtration or treatment, directly from a spigot after a sufficient well casing volume of water was purged from the well and after allowing field measurements of pH, specific conductance, and dissolved oxygen to stabilize to within 0.1 pH unit, 3 percent, and 0.3 mg/L, respectively. Because of the limitations of wading the drains during the irrigation season, and their uniform shape and well-mixed characteristics, a grab (dip) sample was collected in the centroid of flow along with field measurements of pH, specific conductance, and dissolved oxygen.

Table 1. Location and description of groundwater wells sampled for nitrate in the Groundwater Management Area, Yakima County, Washington, April–December 2017.

[**Well No:** See section, "Well Numbering System" in front of report for naming convention explanation. **Latitude and Longitude:** Latitude and longitude at well in decimal degrees referenced to North American Datum of 1983. Land surface elevation: in feet above North American Vertical Datum of 1988. **Type of opening:** P, perforated; X, open hole; O, open end; S, slotted screen. **Type of log available:** D, Driller. **Abbreviation:** ft BLS, foot below land surface; –, no data available]

Well No.	Site No.	Latitude	Longitude	Land surface elevation	Well depth (ft BLS)	Type of opening	Depth of open interval (ft BLS)		Type of log available
							Top	Bottom	
08N/22E-11L02	461134120012801	46.19269	-120.02456	769	144	X	93	144	D
08N/23E-01F02	461233119524401	46.20917	-119.87883	707	–	–	–	–	–
08N/23E-01H02	461232119521001	46.20883	-119.86942	738	125	–	–	–	D
08N/23E-01J01	461224119515801	46.20839	-119.87731	707	105	O	–	–	D
08N/23E-05G01	461228119573501	46.20781	-119.95961	708	140	X	74	140	D
08N/23E-06H02	461239119582401	46.21092	-119.97339	706	90	O	–	–	D
08N/23E-08E01	461144119580701	46.19536	-119.96978	738	90	O	–	–	D
08N/23E-10G01	461139119545901	46.19458	-119.91725	700	145	P	125	145	D
08N/23E-11R01	461106119531501	46.18514	-119.88758	762	158	P	148	158	D
08N/23E-13B01	461104119521901	46.18431	-119.87192	725	185	P	143	183	D
09N/22E-01G02	461753120003301	46.29814	-120.00928	708	138	O	–	–	D
09N/22E-02D01	461802120022101	46.30069	-120.03925	747	225	O	–	–	D
09N/22E-03R01	461717120024001	46.28811	-120.04447	702	102	O	–	–	D
09N/22E-04B01	461807120041901	46.30189	-120.07194	732	257	X	244	257	D
09N/22E-05Q01	461727120052101	46.29089	-120.08906	678	95	O	–	–	D
09N/22E-09J02	461640120035601	46.27769	-120.06561	664	83	O	–	–	D
09N/22E-10A01	461713120023801	46.28683	-120.04375	704	97	O	–	–	D
09N/22E-10N03	461625120033201	46.27361	-120.05892	695	–	–	–	–	–
09N/22E-10N04	461627120033301	46.27411	-120.05908	694	97	O	–	–	D
09N/22E-11D01	461714120022701	46.28733	-120.04094	703	–	–	–	–	–
09N/22E-11M01	461648120021201	46.28000	-120.03672	703	100	O	–	–	D
09N/22E-12R02	461622120000501	46.27292	-120.00142	725	98	O	–	–	D
09N/22E-14B01	461617120015001	46.27136	-120.03058	698	97	O	–	–	D
09N/22E-22K01	461500120025101	46.25011	-120.04747	672	96	O	–	–	D
09N/22E-23J01	461458120011201	46.24903	-120.02111	657	85	O	–	–	D
09N/23E-01D01	461802119532201	46.30067	-119.88947	980	130	S	110	130	D
09N/23E-04R01	461717119562401	46.28775	-119.94111	747	140	X	125	140	D
09N/23E-04R02	461715119562401	46.28758	-119.93997	747	145	P	85	145	D
09N/23E-05N01	461720119583001	46.28889	-119.97500	723	126	X	115	126	D
09N/23E-06B01	461800119590701	46.29986	-119.98539	741	–	–	–	–	–
09N/23E-07M02	461645119594901	46.27917	-119.99706	697	245	P	225	245	D
09N/23E-08E02	461702119583301	46.28397	-119.97589	718	137	O	–	–	D
09N/23E-09H01	461653119562901	46.28133	-119.94142	761	179	P	105	115	D
				–	–	O	150	179	D
09N/23E-11K01	461929119542401	46.27561	-119.90558	816	144	P	124	144	D
09N/23E-13C01	461622119531101	46.27283	-119.88631	877	108	P	50	108	D
09N/23E-14G01	461608119541701	46.26883	-119.90483	816	200	P	160	200	D
09N/23E-15D03	461622119560701	46.27247	-119.93633	742	65	O	–	–	D
09N/23E-15H03	461559119545801	46.26628	-119.91614	781	160	P	97	151	D
09N/23E-16C01D1	461620119564802	46.27214	-119.94792	728	273	P	233	273	D
09N/23E-17L01	461546119580701	46.26292	-119.96869	741	105	P	25	105	D
09N/23E-18C01	461618119592501	46.27175	-119.99036	718	88	O	–	–	D

Table 1. Location and description of groundwater wells sampled for nitrate in the Groundwater Management Area, Yakima County, Washington, April–December 2017.—Continued

Well No.	Site No.	Latitude	Longitude	Land surface elevation	Well depth (ft BLS)	Type of opening	Depth of open interval (ft BLS)		Type of log available
							Top	Bottom	
09N/23E-19D03	461521119595101	46.25578	-119.99850	674	96	O	–	–	D
09N/23E-19Q01	461439119590401	46.24406	-119.98439	672	122	O	–	–	D
09N/23E-20A01	461529119574701	46.25817	-119.96306	750	100	P	80	100	D
09N/23E-21P01	461446119565501	46.24611	-119.94858	796	145	P	125	145	D
09N/23E-24L01	461456119530501	46.24883	-119.88478	822	125	P	85	125	D
09N/23E-25J01	461402119522701	46.23403	-119.87417	819	85	P	45	85	D
09N/23E-26B01	461432119541701	46.24231	–119.90481	830	190	P	170	190	D
09N/23E-27B02	461435119553201	46.24303	-119.92556	806	145	X	116	145	D
09N/23E-28G01	461414119564501	46.23711	-119.94572	741	160	X	117	160	D
09N/23E-29B02	461424119574801	46.24011	-119.96319	688	180	P	140	180	D
09N/23E-31K01	461312119592001	46.21994	-119.98894	706	142	O	–	–	D
09N/23E-34M01	461316119560801	46.22108	-119.93547	670	100	O	–	–	D
09N/23E-35K01	461307119540201	46.21850	-119.90058	668	98	O	–	–	D
09N/23E-36J01	461316119523701	46.22097	-119.87706	771	120	P	80	120	D
10N/21E-01G01	462258120080701	46.38289	-120.13533	885	102	O	–	–	D
10N/21E-02N01	462234120095501	46.37614	-120.16517	851	154	O	–	–	D
10N/21E-03D02	462314120111801	46.38708	-120.18833	900	198	O	–	–	D
10N/21E-04P02	462232120120801	46.37533	-120.20333	824	196	O	–	–	D
10N/21E-05A01	462321120123901	46.38900	-120.21206	843	218	O	–	–	D
10N/21E-09F01	462206120115701	46.36842	-120.19914	785	127	S	117	127	D
10N/21E-11M01	462206120100201	46.36822	-120.16719	794	157	O	–	–	D
10N/21E-12R01	462147120073501	46.36303	-120.12628	821	–	–	–	–	–
10N/21E-13N01	462047120083301	46.34644	-120.14242	784	221	O	–	–	D
10N/21E-15E01	462114120105701	46.35497	-120.18083	784	167	O	–	–	D
10N/21E-16B01	462137120115001	46.36019	-120.19733	764	65	X	60	65	D
10N/21E-16G02	462126120114501	46.35694	-120.19689	763	100	O	–	–	D
10N/21E-23A01	462047120084501	46.34631	-120.14717	766	240	O	–	–	D
10N/21E-24J01	462010120072901	46.33886	-120.12572	778	200	O	–	–	D
10N/22E-01F01	462305120003901	46.38456	-120.01203	1,067	250	X	193	250	D
10N/22E-03B02	462323120030001	46.38903	-120.05119	1,003	120	O	–	–	D
10N/22E-04J01	462254120034301	46.38136	-120.06300	1,015	226	O	–	–	D
10N/22E-05P01	462231120054001	46.37519	-120.09594	919	205	X	185	205	D
10N/22E-06A01	462321120062801	46.38914	-120.10786	994	227	P	217	227	D
10N/22E-07N01	462145120072701	46.36239	-120.12528	808	178	O	–	–	D
10N/22E-08F02	462206120054001	46.36836	-120.09458	874	162	O	–	–	D
10N/22E-08H01	462203120050001	46.36761	-120.08328	867	142	O	–	–	D
10N/22E-08K04	462152120052401	46.36447	-120.09000	855	171	O	–	–	D
10N/22E-08L01	462203120054001	46.36758	-120.09431	873	161	O	–	–	D
10N/22E-11J02	462202120011401	46.36708	-120.02044	908	175	X	160	175	D
10N/22E-13E02	462115120011001	46.35425	-120.01947	858	255	P	235	255	D
10N/22E-14K01	462105120014501	46.35136	-120.02911	813	205	P	185	205	D
10N/22E-17C02	462136120054601	46.36011	-120.09611	838	–	–	–	–	–
10N/22E-18G03	462122120063801	46.35622	-120.11044	815	161	O	–	–	D
10N/22E-19L01	462019120070401	46.33867	-120.11789	783	237	O	–	–	D
10N/22E-20N02	461956120060401	46.33231	-120.10117	774	202	P	181	202	D
10N/22E-21R02	461955120035601	46.33186	-120.06569	778	243	O	–	–	D

Table 1. Location and description of groundwater wells sampled for nitrate in the Groundwater Management Area, Yakima County, Washington, April–December 2017.—Continued

Well No.	Site No.	Latitude	Longitude	Land surface elevation	Well depth (ft BLS)	Type of opening	Depth of open interval (ft BLS)		Type of log available
							Top	Bottom	
10N/22E-22P01	462012120031001	46.33253	-120.05178	774	60	O	–	–	D
10N/22E-23H02	462019120011801	46.33872	-120.02181	782	213	O	–	–	D
10N/22E-24M01	462014120010001	46.33728	-120.01681	799	238	O	–	–	D
10N/22E-26C01	461949120020201	46.33017	-120.03397	757	145	X	140	145	D
10N/22E-27M01	461915120033301	46.32094	-120.05906	790	105	P	85	105	D
10N/22E-27N01	461902120033401	46.31696	-120.06063	803	135	X	122	135	D
10N/22E-29D01	461952120055701	46.33119	-120.09911	771	79	O	–	–	D
10N/22E-30B01	461947120063901	46.32853	-120.11275	772	290	O	–	–	D
10N/22E-34B01	461848120024801	46.31328	-120.04656	893	98	O	–	–	D
10N/22E-34B02	461858120030301	46.31606	-120.05078	801	227	X	222	227	D
10N/22E-35F03	461841120015401	46.31028	-120.03211	749	110	O	–	–	D
10N/22E-36K01	461826120003301	46.30731	-120.00911	742	102	O	–	–	D
10N/23E-18D01	462135119594301	46.35983	-119.99539	896	185	P	165	185	D
10N/23E-20G01	462021119580101	46.33919	-119.96694	807	60	O	–	–	D
10N/23E-22L01	462008119553601	46.33567	-119.92669	946	193	S	173	193	D
10N/23E-23R01	462006119535701	46.33486	-119.89928	1,025	100	X	80	100	D
10N/23E-25J07	461916119524001	46.32122	-119.87772	1,225	399	S	372	392	D
10N/23E-27N01	461903119561001	46.31744	-119.93608	844	185	P	135	165	D
10N/23E-28F01	461929119570201	46.32483	-119.95053	807	245	P	225	245	D
10N/23E-29A01	461947119573401	46.32958	-119.96060	783	52	O	–	–	D
10N/23E-30A01	461952119590201	46.33122	-119.98400	765	70	O	–	–	D
10N/23E-31E02	461846119594901	46.31275	-119.99692	731	115	X	102	115	D
10N/23E-32K02	461827119580201	46.30758	-119.96711	745	169	O	–	–	D
10N/23E-33D01	461900119571901	46.31683	-119.95522	788	63	X	58	63	D
10N/23E-34A01	461859119550801	46.31631	-119.91883	905	115	S	73	93	D
10N/23E-35M01	461822119545401	46.30611	-119.91486	922	126	S	121	126	D
11N/20E-04Q03D1	462744120191001	46.46233	-120.31953	1,031	443	S	42	443	D
11N/20E-06D01	462828120222901	46.47431	-120.37461	879	183	X	158	183	D
11N/20E-07C01	462744120221201	46.46231	-120.37011	854	60	O	–	–	D
11N/20E-07H03	462725120212501	46.45597	-120.35761	868	60	P	57	60	D
11N/20E-08F01	462730120204701	46.45786	-120.34678	922	190	P	170	190	D
11N/20E-09D02	462738120195301	46.46050	-120.33147	947	160	P	140	160	D
11N/20E-09L02	462705120193501	46.45131	-120.32647	931	162	X	117	162	D
11N/20E-10C02	462742120182701	46.46181	-120.30753	1,207	340	X	220	340	D
11N/20E-10P01	462653120182401	46.44792	-120.30664	973	250	P	230	250	D
11N/20E-11R01	462651120162101	46.44758	-120.27247	1,075	280	X	272	280	D
11N/20E-12P02	462653120155901	46.44803	-120.26647	1,140	382	X	360	382	D
11N/20E-13J01	462624120150901	46.44003	-120.25242	1,011	170	P	130	150	D
11N/20E-14M03	462616120173101	46.43767	-120.29203	928	145	P	125	145	D
11N/20E-15B02	462640120180901	46.44453	-120.30258	928	195	X	193	195	D
11N/20E-21B02	462549120192801	46.43033	-120.32431	794	67	O	–	–	D
11N/20E-22Q01	462511120175701	46.41983	-120.29917	828	125	P	105	125	D
11N/20E-23Q02	462508120164301	46.41886	-120.27872	854	138	O	–	–	D
11N/20E-24E02	462534120162001	46.42600	-120.27214	882	210	P	190	210	D
11N/20E-24J03	462528120151101	46.42450	-120.25294	949	238	O	–	–	D
11N/20E-24N01	462508120160301	46.41886	-120.26739	884	140	X	133	140	D
11N/20E-24P03	462519120155601	46.42186	-120.26547	890	152	P	125	152	D
11N/20E-24R01	462511120152201	46.41972	-120.25619	889	275	O	–	–	D

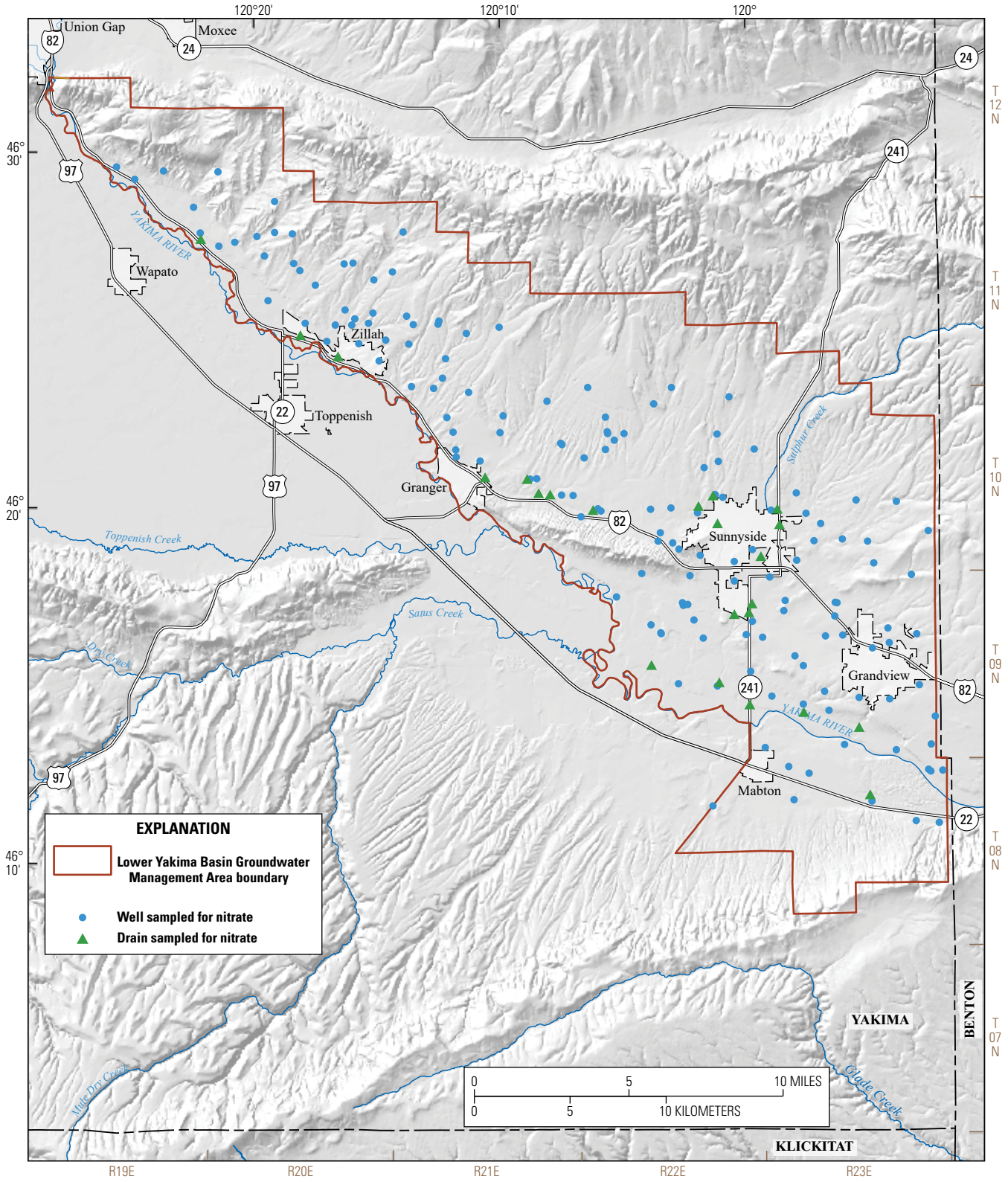
Table 1. Location and description of groundwater wells sampled for nitrate in the Groundwater Management Area, Yakima County, Washington, April–December 2017.—Continued

Well No.	Site No.	Latitude	Longitude	Land surface elevation	Well depth (ft BLS)	Type of opening	Depth of open interval (ft BLS)		Type of log available
							Top	Bottom	
11N/20E-25L01	462437120154601	46.41017	-120.26264	856	165	O	–	–	D
11N/20E-26F01	462440120170401	46.41122	-120.28433	820	135	O	–	–	D
11N/21E-06R01D1	462745120135701	46.46244	-120.23256	1,241	663	P	603	663	D
11N/21E-18G01	462637120142301	46.44372	-120.23969	1,124	325	S	305	325	D
11N/21E-19J01	462523120135001	46.42297	-120.23042	1,002	260	P	210	250	D
11N/21E-20N01	462508120133301	46.41897	-120.22575	1,044	795	P	453	510	D
							610	658	D
11N/21E-21N01	462509120123201	46.41917	-120.20894	1,047	208	O	–	–	D
11N/21E-21N02	462515120123101	46.42072	-120.20850	1,066	281	X	278	281	D
11N/21E-27A01	462504120100301	46.41769	-120.16761	1,135	376	O	301	376	D
11N/21E-28H01	462453120112301	46.41472	-120.18981	1,043	281	P	260	280	D
11N/21E-29M05	462435120134401	46.40983	-120.22892	923	198	O	–	–	D
11N/21E-30F03	462443120143601	46.41169	-120.24439	933	220	X	214	220	D
11N/21E-31D01	462408120145701	46.40211	-120.24908	887	–	–	–	–	–
11N/21E-32N01	462324120133801	46.39003	-120.22708	839	199	O	–	–	D
11N/21E-33C02	462411120121401	46.40303	-120.20394	904	158	O	–	–	D
11N/21E-33M01	462338120122201	46.39386	-120.20608	876	354	O	–	–	D
12N/19E-27Q01	462936120253601	46.49325	-120.42672	902	120	P	100	120	D
12N/19E-35E01	462915120245201	46.48744	-120.41447	882	141	X	138	141	D
12N/19E-36D01	462928120234201	46.49125	-120.39500	1,091	405	P	365	405	D
12N/20E-31B02	462922120214101	46.49083	-120.35789	1,060	402	S	330	400	D
12N/20E-33Q02	462837120191101	46.47689	-120.31964	1,155	322	P	302	322	D

Field measurements were monitored using a Yellow Springs Instruments (YSI®) 600XLM or 6920 V2 data sonde. The sonde was calibrated prior to use, as described in the National Field Manual (U.S. Geological Survey, variously dated). The specific conductance sensor was calibrated daily with standard reference solutions (1,000 µS/cm and checked with solutions ranging from 250 to 750 µS/cm); the pH sensor was calibrated daily with two pH standards (7 and 10, and checked against pH 4 buffer solution); and the dissolved oxygen (DO) sensor was calibrated daily using the air-saturated water method and occasionally verified with zero-DO solution.

Samples for analysis of nitrate concentrations were filtered, in the field, through a 0.45 µm membrane syringe-filter into polyethylene bottles, chilled, and sent to the USGS National Water Quality Laboratory (NWQL) in Lakewood, Colorado.

In addition to collecting environmental samples, quality-control samples consisting of blank and replicate samples, made up 8 percent of all well samples taken (table 3). Blank samples are contaminant-free water submitted to the laboratory and analyzed to ensure that environmental samples have not been contaminated. Two types of blanks were prepared, an equipment blank, prepared by transferring blank water through laboratory cleaned sampling equipment to ensure that neither is a source of contamination; and a field blank, prepared concurrently with environmental samples to ensure that field and laboratory procedures do not result in contaminant or carry-over between sites. Replicates are duplicate environmental samples from a site submitted to the laboratory to determine whether field procedures and analytical results are reproducible.



Base map from USGS and other digital data, various years and scales. Projection: Lambert Conformal Conic, State Plane Washington South. Horizontal datum is North American Datum of 1983

Figure 2. Wells and drains sampled for nitrate in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, April–December 2017.

Table 2. Location of drains sampled for nitrate in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, April–December 2017.

[**Latitude and Longitude:** Latitude and longitude at site in decimal degrees referenced to North American Datum of 1983]

Station name	Site No.	Latitude	Longitude
Buena drain at westbound I-82 near Buena, WA	12505315	46.4142	-120.3025
DID 18 Drain at Sunnyside, WA	12508790	46.3246	-119.9784
DID 3 Drain near Sunnyside, WA	12508840	46.2826	-120.0095
DID 7 Drain near Mabton, WA	12508670	46.2589	-120.0656
DR2 NEET Site Number 3	462021120075700	46.3390	-120.1337
Drain 31 at West Charvet Road at Mabton, WA	12508988	46.2401	-119.9993
Drain 35 off Charvet Road, near Grandview, WA	12508905	46.2365	-119.9629
Grandview Drain at Chase Road near Grandview, WA	12508997	46.2293	-119.9256
Granger Drain at Granger, WA	12505450	46.3435	-120.1870
Joint drain 27.5 at Vanbelle Road	462047120085300	46.3463	-120.1492
Joint drain 34.2 at Woodin Road	462018120012000	46.3382	-120.0232
Joint drain 43.9 at Mabton Sunnyside Road	461700119595400	46.2833	-119.9994
Joint drain 1 at Bus Road near Grandview, WA	12509057	46.1977	-119.9186
Joint drain 14.6 at Chervon Station at Zillah, WA	1250532310	46.4041	-120.2768
Joint drain 28 near Granger, WA	12505448	46.3397	-120.1414
Joint drain 32 at Outlook Road Near Sunnyside, WA	12504509	46.3316	-120.1044
Joint drain 40.2 near Tear Road Near Sunnyside, WA	12508825	46.2875	-119.9975
Joint drain at Yakima Valley Highway at Granger, WA	12505445	46.3474	-120.1775
Joint drain from Rougk Lane near Sunnyside, WA	12508835	46.3333	-120.0332
Joint drain near S. 1st Street at Sunnyside, WA	12508785	46.3251	-120.0203
Roza Canal Wasteway Number 3 near Sawyer, WA	12505150	46.4593	-120.3698
Sulphur Creek Wasteway at Sheller Road at Sunnyside WA	12508788	46.3317	-119.9800
Sulphur Creek Wasteway near Sunnyside, WA	12508850	46.2507	-120.0198
Washout Drain at Sunnyside, WA	12508810	46.3096	-119.9912

Table 3. Numbers of environmental and quality-assurance samples collected from wells and drains in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington.

[Number in parentheses is the percentage of samples from within the group]

Sample type	Number and (percentage) of samples					
	Well		Drain		Total	
Environmental	892	(92)	164	(86)	1,056	(91)
Field blanks	22	(2)	5	(3)	27	(2)
Equipment blanks	7	(1)	6	(3)	13	(1)
Replicates	47	(5)	15	(8)	62	(5)
Total	968	(100)	190	(100)	1,158	(100)

Laboratory Methods

Samples for analysis of nitrate plus nitrite were analyzed colorimetrically by enzymatic reduction as described by Patton and Kryskalla (2011). The results for the nitrate plus nitrite analyses are referred to simply as “nitrate” in this report because nitrite was below the detection level at all sites during the first round of sampling collection.

Results

Quality Control Results

Quality-assurance sampling included collecting replicate and blank samples for the analysis of nitrate. The relative percent difference between these replicate samples ranged from 0 to 10 percent. Nitrate was not detected in any blank samples with the exception of one sample with a concentration of 0.043 mg/L, just above the reporting limit of 0.04 mg/L. No changes were made to the dataset based on these quality-control data.

During the second round of sampling in May and June, there was a mix-up of samples either by the laboratory, or field personnel. It was undetermined which was the issue, resulting in the rejection of 16 results from that sampling round. It was evident that sample results were incorrect (actually reversed) based on the trending result in the groundwater well. In these cases, where it was obvious the results were incorrect and the nitrate value was greater than four standard deviations of the sample mean, the result was rejected.

Results of Water-Quality Analysis

Results of nitrate concentrations for individual samples collected in the GWMA from April to December 2017 are listed in table 4 for groundwater wells and table 5 for surface-water drain sites. All analytical results, including field measurements are available from the USGS NWIS web site https://waterdata.usgs.gov/wa/nwis/.

Nitrate concentrations in groundwater samples ranged from less than 0.04 to 45.2 mg/L and less than 0.04 to 25.2 mg/L in surface water from drain sites. The average nitrate concentration for groundwater samples was 6.1 mg/L as nitrogen. Concentrations of nitrate averaged 5.5 mg/L in drain site samples. The 10 mg/L maximum contaminant level (MCL) established by the EPA for drinking water was exceeded by 20 percent of samples from wells exceeded in 13 percent of samples from drain sites (table 6). At least one nitrate concentration above the MCL was detected in 26 percent of wells and 33 percent of drain sites sampled. Nitrate was not detected in 13 percent of all samples (below the method detection level of 0.04 mg/L), 15 percent of well samples, and 5 percent of drain site samples.

Table 4. Nitrate concentrations in groundwater samples collected from drinking water wells in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, April–December, 2017.

[All values in milligrams per liter. **Abbreviations:** <, less than; –, no data; –*, no data (sample tap winterized; –**, no data (could not access property—no permission); R, result value reviewed and rejected]

Well No.	April/May	May/June	July	September	October	December
08N/22E-11L02	16.1	14.3	14.2	13.6	15.7	15.4
08N/23E-01F02	0.247	0.292	0.53	0.594	0.936	0.522
08N/23E-01H02	0.443	1.15	1.41	1.94	1.83	4.1
08N/23E-01J01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
08N/23E-05G01	11.2	–	–	–	–	–
08N/23E-06H02	10.3	7.66	7.36	7.49	8.37	7.97
08N/23E-08E01	14.3	10.8	16.2	17.7	17.7	19.7
08N/23E-10G01	11	11.4	11.2	11.3	11.3	–*
08N/23E-11R01	0.681	1.37	2.27	1.75	1.16	0.715
08N/23E-13B01	2.6	3.54	4.12	4.93	5.19	3.67
09N/22E-01G02	11.5	10.9	10.8	10.5	11.1	11.6
09N/22E-02D01	2.28	2.18	2	2.04	2.29	2.36
09N/22E-03R01	4.77	4.56	4.54	4.58	6.94	9.13
09N/22E-04B01	2.37	1.05	2.55	1.02	0.79	0.739
09N/22E-05Q01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/22E-09J02	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/22E-10A01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/22E-10N03	–	0.47	0.322	0.075	<0.040	<0.040
09N/22E-10N04	–	–	<0.040	<0.040	<0.040	<0.040
09N/22E-11D01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/22E-11M01	8.02	7.13	7.11	8.89	8.87	8.93
09N/22E-12R02	14.5	16.4	17.9	18	17.9	17.9
09N/22E-14B01	<0.040	0.057	<0.040	<0.040	<0.040	<0.040
09N/22E-22K01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/22E-23J01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/23E-01D01	2.27	2.18	2.16	2.23	2.34	2.57
09N/23E-04R01	4.42	4.44	4.4	4.62	4.51	4.49

Table 4. Nitrate concentrations in groundwater samples collected from drinking water wells in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, April–December, 2017.—Continued

Well No.	April/May	May/June	July	September	October	December
09N/23E-04R02	4.17	4.12	4.12	4.25	4.2	4.2
09N/23E-05N01	5.39	5.29	5.29	5.45	5.31	5.42
09N/23E-06B01	17.3	17.4	17	17.3	16.9	–*
09N/23E-07M02	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/23E-08E02	7.19	7.42	7.62	7.92	7.87	7.8
09N/23E-09H01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/23E-11K01	6.23	6.43	6.29	6.58	6.37	6.4
09N/23E-13C01	10.3	10.7	10.4	10.7	10.7	11.1
09N/23E-14G01	14.2	15.1	17.3	24.1	32.9	–**
09N/23E-15D03	12.8	13	12.8	12.7	12.8	12.8
09N/23E-15H03	5.87	5.27	4.54	5.6	5.57	5.73
09N/23E-16C01D1	2.62	2.66	2.58	2.57	2.62	–*
09N/23E-17L01	R	19.2	19.3	20.7	19.8	–*
09N/23E-18C01	1.89	1.72	1.71	1.69	1.88	1.85
09N/23E-19D03	8.07	8.29	8.26	8.6	–	–
09N/23E-19Q01	2.42	2.19	2.13	2.36	2.38	2.44
09N/23E-20A01	5.02	4.73	3.92	3.57	3.61	3.62
09N/23E-21P01	9.3	9.5	9.47	10.1	10.3	10.4
09N/23E-24L01	8.2	5.26	5.13	7.52	7.69	8.25
09N/23E-25J01	12	12.3	13	11.1	10.1	12.8
09N/23E-26B01	2.51	3.92	4.1	4.64	2.67	2.58
09N/23E-27B02	6.13	5.94	5.6	5.41	5.34	5.65
09N/23E-28G01	3.58	3.68	3.75	3.93	3.9	3.84
09N/23E-29B02	4.56	4.66	4.57	4.78	4.73	4.89
09N/23E-31K01	8.41	7.98	8.63	10.7	10.7	10.6
09N/23E-34M01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/23E-35K01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/23E-36J01	9.84	5.54	5.36	7.19	6.25	–*
10N/21E-01G01	43.1	R	40.8	41.7	39.4	42.5
10N/21E-02N01	11.1	R	7.04	7.6	7.68	10.3
10N/21E-03D02	11.6	12.4	12.4	12.2	11.5	–*
10N/21E-04P02	3.72	R	3.58	3.79	3.75	3.88
10N/21E-05A01	4.63	4.05	4.36	5	4.67	5.28
10N/21E-09F01	2.56	1.7	2.18	2.73	2.58	2.88
10N/21E-11M01	11.1	8.27	8.63	8.76	8.26	11.3
10N/21E-12R01	15	15.7	15.5	16.2	15.6	15.9
10N/21E-13N01	<0.040	0.12	0.211	<0.040	<0.040	<0.040
10N/21E-15E01	2.87	R	3.05	3.19	3.01	3.14
10N/21E-16B01	14.8	R	15.5	15.5	13.2	12.7
10N/21E-16G02	10.8	10.5	9.82	9.87	9.98	10.7
10N/21E-23A01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
10N/21E-24J01	<0.040	R	<0.040	<0.040	<0.040	<0.040
10N/22E-01F01	4.77	3.94	4.02	4.24	4.2	–*
10N/22E-03B02	45.2	43.2	44	44.5	43.1	44.7
10N/22E-04J01	3.93	R	3.83	3.85	3.69	3.92
10N/22E-05P01	8.14	R	7.66	7.98	8.04	8.56
10N/22E-06A01	5.05	6.38	6	6.56	4.85	4.94
10N/22E-07N01	15.8	15.8	16.9	16.5	15.5	15.8
10N/22E-08F02	9.91	9.26	9.96	9.98	9.48	10.3
10N/22E-08H01	6.05	5.79	6.42	6.77	6.82	6.83
10N/22E-08K04	9.66	8.27	9.31	9.36	8.95	9.09
10N/22E-08L01	8.42	8.35	8.44	8.76	8.37	8.92
10N/22E-11J02	10.8	10.5	11	8.31	8.7	10.4
10N/22E-13E02	7.11	R	6.88	6.73	6.73	7.16

Table 4. Nitrate concentrations in groundwater samples collected from drinking water wells in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, April–December, 2017.—Continued

Well No.	April/May	May/June	July	September	October	December
10N/22E-14K01	3.56	3.51	4.61	4.88	4.4	3.83
10N/22E-17C02	12.1	9.76	8.41	10.2	18.9	18.1
10N/22E-18G03	9.41	9.3	9.16	9.04	9.03	9.01
10N/22E-19L01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
10N/22E-20N02	<0.040	<0.040	<0.040	<0.040	–	–
10N/22E-21R02	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
10N/22E-22P01	10.4	10.8	10.7	10.9	11	11
10N/22E-23H02	4.93	4.98	4.96	5.08	5.04	5
10N/22E-24M01	3.29	3.73	3.76	3.73	3.6	3.78
10N/22E-26C01	0.402	0.283	0.342	0.352	0.395	0.465
10N/22E-27M01	10.5	R	10.8	10.4	10.6	10.8
10N/22E-27N01	5.91	5.61	5.83	5.81	5.92	5.79
10N/22E-29D01	10.5	10.3	10.1	10.2	10.2	11.3
10N/22E-30B01	5.87	R	5.08	5.37	5.73	5.89
10N/22E-34B01	14.9	17.2	16.9	15.5	12.7	9.67
10N/22E-34B02	8.55	8.56	8.46	8.52	8.62	8.79
10N/22E-35F03	2.16	2.11	2.13	2.04	2.1	2.09
10N/22E-36K01	17	18.2	16.1	11.4	9.87	10.7
10N/23E-18D01	3.52	3.66	3.88	3.83	3.84	3.81
10N/23E-20G01	8.78	8.77	8.28	7.71	7.84	8.09
10N/23E-22L01	6.36	5.75	5.54	5.33	5.41	5.59
10N/23E-23R01	4.46	4.26	12.9	21.7	19.5	11.3
10N/23E-25J07	2.76	2.47	2.84	2.65	3.05	2.51
10N/23E-27N01	2.17	3.28	3.43	2.62	1.99	2.07
10N/23E-28F01	4.15	3.72	3.87	3.88	4.51	4.56
10N/23E-29A01	9.2	9.56	9.77	9.45	9.77	9.86
10N/23E-30A01	19.4	20.6	21.6	21.7	21	22.3
10N/23E-31E02	12.5	12.8	12.8	16	12.7	13.4
10N/23E-32K02	4.05	R	4.76	5.73	4.17	4.14
10N/23E-33D01	9.21	9.82	9.67	10.2	9.49	9.82
10N/23E-34A01	10.3	10.2	11.3	11.6	12.4	14.2
10N/23E-35M01	9.28	11.4	11.7	9.75	10.1	10.2
11N/20E-04Q03D1	0.748	0.773	0.749	0.767	0.772	–*
11N/20E-06D01	7.24	7.31	7.56	8.1	7.63	7.6
11N/20E-07C01	3.29	3.13	3.27	3.17	3.57	3.44
11N/20E-07H03	2.46	2.43	2.39	2.34	2.4	2.55
11N/20E-08F01	4.72	4.42	4.28	3.91	4.17	–*
11N/20E-09D02	2.05	2.25	2.17	2.07	2.18	2.15
11N/20E-09L02	3.4	3.35	3.71	3.5	3.88	3.32
11N/20E-10C02	1.76	1.21	1.1	1.03	1.26	1.53
11N/20E-10P01	2.19	2.23	2.13	1.99	2.18	2.13
11N/20E-11R01	2.46	2.66	2.57	2.47	2.75	2.48
11N/20E-12P02	3.23	3.2	3.17	3.05	3.21	3.25
11N/20E-13J01	2	1.96	1.86	1.76	1.77	1.92
11N/20E-14M03	6.25	6.31	6.27	6.15	5.43	5.48
11N/20E-15B02	1.38	1.37	1.45	1.47	1.58	1.57
11N/20E-21B02	2.44	2.43	2.79	2.06	2.48	2.56
11N/20E-22Q01	1.35	1.33	1.34	1.29	1.38	–*
11N/20E-23Q02	1.64	1.69	1.56	1.46	1.53	1.66
11N/20E-24E02	7.4	7.29	7.38	7.5	7.38	7.41
11N/20E-24J03	5.08	4.95	4.92	4.63	4.9	4.99
11N/20E-24N01	5.44	5.31	5.34	4.99	5.4	5.56
11N/20E-24P03	5.01	4.77	5.27	4.96	5.6	5.53
11N/20E-24R01	–	2.86	2.87	2.61	2.72	2.75

Table 4. Nitrate concentrations in groundwater samples collected from drinking water wells in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, April–December, 2017.—Continued

Well No.	April/May	May/June	July	September	October	December
11N/20E-25L01	3.91	3.95	3.96	3.56	4.04	4.07
11N/20E-26F01	–	2.32	2.28	2.13	2.23	–*
11N/21E-06R01D1	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
11N/21E-18G01	2.48	R	2.35	2.27	2.28	2.23
11N/21E-19J01	3.11	3.08	3.08	3.01	3.14	3.11
11N/21E-20N01	1.98	2.13	2.12	2.2	2.31	2.32
11N/21E-21N01	2.09	2.03	1.99	1.84	1.99	1.96
11N/21E-21N02	1.33	1.33	1.29	1.21	1.25	1.35
11N/21E-27A01	1.22	5.46	0.078	4.98	5.47	5.74
11N/21E-28H01	2.43	2.25	2.41	2.41	2.32	2.37
11N/21E-29M05	8.55	8.46	8.41	8.61	8.15	8.26
11N/21E-30F03	17.6	17.6	17.3	17.3	17.7	17.5
11N/21E-31D01	3.1	2.93	2.9	2.82	2.9	2.96
11N/21E-32N01	7.99	R	8.46	8.65	7.97	8.7
11N/21E-33C02	9.72	R	9.79	10	9.8	10.3
11N/21E-33M01	6.56	R	6.58	6.99	6.44	7.05
12N/19E-27Q01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
12N/19E-35E01	1.75	3.12	1.19	1.95	0.961	1.71
12N/19E-36D01	<0.040	R	<0.040	<0.040	<0.040	<0.040
12N/20E-31B02	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
12N/20E-33Q02	–	0.856	0.762	0.772	0.733	0.678

Table 5. Nitrate concentrations in surface-water samples collected from drain sites in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, April–December 2017.

[All values in milligrams per liter. **Abbreviations:** <;,less than; D, site dry]

Station name	April	May	June/August	August	September	October	December
Buena Drain at Westbound I-82 near Buena, WA	2.61	1.38	0.177	0.38	0.543	0.83	1.94
DID 18 drain at Sunnyside, WA	9.32	6.41	5.59	5.57	6.34	9.42	9.87
DID 3 drain near Sunnyside, WA	11.3	12.3	8.22	3.07	4.85	7.94	8.22
DID 7 drain near Mabton, WA	0.653	0.557	0.519	<0.040	0.988	0.995	1.25
DR2 NEET Site Number 3	6.13	4.82	3	1.27	3.64	7.97	7.58
DRAIN 31 at West Charvet Road at Mabton, WA	20.8	4.74	4.95	4.64	6.86	25.2	24.3
DRAIN 35 off Charvet Road, near Grandview, WA	5.16	3.42	2.41	2.41	2.89	5.49	5.31
Grandview Drain at Chase Road near Grandview, WA	6.84	6.24	4.78	3.94	4.99	6.55	6.98
Granger Drain at Granger, WA	5.28	3.91	2.47	3.08	2.87	7.19	7.66
Joint drain 27.5 at Vanbelle Road	5.66	3.1	1.94	3.36	3.56	9.2	9.85
Joint drain 34.2 at Woodin Road	10.7	5.88	5.01	4.64	4.03	15.9	16.5
Joint drain 43.9 at Mabton Sunnyside Road	6.19	4.58	4.16	3.68	4.03	6.63	8.22
Joint drain 1 at Bus Road Near Grandview, WA	4.35	7.13	6.11	6.27	13.6	18.6	12.6
Joint drain 14.6 at Chervon Station at Zillah, WA	<0.040	0.343	<0.040	0.09	0.334	0.087	1.29
Joint drain 28 near Granger, WA	9.98	5	3.37	4.06	5.96	9.73	9.81
Joint drain 32 at Outlook Road near Sunnyside, WA	9.28	4.33	2.96	2.33	2.99	12.8	14.3
Joint drain 40.2 near Tear Road near Sunnyside, WA	10.5	8.03	7.98	7.58	8.32	11.5	13.9
Joint drain at Yakima Valley Highway at Granger, WA	10.2	5.46	3.5	3.49	3.52	10.7	10.9
Joint drain from Rougk Lane near Sunnyside, WA	4.14	4.09	2.53	1.35	3.08	7.78	9.06
Joint drain near S. 1st Street at Sunnyside, WA	5.37	4.74	3.44	1.97	3.97	7.61	7.78
Roza Canal Wasteway Number 3 near Sawyer, WA	<0.040	0.072	<0.040	<0.040	<0.040	D	D
Sulphur Creek Wasteway at Sheller Road at Sunnyside WA	<0.040	0.242	0.075	<0.040	0.21	D	D
Sulphur Creek Wasteway near Sunnyside, WA	3.25	4.65	3.91	2.43	2.4	7.84	9.2
Washout Drain at Sunnyside, WA	9.24	8.3	5.7	5.82	6.31	10.8	11

Table 6. Statistical summary of nitrate concentrations in groundwater and surface-water samples collected from domestic wells and drains in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington.

[**Minimum, Maximum, and Median:** All values in milligrams per liter. Number of detections exceeding drinking water standard: The drinking water standard (maximum contaminant level) established by the U.S. Environmental Protection Agency for nitrate concentration is 10 milligrams per liter (U.S. Environmental Protection Agency, 2012). **Remarks:** –, no remark. **Symbol:** <, less than]

Well No. or station name	Minimum	Maximum	Median	Number of samples	Number of detections exceeding drinking water standard	Remarks
			Wells			
08N/22E-11L02	13.6	16.1	14.8	6	6	–
08N/23E-01F02	0.247	0.936	0.526	6	0	–
08N/23E-01H02	0.443	4.1	1.62	6	0	–
08N/23E-01J01	<0.040	<0.040	<0.040	6	0	–
08N/23E-05G01	11.2	11.2	11.2	1	1	Dropped from network in May
08N/23E-06H02	7.36	10.3	7.81	6	1	–
08N/23E-08E01	10.8	19.7	16.9	6	6	–
08N/23E-10G01	11	11.4	11.3	5	5	–
08N/23E-11R01	0.681	2.27	1.26	6	0	–
08N/23E-13B01	2.6	5.19	3.89	6	0	–
09N/22E-01G02	10.5	11.6	11	6	6	–
09N/22E-02D01	2	2.36	2.23	6	0	–
09N/22E-03R01	4.54	9.13	4.67	6	0	–
09N/22E-04B01	0.739	2.55	1.03	6	0	–
09N/22E-05Q01	<0.040	<0.040	<0.040	6	0	–
09N/22E-09J02	<0.040	<0.040	<0.040	6	0	–
09N/22E-10A01	<0.040	<0.040	<0.040	6	0	–
09N/22E-10N03	<0.040	0.47	0.32	5	0	Added to network in May
09N/22E-10N04	<0.040	<0.040	<0.040	4	0	Added to network in May
09N/22E-11D01	<0.040	<0.040	<0.040	6	0	–
09N/22E-11M01	7.11	8.93	8.44	6	0	–
09N/22E-12R02	14.5	18	17.9	6	6	–
09N/22E-14B01	<0.040	0.057	<0.040	6	0	–
09N/22E-22K01	<0.040	<0.040	<0.040	6	0	–
09N/22E-23J01	<0.040	<0.040	<0.040	6	0	–
09N/23E-01D01	2.16	2.57	2.25	6	0	–
09N/23E-04R01	4.4	4.62	4.46	6	0	–
09N/23E-04R02	4.12	4.25	4.18	6	0	–
09N/23E-05N01	5.29	5.45	5.35	6	0	–
09N/23E-06B01	16.9	17.4	17.3	5	5	–
09N/23E-07M02	<0.040	<0.040	<0.040	6	0	–
09N/23E-08E02	7.19	7.92	7.71	6	0	–
09N/23E-09H01	<0.040	<0.040	<0.040	6	0	–
09N/23E-11K01	6.23	6.58	6.38	6	0	–
09N/23E-13C01	10.3	11.1	10.7	6	6	–
09N/23E-14G01	14.2	32.9	17.3	5	5	–
09N/23E-15D03	12.7	13	12.8	6	6	–
09N/23E-15H03	4.54	5.87	5.58	6	0	–
09N/23E-16C01D1	2.57	2.66	2.62	5	0	–
09N/23E-17L01	19.2	20.7	19.5	4	4	–
09N/23E-18C01	1.69	1.89	1.78	6	0	–
09N/23E-19D03	8.07	8.6	8.27	4	0	Dropped from network in October
09N/23E-19Q01	2.13	2.44	2.37	6	0	–
09N/23E-20A01	3.57	5.02	3.77	6	0	–
09N/23E-21P01	9.3	10.4	9.8	6	3	–
09N/23E-24L01	5.13	8.25	7.6	6	0	–
09N/23E-25J01	10.1	13	12.1	6	6	–

Table 6. Statistical summary of nitrate concentrations in groundwater and surface-water samples collected from domestic wells and drains in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington.—Continued

Well No. or station name	Minimum	Maximum	Median	Number of samples	Number of detections exceeding drinking water standard	Remarks
			Wells—Continued			
09N/23E-26B01	2.51	4.64	3.29	6	0	–
09N/23E-27B02	5.34	6.13	5.62	6	0	–
09N/23E-28G01	3.58	3.93	3.79	6	0	–
09N/23E-29B02	4.56	4.89	4.69	6	0	–
09N/23E-31K01	7.98	10.7	9.61	6	3	–
09N/23E-34M01	<0.040	<0.040	<0.040	6	0	–
09N/23E-35K01	<0.040	<0.040	<0.040	6	0	–
09N/23E-36J01	5.36	9.84	6.25	5	0	–
10N/21E-01G01	39.4	43.1	41.7	5	5	–
10N/21E-02N01	7.04	15.4	8.99	6	3	–
10N/21E-03D02	11.5	12.4	12.2	5	5	–
10N/21E-04P02	3.58	3.88	3.75	5	0	–
10N/21E-05A01	4.05	5.28	4.65	6	0	–
10N/21E-09F01	1.7	2.88	2.57	6	0	–
10N/21E-11M01	8.26	11.3	8.69	6	2	–
10N/21E-12R01	15	16.2	15.6	6	6	–
10N/21E-13N01	0.12	0.211	0.165	6	0	–
10N/21E-15E01	2.87	3.19	3.05	5	0	–
10N/21E-16B01	12.7	15.5	14.8	5	5	–
10N/21E-16G02	9.82	10.8	10.2	6	3	–
10N/21E-23A01	<0.040	<0.040	<0.040	6	0	–
10N/21E-24J01	<0.040	<0.040	<0.040	5	0	–
10N/22E-01F01	3.94	4.77	4.2	5	0	–
10N/22E-03B02	43.1	45.2	44.2	6	6	–
10N/22E-04J01	3.69	3.93	3.85	5	0	–
10N/22E-05P01	7.66	8.56	8.04	5	0	–
10N/22E-06A01	4.85	6.56	5.52	6	0	–
10N/22E-07N01	15.5	16.9	15.8	6	6	–
10N/22E-08F02	9.26	10.3	9.93	6	1	–
10N/22E-08H01	5.79	6.83	6.59	6	0	–
10N/22E-08K04	8.27	9.66	9.2	6	0	–
10N/22E-08L01	8.35	8.92	8.43	6	0	–
10N/22E-11J02	8.31	11	10.4	6	4	–
10N/22E-13E02	6.73	7.16	6.88	5	0	–
10N/22E-14K01	3.51	4.88	4.11	6	0	–
10N/22E-17C02	8.41	18.9	11.1	6	4	–
10N/22E-18G03	9.01	9.41	9.1	6	0	–
10N/22E-19L01	<0.040	<0.040	<0.040	6	0	–
10N/22E-20N02	<0.040	<0.040	<0.040	4	0	Dropped from network in October
10N/22E-21R02	<0.040	<0.040	<0.040	6	0	–
10N/22E-22P01	10.4	11	10.8	6	6	–
10N/22E-23H02	4.93	5.08	4.99	6	0	–
10N/22E-24M01	3.29	3.78	3.73	6	0	–
10N/22E-26C01	0.283	0.465	0.373	6	0	–
10N/22E-27M01	10.4	10.8	10.6	5	5	–
10N/22E-27N01	5.61	5.92	5.82	6	0	–
10N/22E-29D01	10.1	11.3	10.2	6	6	–
10N/22E-30B01	5.08	5.89	5.73	5	0	–
10N/22E-34B01	9.67	17.2	15.2	6	5	–
10N/22E-34B02	8.46	8.79	8.55	6	0	–

Table 6. Statistical summary of nitrate concentrations in groundwater and surface-water samples collected from domestic wells and drains in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington.—Continued

Well No. or station name	Minimum	Maximum	Median	Number of samples	Number of detections exceeding drinking water standard	Remarks
			Wells—Continued			
10N/22E-35F03	2.04	2.16	2.1	6	0	–
10N/22E-36K01	9.87	18.2	13.7	6	5	–
10N/23E-18D01	3.52	3.88	3.82	6	0	–
10N/23E-20G01	7.71	8.78	8.18	6	0	–
10N/23E-22L01	5.33	6.36	5.56	6	0	–
10N/23E-23R01	4.26	21.7	12.1	6	4	–
10N/23E-25J07	2.47	3.05	2.7	6	0	–
10N/23E-27N01	1.99	3.43	2.39	6	0	–
10N/23E-28F01	3.72	4.56	4.01	6	0	–
10N/23E-29A01	9.2	9.86	9.66	6	0	–
10N/23E-30A01	19.4	22.3	21.3	6	6	–
10N/23E-31E02	12.5	16	12.8	6	6	–
10N/23E-32K02	4.05	5.73	4.17	5	0	–
10N/23E-33D01	9.21	10.2	9.74	6	1	–
10N/23E-34A01	10.2	14.2	11.4	6	6	–
10N/23E-35M01	9.28	11.7	10.1	6	4	–
11N/20E-04Q03D1	0.748	0.773	0.767	5	0	–
11N/20E-06D01	7.24	8.1	7.58	6	0	–
11N/20E-07C01	3.13	3.57	3.28	6	0	–
11N/20E-07H03	2.34	2.55	2.41	6	0	–
11N/20E-08F01	3.91	4.72	4.28	5	0	–
11N/20E-09D02	2.05	2.25	2.16	6	0	–
11N/20E-09L02	3.32	3.88	3.45	6	0	–
11N/20E-10C02	1.03	1.76	1.23	6	0	–
11N/20E-10P01	1.99	2.23	2.15	6	0	–
11N/20E-11R01	2.46	2.75	2.52	6	0	–
11N/20E-12P02	3.05	3.25	3.2	6	0	–
11N/20E-13J01	1.76	2	1.89	6	0	–
11N/20E-14M03	5.43	6.31	6.2	6	0	–
11N/20E-15B02	1.37	1.58	1.46	6	0	–
11N/20E-21B02	2.06	2.79	2.46	6	0	–
11N/20E-22Q01	1.29	1.38	1.34	5	0	–
11N/20E-23Q02	1.46	1.69	1.6	6	0	–
11N/20E-24E02	7.29	7.5	7.39	6	0	–
11N/20E-24J03	4.63	5.08	4.93	6	0	–
11N/20E-24N01	4.99	5.56	5.37	6	0	–
11N/20E-24P03	4.77	5.6	5.14	6	0	–
11N/20E-24R01	2.61	2.87	2.75	5	0	Added to network in June
11N/20E-25L01	3.56	4.07	3.95	6	0	–
11N/20E-26F01	2.13	2.32	2.25	4	0	Added to network in July
11N/21E-06R01D1	<0.040	<0.040	<0.040	6	0	–
11N/21E-18G01	2.23	2.48	2.28	5	0	–
11N/21E-19J01	3.01	3.14	3.09	6	0	–
11N/21E-20N01	1.98	2.32	2.16	6	0	–
11N/21E-21N01	1.84	2.09	1.99	6	0	–
11N/21E-21N02	1.21	1.35	1.31	6	0	–
11N/21E-27A01	0.078	5.74	5.22	6	0	–
11N/21E-28H01	2.25	2.43	2.39	6	0	–
11N/21E-29M05	8.15	8.61	8.43	6	0	–
11N/21E-30F03	17.3	17.7	17.55	6	6	–
11N/21E-31D01	2.82	3.1	2.91	6	0	–
11N/21E-32N01	7.97	8.7	8.46	5	0	–

Table 6. Statistical summary of nitrate concentrations in groundwater and surface-water samples collected from domestic wells and drains in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington.—Continued

Well No. or station name	Minimum	Maximum	Median	Number of samples	Number of detections exceeding drinking water standard	Remarks
			Wells—Continued			
11N/21E-33C02	9.72	10.3	9.8	5	2	–
11N/21E-33M01	6.44	7.05	6.58	5	0	–
12N/19E-27Q01	<0.040	<0.040	<0.040	6	0	–
12N/19E-35E01	0.961	3.12	1.73	6	0	–
12N/19E-36D01	<0.040	<0.040	<0.040	5	0	–
12N/20E-31B02	<0.040	<0.040	<0.040	6	0	–
12N/20E-33Q02	0.678	0.856	0.762	5	0	Added to network in May
			Total	892	181	
			Surface-water drain sites			
Buena Drain at Westbound I-82 near Buena, WA	0.177	2.61	0.83	7	0	–
Did 18 drain at Sunnyside, WA	5.57	9.87	6.41	7	0	–
Did 3 drain near Sunnyside, WA	3.07	12.3	8.22	7	2	–
Did 7 drain near Mabton, WA	<0.040	1.25	0.65	7	0	–
DR2 NEET Site Number 3	1.27	7.97	4.82	7	0	–
Drain 31 at West Charvet Road at Mabton, WA	4.64	25.2	6.86	7	3	–
Drain 35 off Charvet Road, near Grandview, WA	2.41	5.49	3.42	7	0	–
Grandview Drain at Chase Road near Grandview, WA	3.94	6.98	6.24	7	0	–
Granger Drain at Granger, WA	2.47	7.66	3.91	7	0	–
Joint drain 27.5 at Vanbelle Road	1.94	9.85	3.56	7	0	–
Joint drain 34.2 at Woodin Road	4.03	16.5	5.88	7	3	–
Joint drain 43.9 at Mabton Sunnyside Road	3.68	8.22	4.58	7	0	–
Joint drain 1 at Bus Road near Grandview, WA	4.35	18.6	7.13	7	3	–
Joint drain 14.6 at Chervon Station at Zillah, WA	<0.040	1.29	0.33	7	0	–
Joint drain 28 near Granger, WA	3.37	9.98	5.96	7	0	–
Joint drain 32 at Outlook Road near Sunnyside, WA	2.33	14.3	4.33	7	2	–
Joint drain 40.2 near Tear Road near Sunnyside, WA	7.58	13.9	8.32	7	3	–
Joint drain at Yakima Valley Highway at Granger, WA	3.49	10.9	5.46	7	3	–
Joint drain from Rougk Lane near Sunnyside, WA	1.35	9.06	4.09	7	0	–
Joint drain near S. 1st Street at Sunnyside, WA	1.97	7.78	4.74	7	0	–
Roza Canal Wasteway Number 3 near Sawyer, WA	<0.040	0.072	<0.040	5	0	–
Sulphur Creek Wasteway at Sheller Road at Sunnyside WA	<0.040	0.242	0.075	5	0	–
Sulphur Creek Wasteway near Sunnyside, WA	2.4	9.2	3.91	7	0	–
Washout Drain at Sunnyside, WA	5.7	11	8.3	7	2	–
			Total	164	21	–

Summary

Nitrate contamination in drinking water of the lower Yakima River Basin Groundwater Management Area (GWMA) is a major concern for local, state and federal agencies. During April through December 2017, the U.S. Geological Survey (USGS) conducted a large sampling collection effort, consisting of the collection of samples (892) from 156 domestic drinking water wells, and 164 samples from 24 drains sites, to fill identified nitrate concentration data gaps and help establish a baseline condition of nitrate concentrations for future assessments within the GWMA.

Domestic well sample locations were selected based on owner permission, ability to collect a representative sample and spatial distribution across the study area. Drains sites were selected based on distribution across the GWMA, and ability to access the site and collect a representative sample.

Sampling collection, processing, and field analyses were in accordance with applicable USGS procedures and included thorough well purging, use of non-contaminating equipment, and quality-assurance sampling. Quality assurance samples made up 8 percent of all samples and included blanks and replicates. No changes were made to the dataset based on these quality-assurance data.

The mean nitrate concentration collected from domestic wells and drains was 6.1 milligrams per liter (mg/L) and 5.6 mg/L, respectively. The 10 mg/L maximum contaminant level (MCL) was exceeded by 20 percent of samples from wells and 13 percent of samples from drains. At least one nitrate concentrations was detected above the (MCL) in 26 percent of wells and 33 percent of drains sampled nitrate was not detected (<0.04 mg/L) in 13 percent of all samples.

References Cited

Ely, D.M., Bachmann, M.P., and Vaccaro, J.J., 2011, Numerical simulation of groundwater flow for the Yakima River Basin aquifer system, Washington: U.S. Geological Survey Scientific Investigations Report 2011–5155, 90 p.

Jones, M.A., and Vaccaro, J.J., 2008, Extent and depth to top of basalt and interbed hydrogeologic units, Yakima River Basin aquifer system, Washington: U.S. Geological Survey Scientific Investigations Report 2008–5045, 22 p., 5 pls.

Jones, M.A., Vaccaro, J.J., and Watkins, A.M., 2006, Hydrogeologic framework of sedimentary deposits in six structural basins, Yakima River Basin, Washington: U.S. Geological Survey Scientific Investigations Report 2006–5116, 24 p., 7 pls.

Patton, C.J., and Kryskalla, J.R., 2011, Colorimetric determination of nitrate plus nitrite in water by enzymatic reduction, automated discrete analyzer methods: U.S. Geological Survey Techniques and Methods, book 5, chap. B8, 34 p.

U.S. Environmental Protection Agency, 2012, Relation between nitrate in water wells and potential sources in the lower Yakima Valley, Washington: U.S. Environmental Protection Agency, EPA-910-R-12-003.

U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, accessed March 15, 2016 at http://pubs.water.usgs.gov/twri9A.

Washington State Department of Ecology, 2010, Lower Yakima Valley groundwater quality preliminary assessment and recommendations document: Washington State Department of Ecology Publication No. 10-10-009.

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