SUMMARY OF HYDROLOGIC CONDITIONS

Hydrologic Setting

A distinctively varied climate characterizes Washington and results primarily from two features: (1) the Cascade Range, and (2) the prevailing marine influence of the Pacific Ocean. The north-south trending Cascade Range divides Washington into two areas: the wet western part and the dry eastern part. Average annual precipitation west of the Cascade Range is about 70 inches and ranges from about 30 to 40 inches in the Puget Sound Basin to about 150 to 200 inches on the western slopes of the Olympic Mountains, where temperate rain forests thrive. The Cascade Range acts as a barrier to air masses that move across the State, producing 100 to 150 inches of annual precipitation on the high western slopes of the Cascade Range and leaving much less moisture in the clouds for eastern Washington. Average annual precipitation in eastern Washington is 7 to 40 inches, with the driest area being the Columbia Basin, where sagebrush and grasses grow and irrigation is required for most crops. About two-thirds of precipitation in Washington occurs from October to March, either as rain in the low elevations or as snow at high elevations. Occasionally during winter, western Washington receives large amounts of rainfall from Pacific storms, accompanied by mild temperatures. The combination of melting snowpack at high elevations and rainfall during these storms can produce flooding in the low elevations. Snowpack and glaciers in the Olympic Mountains and Cascade Range are sources of water for many rivers in Washington and become the primary source of flow during the relatively dry summer.

Washington's varied climate and topography (fig. 1) result in variable streamflow patterns throughout the State, as shown in monthly discharge graphs for selected long-term gaging stations (fig. 2, table 1). Discharge at Chehalis River near Grand Mound (fig. 2A) is representative of streamflow patterns in the southwest lowlands of the State, where seasonal high flow occurs from November to March, coinciding with typical winter rainfall. Flow normally decreases through the spring and summer months due to generally dry weather and absence of snowpack. Discharge at the Quinault River at Quinault Lake (fig. 2B) is representative of the Olympic Peninsula. Two seasonal peak periods at this gaging station result from winter rainfall from November to January and late spring snowmelt from high elevations in May and June. Winter rainfall and spring snowmelt in the East Fork Lewis River near Heisson in the southern Cascade Range overlap to produce a high-flow season generally lasting from November to April (fig. 2C). High flow in the Nooksack River at Deming (fig. 2D) is generated by rainfall in winter and in May and June from a combination of spring rainfall and snowmelt. Discharge at Puyallup River near Orting (fig. 2E) is representative of typical winter rainfall of the central Cascade Range and a late spring snowmelt sustained by permanent snowfields and glaciers on the west slope of the Cascade Range.

Peak flows in rivers draining the east side of the Cascade Range, such as the Wenatchee River at Plain (fig. 2F), normally occur in April to July because of snowmelt. Streamflow during winter generally stays low due to freezing weather that maintains or contributes to the snowpack; exceptions occur when mild weather and heavy rain combine to cause flooding. Discharge at Ahtanum Creek at Union Gap (fig. 2G) and the Walla Walla River near Touchet (fig. 2H) are representative of agricultural drainage basins in the lower Columbia Basin, where irrigation-return flows cause an increase in discharge from August to winter. During winter, high flows are sustained by a combination of precipitation and return flow. Discharge at Hangman Creek at Spokane (fig. 2I) is representative of rivers in central-eastern Washington, where a combination of precipitation and melting snow produces maximum discharge in late winter and early spring.

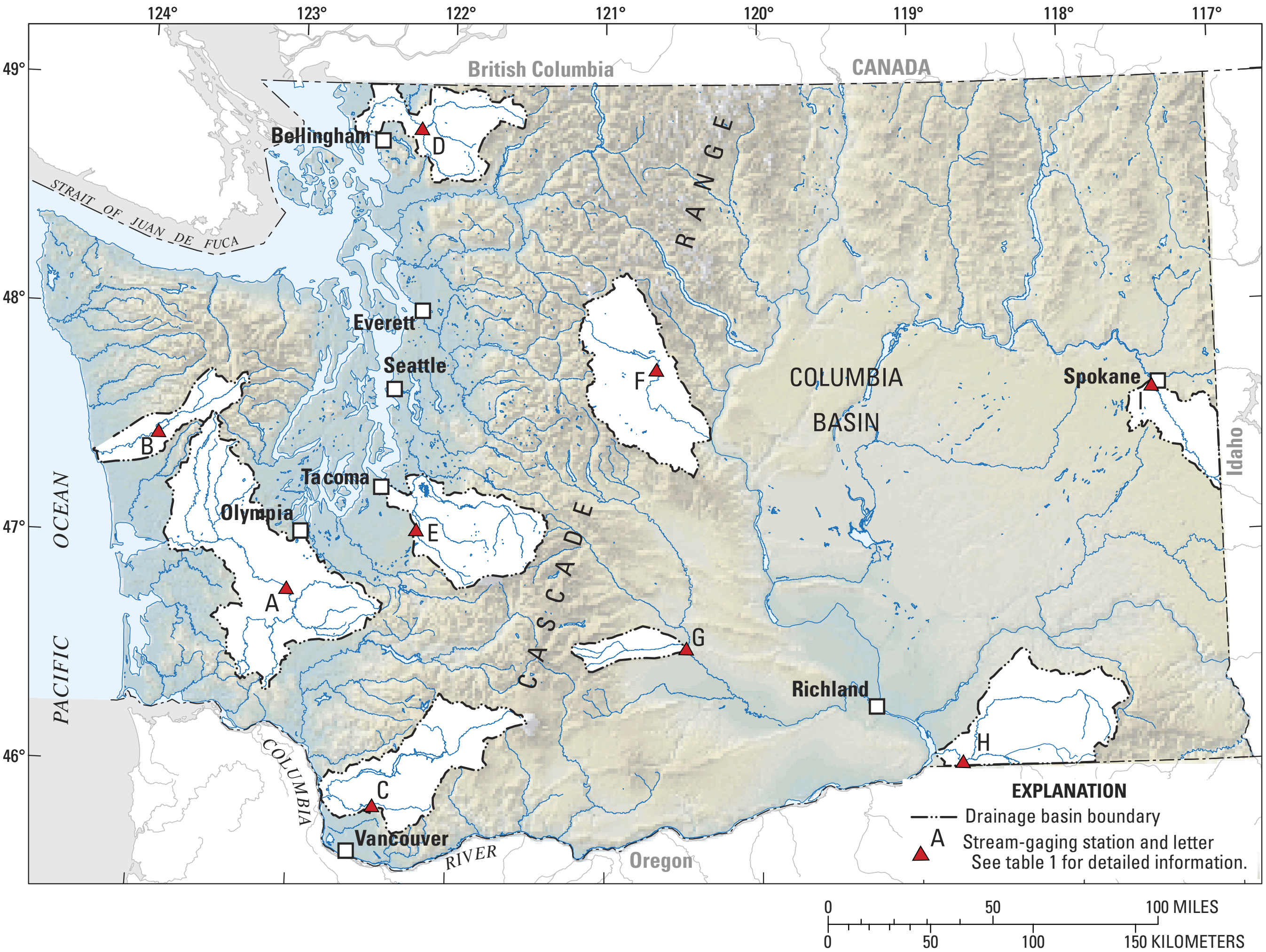

Figure 1. Selected stream-gaging stations and drainage basins in Washington.

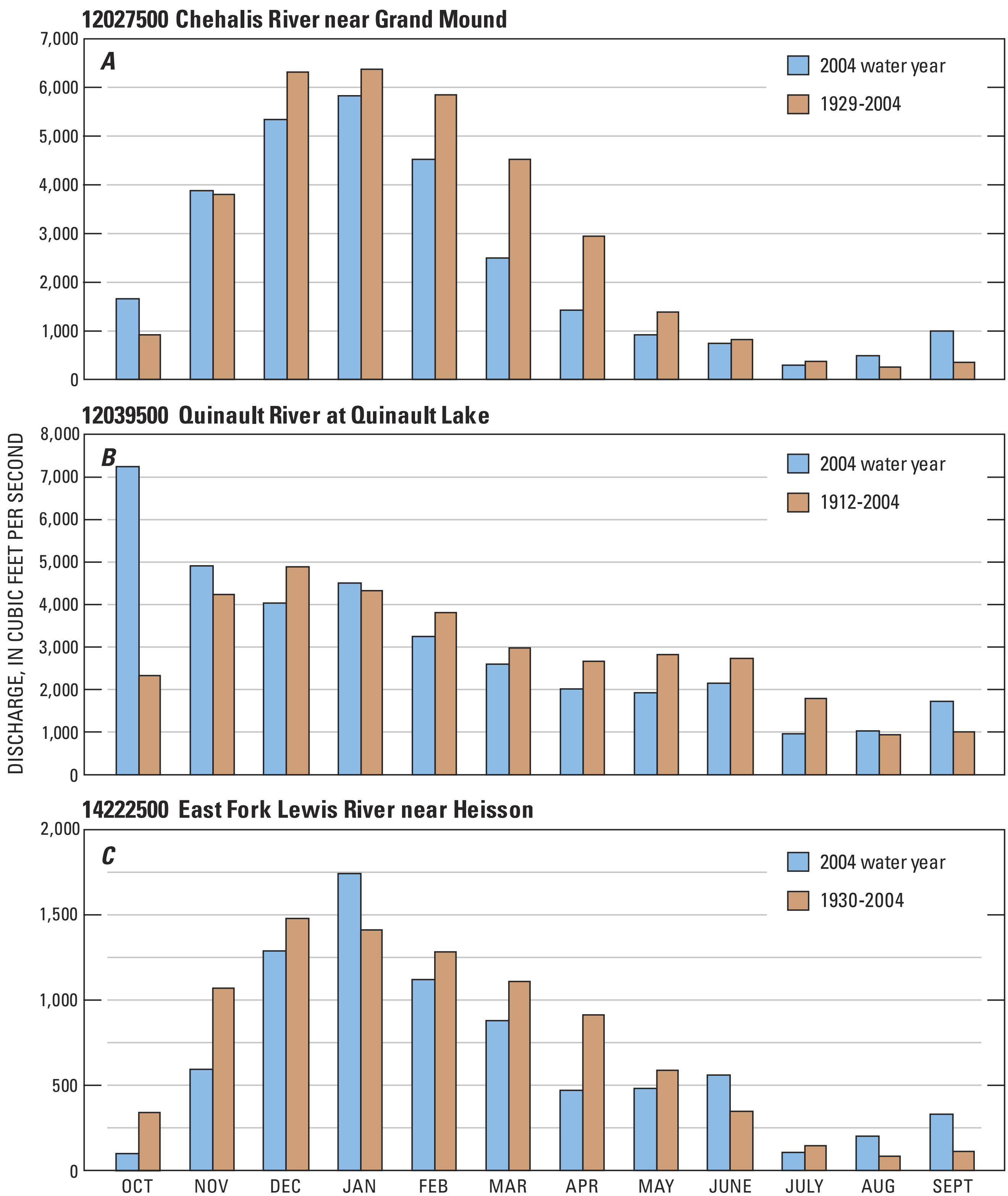

Figure 2. Monthly mean discharge for water year 2004 compared with the mean monthly discharge for the period of record, for selected stream-gaging stations.

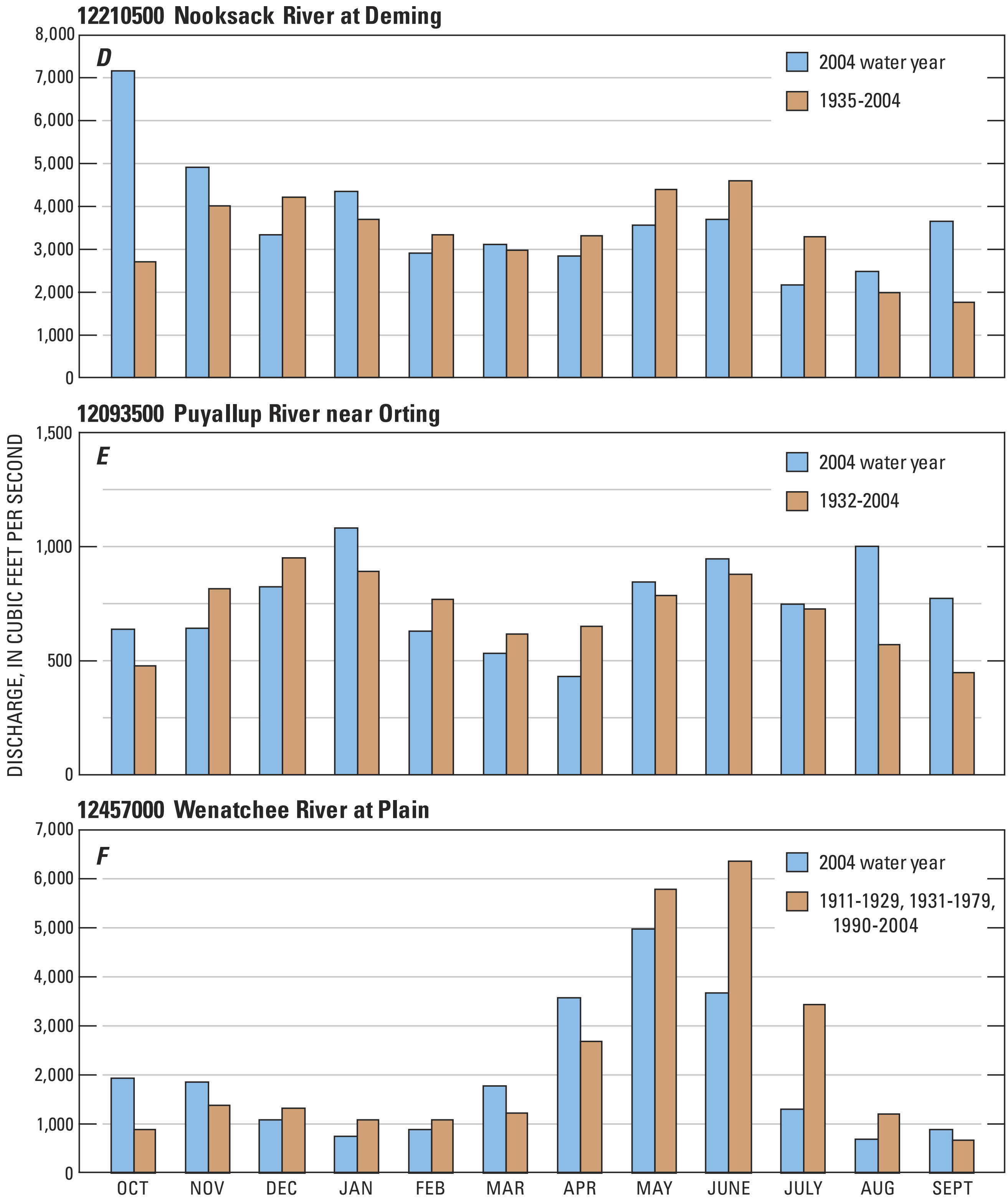

Figure 2. —*Continued.*

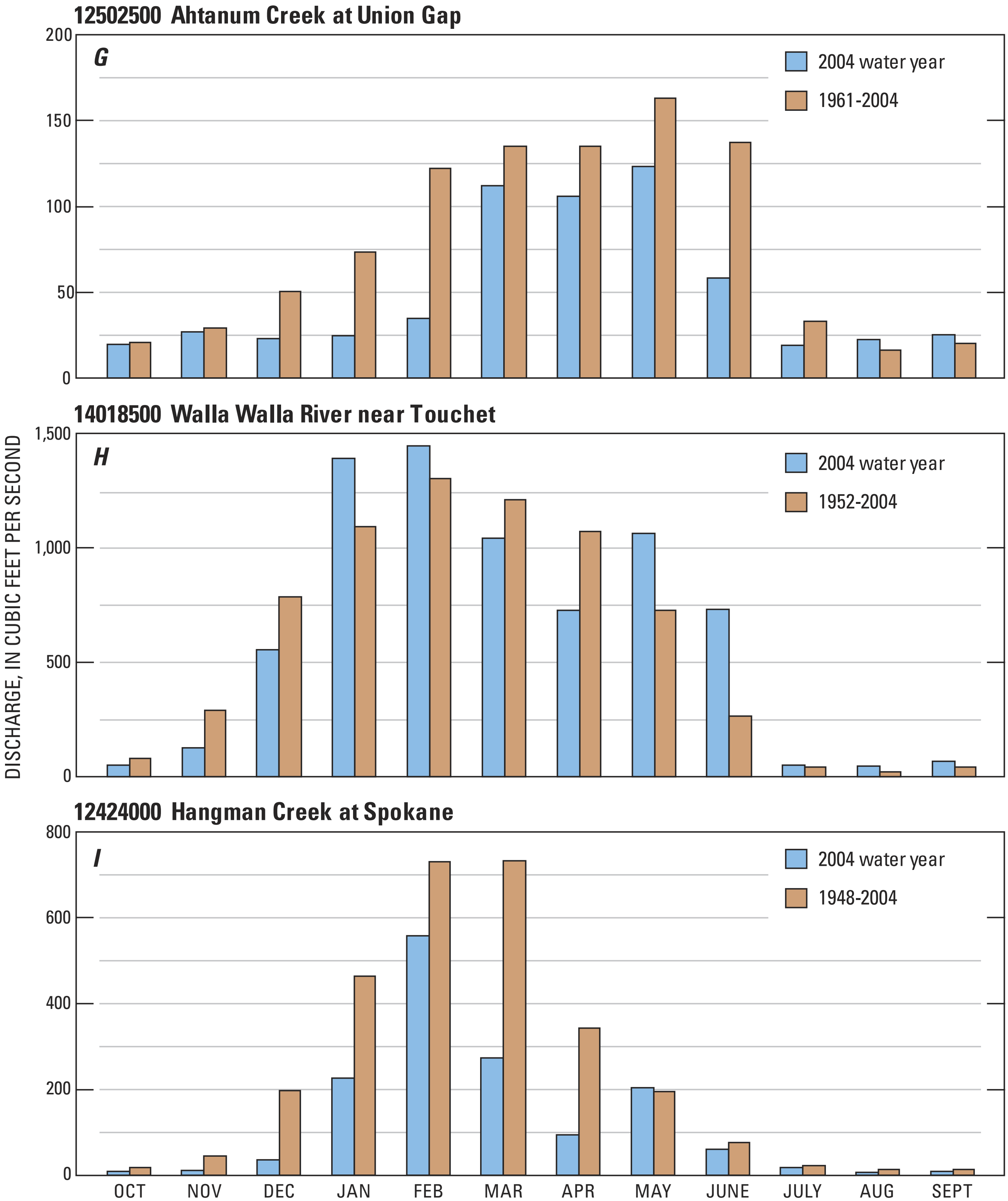

Figure 2. —*Continued.*

Table 1. Selected streamflow-gaging stations in Washington.

Letter in figure 2	Station No.	Streamflow-gaging station	Period of record	Annual mean streamflow, 2004 water year	
				Streamflow, in cubic feet per second	Percentage of long-term mean
A	12027500	Chehalis River near Grand Mound	1929-2004	2,378	85
B	12039500	Quinault River at Quinault Lake	1912-2004	3,034	106
C	14222500	East Fork Lewis River near Heisson	1930-2004	656	89
D	12210500	Nooksack River at Deming	1935-2004	3,687	110
E	12093500	Puyallup River near Orting	1932-2004	758	106
F	12457000	Wenatchee River at Plain	1911-1929, 1931-79, 1990-2004	1,948	86
G	12502500	Ahtanum Creek at Union Gap	1961-2004	50	64
H	14018500	Walla Walla River near Touchet	1952-2004	606	106
I	12424000	Hangman Creek at Spokane	1948-2004	124	53

Hydrologic Conditions for Water Year 2004

Streamflow is largely influenced by precipitation and snowpack and both generally were below average statewide during water year 2004. Precipitation in October ranged from significantly below average in southeastern Washington to significantly above average in northwestern Washington. Precipitation in November was significantly below average in eastern Washington and below average to near average in the western part of the State. Precipitation in December was near average throughout the State. In January, precipitation was above average in southwestern, southeastern, and northeastern Washington and below average in the Cascade Range. Precipitation in February was significantly below average in the Cascade Range, below average in western Washington and eastern Washington along the Idaho border, and near average in central Washington. Precipitation in March and April was below average for most of the State. In May, precipitation was above average for most of the State, except in the Olympic Peninsula, which was near average, and the eastern-central Cascade Range, which was below average. Precipitation in June was below average for most of the State, except for the Columbia River Gorge, which was significantly above average. Precipitation in July was above average throughout the State except for the extreme northern Cascade Range, which was below average. Precipitation in August was significantly above average throughout the state. Precipitation in September was near average for most of the State, except in central and southeastern Washington, which was below average.

Snowpack for water year 2004, measured from January through June, was slightly below average throughout most of the State. In January, statewide snowpack was near average. In April, statewide snowpack had declined to 87 percent of average although the snowpack in individual basins ranged from 70-105 percent of average. The snowpack reached its peak in late March to mid-April in all areas. In many areas of the State, snowmelt occurred earlier than usual, which is normally from late April to late June.

Annual mean streamflow in Washington during water year 2004 ranged from slightly above average in a few areas of the State to significantly below average in eastern Washington, as indicated by data collected at selected long-term streamflow-gaging stations (fig. 1, table 1). Annual mean streamflow ranged from 85 to 110 percent of average in western Washington (sites A-E, fig. 1, table 1). In eastern Washington, annual mean streamflow was 106 percent of average in the Walla Walla Basin (site H), but was only 86 percent of average in the Wenatchee River (site F), 64 percent of average in Ahtanum Creek (site G), and 53 percent of average in Hangman Creek (site I).

For rivers draining to the Pacific Ocean (figs. 2A and 2B), monthly mean discharge was above average in October and November. A large precipitation event during October in the northwestern part of the State resulted in discharge in the Quinault River over 300 percent of average, the highest discharge for all Octobers on record (93 years). After November, discharge in the Chehalis and Quinault Rivers primarily was below average from December through May, which normally is when discharge is high due to winter precipitation and spring snowmelt. In June and July, discharge was near average in the Chehalis River and below average in the Quinault River. In August and September, discharge was above average in both rivers.

Discharge generally increased from south to north in rivers draining the western side of the Cascade Range. October precipitation in the northwestern part of the State resulted in flows that were 265 percent of average in the Nooksack River (fig. 2D) and 135 percent of average in the Puyallup River (fig. 2E). In contrast, discharge for October in the Lewis River Basin (fig. 2C) in the southern Cascade Range was only 29 percent of average. During November through May when discharge is typically high due to winter precipitation, streamflow was 97 percent of average in the Nooksack River, 91 percent of average in the Puyallup River, and 84 percent of average in the Lewis River Basin. Discharge in August and September was above average for all rivers draining the western side of the Cascade Range.

Precipitation in October and November originating from Pacific systems resulted in high streamflow in rivers draining the eastern side of the Cascade Range. Monthly mean discharge in the Wenatchee River (fig. 2F), which is representative of rivers in the central and northern Cascade Range, was 219 percent of average in October and 135 percent in November. Early snowmelt resulted in above average flows in the Wenatchee River during March and April, but with minimal snow left by May, discharge was only 65 percent of average during May through August. After average flow in October and November, monthly mean discharge in Ahtanum Creek in the Yakima River Basin (fig. 2G) was below average for most of year. Monthly mean discharge in Ahtanum Creek for December through February ranged from 29 to 45 percent of average and during March through June, 43 to 83 percent of average.

Discharge in eastern Washington varied by region. In the Walla Walla River in southeastern Washington (fig. 2H), discharge was below average for October through December, above average in January and February, below average in March and April, and above average in May and June. Discharge in Hangman Creek in central-eastern Washington (fig. 2I) generally was below average throughout the year, most notably during January through April when most discharge occurs.

Surface-Water Quality

The National Water-Quality Assessment (NAWQA) program was established to assess the current water-quality conditions for a large part of the Nation's freshwater streams, rivers, and aquifers and to describe how water quality is changing over time. In 2004, Washington operated nine surface-water-quality NAWQA stations throughout the State (fig. 3). Six of the stations are in eastern Washington (Palouse River at Hooper, Crab Creek near Ritzville, Yakima River at Kiona, DR2 near Granger, Sunnyside Canal Diversion near Sunnyside, and Granger Drain at Granger) and are representative of agricultural land use; three are in western Washington, one representing urban land use (Thornton Creek near Seattle), one integrating mixed land use for which the samples are collected at a site locally influenced by urban land use (Duwamish River at Tukwila), and one representing relatively pristine conditions (North Fork Skokomish River near Hoodsport). In addition to these NAWQA stations, the USGS Washington Water Science Center also continued operation of two long-term monitoring sites on the middle Columbia River (Columbia River at Richland and Columbia River near Priest Rapids Dam) and monitored irrigation return flow at four sites in the Columbia Basin Irrigation Project (CBIP)—Crab Creek near Beverly, Lind Coulee Wasteway near Warden, Sand Hollow near Vantage, and Red Rock Coulee near Smyrna, fig. 3).

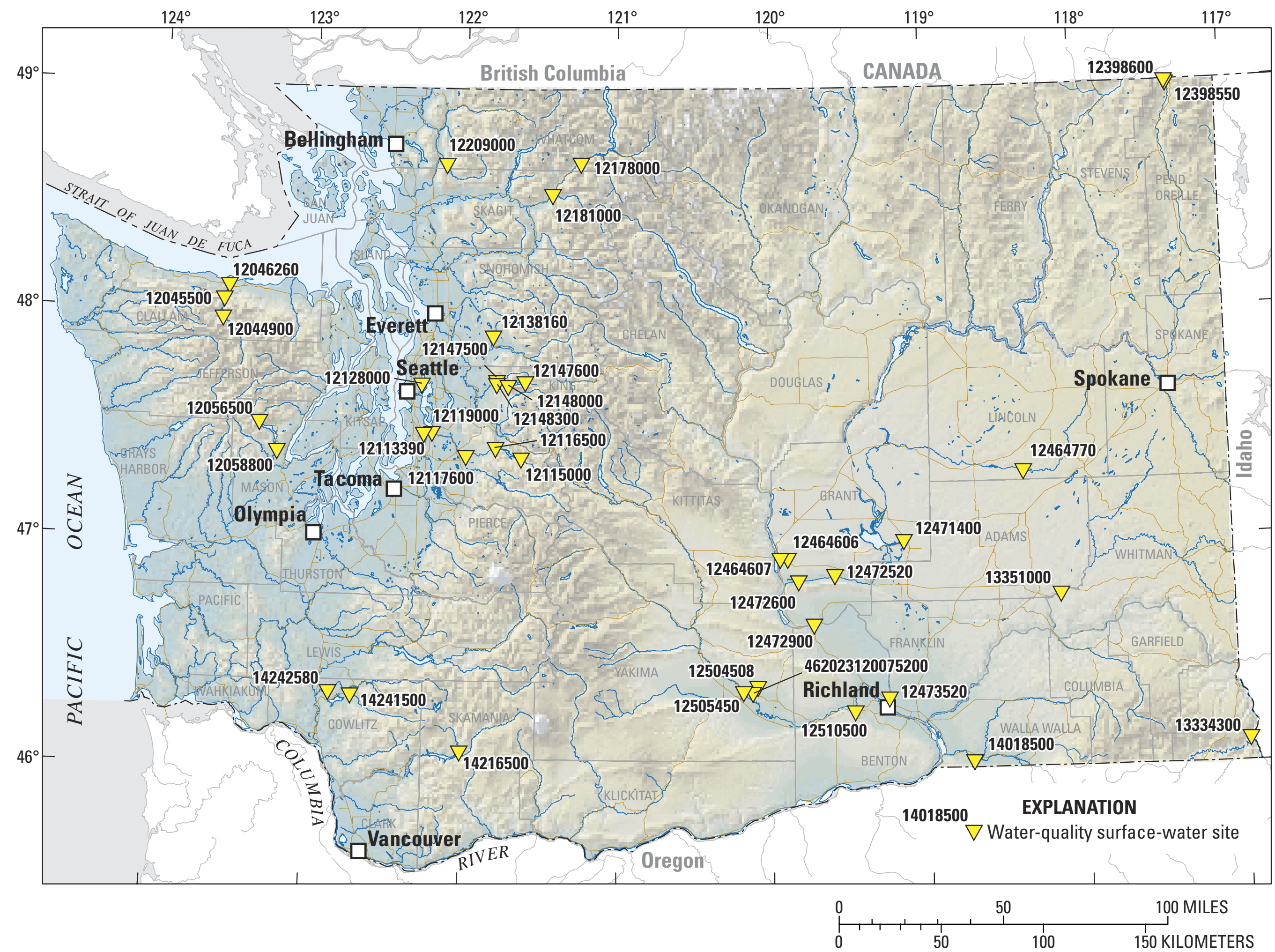

Figure 3. Surface-water stations with water-quality data collection in Washington, water year 2004.

Specific conductance and dissolved-solids concentration generally have an inverse relation to streamflow. The smallest dissolved solids concentrations usually are during the high flows of late fall and winter and early spring runoff, when rainfall and snowmelt are the major sources of water. Dissolved solids in western Washington are usually most concentrated during late summer and early fall, when base flow from ground-water sources is the dominant component of flow; but in eastern Washington, dissolved solids may be more concentrated during the irrigation season due to irrigation return flows. Analysis of dissolved solids at seven of the sites was discontinued in 2001, but there is a good relation between dissolved solids and specific conductance. Specific conductance at the surface-water NAWQA, CBIP, and Columbia River stations during 2004 ranged from an average of 82 µS/cm (microsiemens per centimeter at 25 degrees celsius) at the North Fork Skokomish River near Hoodsport to an average of 610 µS/cm at Crab Creek near Beverly. The largest value of specific conductance measured during 2004 was 818 µS/cm, in a sample from Crab Creek near Beverly during February, and the smallest value of specific conductance measured was 52 µS/cm, in a sample from the Duwamish River at Tukwila during June. The average specific conductance for all stations sampled was 346 µS/cm.

Surface waters in Washington generally are classified as clear and carry only small amounts of sediment, except where influenced by glaciers, unconsolidated volcanic deposits, or disturbed soils. Water flowing in the Columbia River is very low in sediment, usually less than 10 mg/L (milligrams per liter), and at times no measurable sediment is detected. The streams east of the Cascades that characteristically carry sediment concentrations greater than 10 mg/L are those that carry return flow from heavily irrigated and farmed lands in the semiarid region.

Concentrations of suspended sediment in samples from the Columbia River during 2004 ranged from 1 to 4 mg/L. Concentrations of suspended sediment in samples from NAWQA stations ranged from an average of 1.2 mg/L at North Fork Skokomish River near Hoodsport to an average of 174 mg/L at Granger Drain at Granger. Samples from Granger Drain at Granger generally had the largest sediment concentrations, ranging from 36 to 1,990 mg/L. The largest sediment concentration (1,990 mg/L in a sample during April) was measured at Granger Drain at Granger. The smallest sediment concentration (less than 0.5 mg/L in a sample collected during September) was measured at the North Fork Skokomish River near Hoodsport.

Forty different pesticides, metabolites (degradation products), or other trace organic compounds were detected in samples collected from the eight NAWQA surface-water stations and four irrigation return flow stations during water year 2004. Samples analyzed by high performance liquid chromatography/mass spectrometry are subject to a final review by the National Water Quality Laboratory and will be released later in 2005. Those results are not included in these statistics. The herbicides atrazine, simazine, and trifluralin, as well as the pesticide degradates 2-chloro-4-isopropylamino-6-amino-s-triazine, referenced in this report as CIAT and commonly referred to as deethylatrazine, and alachlor ethanesulfonic acid (referenced in this report as alachlor ESA) were the herbicides or degradates detected most frequently in samples from the stations in eastern and western Washington. Samples for the analysis of pesticides were not collected from the reference station North Fork Skokomish River during 2004. Carbaryl and azinphos-methyl were the insecticides detected most frequently in samples from eastern and western Washington. Samples collected from Thornton Creek near Seattle and the Duwamish River at Tukwila contained the insecticide carbaryl and the herbicides prometon and simazine. Samples from Thornton Creek also contained the insecticide diazinon and the herbicide trifluralin, and samples from the Duwamish River also contained the herbicides atrazine, trifluralin, metolachlor, and pendimethalin. Concentrations in samples from these urban sites ranged from at or near the limit of detection to a maximum of 0.053 µg/L in March for the insecticide carbaryl at Thornton Creek.

Four herbicides, 2 insecticides and 1 herbicide degradate were detected in samples from Crab Creek near Ritzville, ranging in concentration from at or near the limit of detection to a maximum concentration of 0.01 µg/L for the herbicide prometon. Ten herbicides, 2 insecticides, and 1 herbicide degradate were detected in samples from Palouse River at Hooper, ranging in concentration from at or near the limit of detection to a maximum concentration of 0.031 µg/L for triallate. Eleven herbicides, 2 insecticides, and 1 herbicide degradate were detected in samples from the Yakima River at Kiona, ranging in concentration from at or near the limit of detection to a maximum concentration of E0.100 µg/L for the herbicide terbacil. Ten herbicides, 8 insecticides, 13 pesticide degradates, and 1 fungicide were detected in samples from Granger Drain at Granger, with a maximum concentration of 2.31 µg/L for the herbicide degradate acetachlor oxamilic acid. Nine herbicides, 6 insecticides, 8 pesticide degradates, and 1 fungicide were detected in samples from DR2 near Granger, ranging in concentration from at or near the limit of detection to a maximum concentration of 0.471 µg/L for the insecticide carbaryl. Five herbicides, 4 insecticides, 2 pesticide degradates, and 1 fungicide were detected in samples from the Sunnyside Canal Diversion near Sunnyside, ranging in concentration from at or near the limit of detection to a maximum of 0.068 µg/L for the insecticide azinphos-methyl. Eleven herbicides, 5 insecticides; and 1 pesticide degradate were detected in samples from Sand Hollow near Vantage, ranging in concentration from at or near the limit of detection to a maximum of 0.259 µg/L for the herbicide terbacil. Eleven herbicides, 3 insecticides, and 1 pesticide degradate were detected in samples from Lind Coulee Wasteway near Warden, ranging in concentration from at or near the limit of detection to a maximum of 0.134 µg/L for the herbicide metolachlor. Ten herbicides, 5 insecticides, and 1 pesticide degradate were detected in samples from Red Rock Coulee near Smyrna, ranging in concentration from at or near the limit of detection to a maximum of E0.050 µg/L for the herbicide terbacil. Seven herbicides, 3 insecticides, and 1 pesticide degradate were detected in samples from Crab Creek near Beverly, ranging in concentrations from at or near the limit of detection to a maximum of 0.032 µg/L for the herbicide EPTC.

Concentrations for pesticides detected in only one sample from NAWQA or CBIP surface-water stations during the 2004 water year exceeded the U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Levels or Health Advisories for drinking water. Concentrations of dieldrin in one sample from DR2 near Granger, collected in July, was above the USEPA health advisory for drinking water associated with a 10^{-6} (one in a million) cancer risk. The USEPA fresh-water chronic criteria for the protection of aquatic life for carbaryl, diazinon, azinphos-methyl, and chlorpyrifos are 0.02, 0.009, 0.01, and 0.041 µg/L, respectively.

Concentrations of carbaryl in 3 samples from Thornton Creek (in January, March, and August); 5 samples from Granger Drain (in April and August); 7 samples from DR2 near Granger (in July through October); one sample from Sunnyside Canal Diversions near Sunnyside (in April); and one sample from the Yakima River (in April) exceeded the fresh-water chronic criteria for the protection of aquatic life. Concentrations of diazinon in 2 samples from Thornton Creek near Seattle during November and January, 1 sample from Granger Drain near Granger during May, and 1 sample from Red Rock Coulee during July exceeded the fresh-water chronic criteria for the protection of aquatic life. Concentrations of azinphos-methyl in 11 samples from Granger Drain at Granger from May through August; 11 samples from DR2 near Granger from May through August; 3 samples from Sunnyside Canal Diversions near Sunnyside during May through July; 2 samples from Sand Hollow near Vantage in June and July; 1 sample from Yakima River at Kiona during May; 1 sample from Lind Coulee Wasteway near Warden during June; 1 sample from Crab Creek near Beverly in June; and 1 sample from Red Rock Coulee near Smyrna during June exceeded the fresh-water chronic criteria for the protection of aquatic life. Concentrations of chlorpyrifos in 1 sample collected from Sand Hollow near Vantage in April exceeded the fresh-water chronic criteria for the protection of aquatic life.

Ground Water

Water levels were measured in 67 wells in Washington during water year 2004 (fig. 4). In eastern Washington, water levels in the Spokane County water-table well (25N/45E-16C01) were above average from October through February, declined below average for most of March through August, and rose above average in September (table. 2). Overall, the 2004 water levels for well 25N/45E-16C01 were neither remarkably high nor low when compared to long-term water levels (fig. 5). Water levels in the Whitman County water-table well (18N/43E-35L01) also were near average all year. Water levels in the Columbia County water-table well (10N/37E-23R01) were below average all year. Water levels in Lincoln County water-table well (24N/36E-16A01) were below average all months except November. Water levels in confined wells 24N/36E-16A06 and 24N/36E-16A08 at the same Lincoln County location were above average except during July, and below average except during July, respectively.

In western Washington, water levels in confined well 16N/02W-29L02P2 in Thurston County started the year below average, increased to above average during the winter months, and decreased to below average for the remainder of the year. Overall, water year 2004 water levels for well 16N/02W-29L02P2 were neither remarkably high nor low when compared to long-term water levels (fig. 6). Water levels in confined well 22N/01W-36H01D11 in Pierce County were below average for four out of the five measurements. The relatively large departures (-3.3 to +6.3 ft) at the well 22N/01W-36H01D11 are in part influenced by the relatively short period of record.

Table 2. Departure from long-term average ground-water levels.

[All values are in feet; —, no data; *, less than 10 years of record]

Well No.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Eastern Washington												
25N/45E-16C01	+2.7	—	+1.9	+1.2	+0.2	-1.1	+0.1	-0.5	-2.1	-1.0	-0.4	+0.4
18N/43E-35L01	+1.2	-0.04	—	+.9	—	+.2	—	—	-.2	—	-.4	-.9
10N/37E-23R01	—	—	—	-1.1*	—	-3.3*	—	-1.9*	—	-.8*	—	—
24N36E-16A01	-1.5	+.3	-1.8	-2.9	-1.3	-2.1	-3.3	-1.0	-1.6	-2.8	-1.1	-1.6
24N/36E-16A06	—	+3.4*	+2.1	—	+.1	—	—	+1.2	—	-.6	—	+.4
24N/36E-16A08	—	-.2*	-8.6	—	-6.3	—	—	-7.5	—	+2.4	—	-5.4
Western Washington												
16N/02W-29L02P2	-0.3	+1.8	+5.1	+3.8	+2.5	-0.8	-0.9	-1.9	-0.6*	-2.1	-2.2	-0.4
22N/01W-36H01D11	—	-3.2*	—	—	+6.3*	—	—	-.7*	—	-1.4*	—	-3.3*

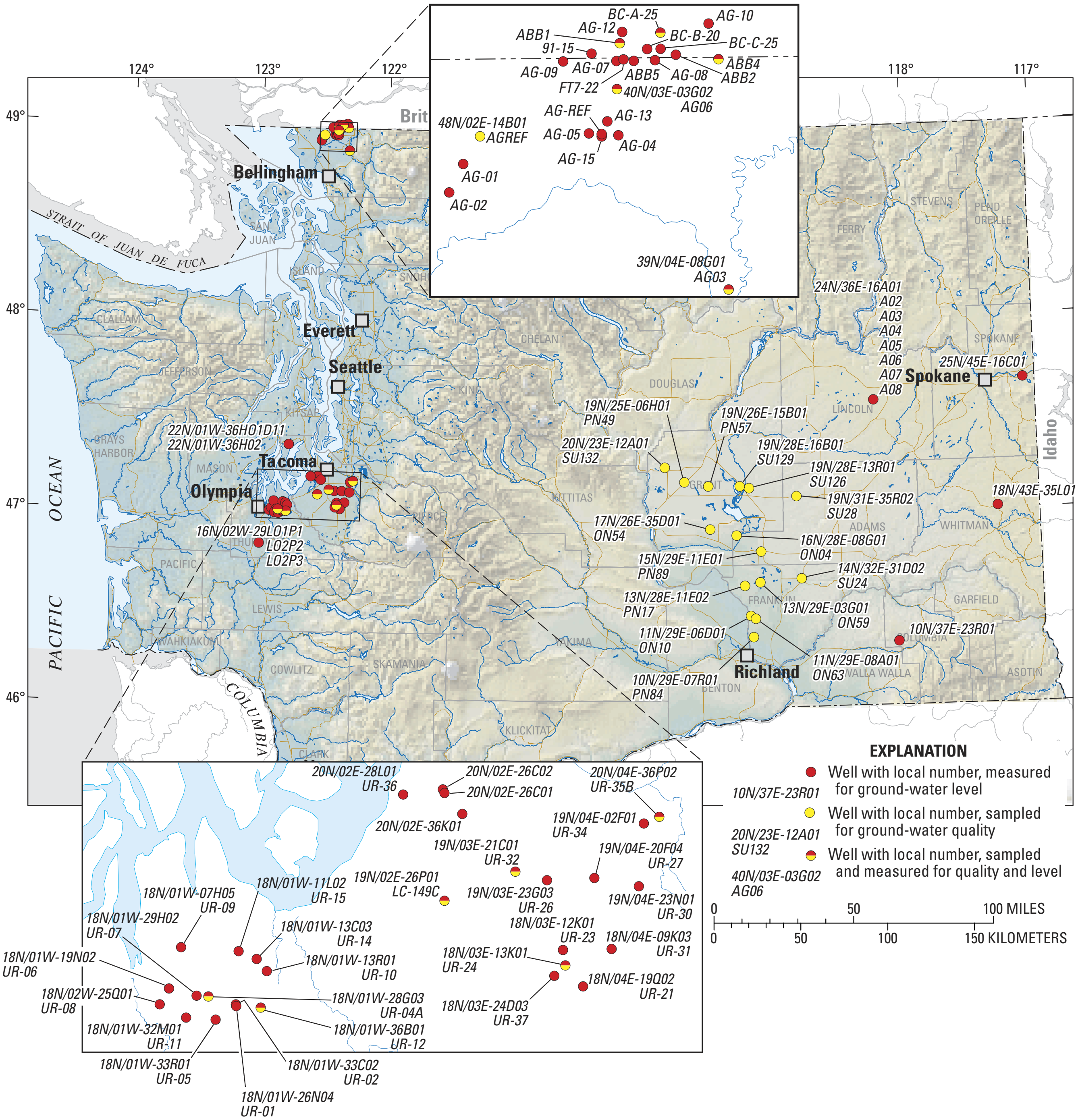

Figure 4. Ground-water wells with water-quality data.

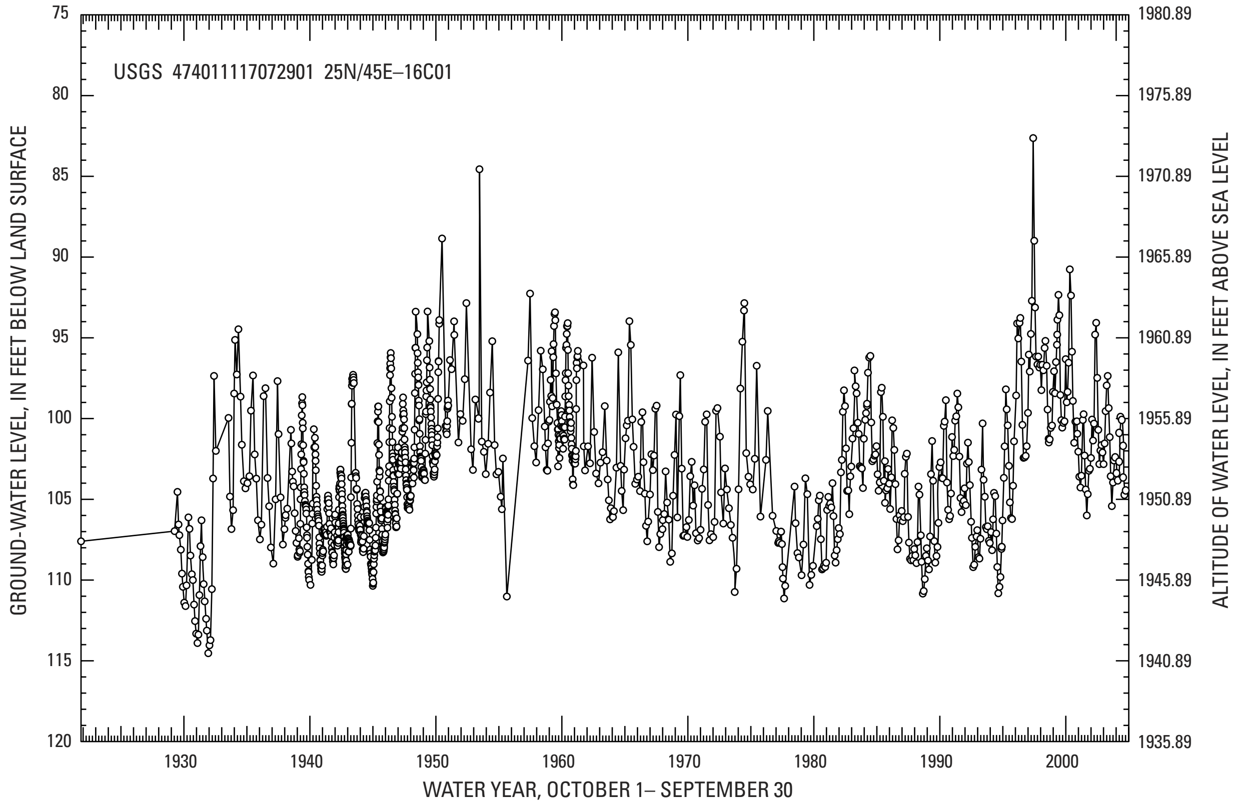

Figure 5. Long-term water levels for well 25N/45E-16C01.

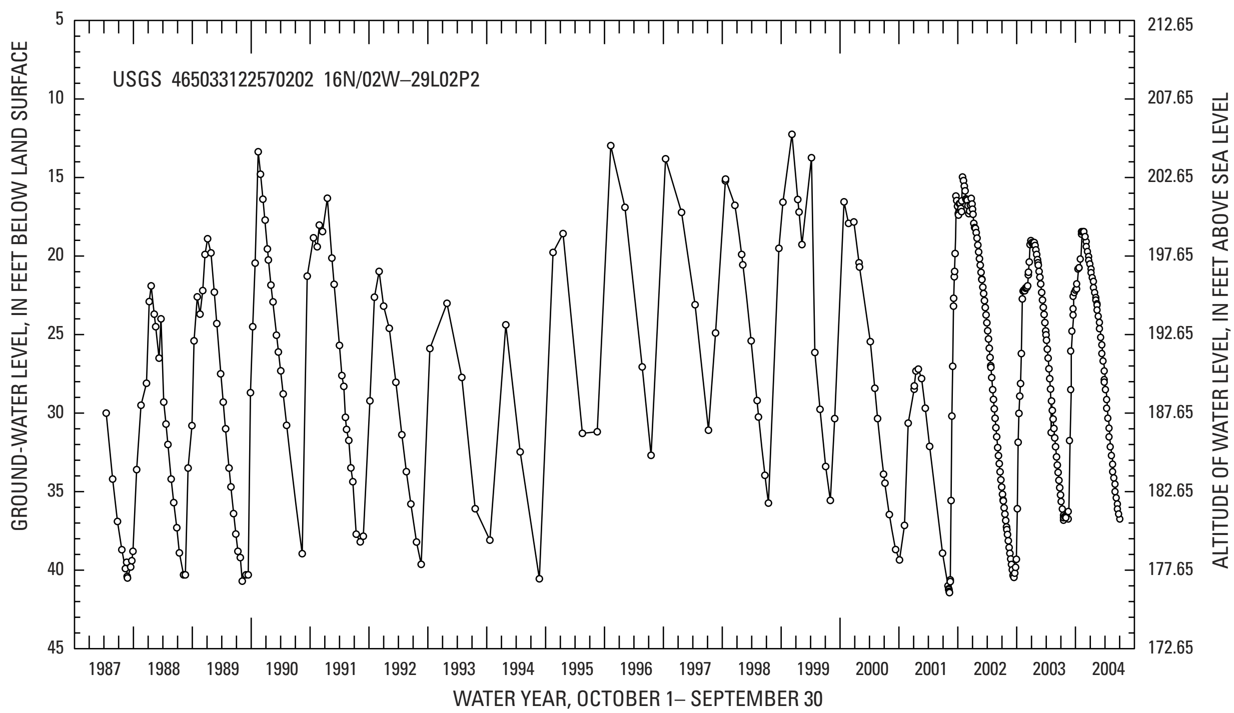

Figure 6. Long-term water levels for well 16N/02W-29L02P2.

Ground-Water Quality

Chemical analysis samples were collected from 27 wells (fig. 4, table 3) in Washington during water year 2004. Samples were collected from 5 wells representing urban land-use in western Washington, 5 wells representing agricultural land-use in western Washington and British Columbia, 10 wells representing agricultural land-use in eastern Washington, 5 wells representing major aquifers in eastern Washington, 1 urban land-use reference well, and 1 agricultural land-use reference well. Well depths in the networks range from 19 to 1,000 ft, with an average depth of 51.1 ft in the western Washington urban land-use network, 38.1 ft in the western Washington agricultural land-use network, 501 ft in the major aquifer network in eastern Washington, and 45.9 ft in the eastern Washington agricultural land-use network.

Table 3. Wells where chemical analysis samples were collected from ground-water network wells in Washington and British Columbia, water year 2004.

Well identification No.	Local well No.	Station identification No.
Western Washington urban land-use network		
UR-04A	18N/01W-28G03	470110122484201
UR-12	18N/01W-36B01	470035122444601
UR-24	18N/03E-13K01	470240122214501
UR-32	19N/03E-21C01	470732122252801
UR-35B	20N/04E-36P02	471018122143302
Western Washington and British Columbia agricultural land-use network		
ABB1	092G.008.2.2.2-99	490042122241001
ABB4	092G.009.1.2.1	490011122193201
AG03	39N/04E-08G01	485303122190901
AG06	40N/03E-03G02	485917122241901
BC-A-25	092G.009.1.1.4-18	490101122221501
Eastern Washington major aquifer network		
SU24	14N/32E-31D02	463943118511001
SU28	19N/31E-35R02	470518118523601
SU126	19N/28E-13R01	470805119140501
SU129	19N/28E-16B01	470844119182501
SU132	20N/23E-12A01	471449119522801
Eastern Washington agricultural land-use network		
ON04	16N/28E-08G01	465328119195901
ON10	11N/29E-06D01	462824119140801
0N54	17N/26E-35D01	465531119315501
ON59	13N/29E-03G01	463843119095201
ON63	11N/29E-08A01	462727119115801
PN17	13N/28E-11E02	463745119164601
PN49	19N/25E-06H01	471013119433401
PN57	19N/26E-15B01	470850119323501
PN84	10N/29E-07R01	462141119130501
PN89	15N/29E-11E01	464819119091001
Urban land-use reference well		
LC-149C	19N/02E-26P01	470603122305101
Agricultural land-use reference well		
AGREF	48N/02E-14B01	485751122304601

In all 27 wells, specific conductance samples ranged from 101 µS/cm in BC-A-25 to 1,460 µS/cm in SU28, dissolved oxygen ranged from 0.3 mg/L in AG03 to 9.8 mg/L in PN57, and pH ranged from 5.8 units measured in ABB1 to 8.0 units measured in both PN57 and SU129.

Alkalinity and dissolved solids measured in samples from the networks in eastern Washington generally were higher than those detected in samples from ground water networks in western Washington. Average alkalinity measured in samples from eastern Washington agricultural land-use and major aquifer networks were 269.7 and 197.2 mg/L, respectively, and dissolved solids concentrations were 487.4 and 449.7 mg/L, respectively. Average alkalinity measured in samples from western Washington agricultural land-use and urban land-use networks were 53.0 and 94.8 mg/L, respectively; and dissolved solids concentrations were 190.6 and 203.3 mg/L, respectively.

Nitrite plus nitrate concentrations in samples from all 27 wells ranged from 0.39 to 29.4 mg/L. In all cases, nitrite concentrations were negligible and nitrate was the major contributor to total nitrogen. Nitrite plus nitrate concentrations generally were higher in samples from wells in the agricultural land-use networks, with average concentrations of 9.49 mg/L in samples from the eastern Washington agricultural land-use network and 11.16 mg/L in samples from the western Washington agricultural land-use network. Average concentrations of nitrite plus nitrate in samples from the major aquifer and urban land-use networks were 8.61 and 4.47 mg/L, respectively. Nitrate concentrations in samples from several wells (ABB1, ABB4, ON10, ON59, PN49, and PN84) exceeded the USEPA Maximum Contaminant Level (MCL) drinking water criterion for nitrate. Phosphate concentrations in all wells were relatively low, ranging from at or near the limit of detection to a maximum of 0.043 mg/L in samples from PN84 and SU28. In general, trace element concentrations in ground water samples were higher in eastern Washington than in samples from western Washington. Average arsenic, lead, molybdenum, nickel, and selenium concentrations in ground water samples from the eastern Washington agricultural land-use were 5.52, <0.08, 3.6, 2.13, and 0.45 µg/L, respectively. Average concentrations in ground water samples from the major aquifer network were 4.97, 0.48, 5.6, 0.73, and 0.6 µg/L, respectively. In comparison, trace element concentrations in all ground water samples from the western Washington networks were at or near the respective limits of detection except for nickel, with average concentrations of 0.56 µg/L in samples from the urban land-use network and 2.99 µg/L in samples from the agricultural land-use network. The maximum concentration of nickel was 18.6 µg/L detected in a sample from AG03. Arsenic concentrations detected in a sample from PN49 and nickel concentrations detected in ground water samples from AG03 exceeded the USEPA MCL for drinking water.

Strontium, vanadium, and lithium concentrations also were higher in samples from ground water networks in eastern Washington than in samples from western Washington. Average concentrations in ground water samples from the eastern Washington agricultural land-use network were 512.2, 22.8, and 6.04 µg/L, respectively, and average concentrations in ground water samples from the eastern Washington major aquifer network were 372.4, 28.2, and 7.47 µg/L, respectively. In comparison, average concentrations in ground water samples from the western Washington urban land-use network were 138, 10.4, and 3.9 µg/L, respectively, and average concentrations in samples of ground water from the western Washington agricultural land-use network were 155.2, 2.26, and (median) <0.6 µg/L, respectively.

In general, more pesticides were detected in ground water samples from networks in eastern Washington than in samples from ground water networks in western Washington. Five herbicides and one herbicide degradation product were detected in ground water samples in eastern and western Washington. Concentrations ranged from at or near the limit of detection to a maximum of 0.42 µg/L of atrazine in a sample from ON63. Atrazine was detected in 7 of the 15 wells sampled in eastern Washington and only in 1 sample from western Washington. The herbicide degradation product 2-chloro-4-isopropylamino-6-amino-s-triazine, referenced in this report as CIAT and commonly referred to as deethylatrazine, was detected in 9 samples from eastern Washington ground water networks, ranging in concentrations from at or near the limit of detection to a maximum of 0.054 µg/L in a sample from PN84. CIAT was detected in only 2 samples in western Washington ground water networks with a maximum of 0.024 µg/L in a sample from AGREF. Metribuzin was detected in

3 samples collected from the eastern Washington agricultural land-use network, in 1 sample from the major aquifer network, and in no samples from the western Washington ground water networks. Prometon was detected, in an unquantifiable amount, in one sample from each ground water network in eastern Washington. Simazine was detected in 1 sample from each ground water network in eastern Washington and in 2 samples from the western Washington agricultural land-use network. The herbicide terbacil was detected in only one sample (ON59) at a concentration of 0.304 μg/L from the eastern Washington agricultural land-use network. No pesticide concentrations exceeding USEPA MCLs or advisories for drinking water were detected in ground water samples.

Nine volatile organic compounds (VOCs) were detected in samples collected for analysis of VOCs in Washington. Concentrations of dichloromethane ranged from at or near the limit of detection to a maximum of 1.5 μg/L in a sample from ABB4. Detection of BTEX compounds (benzene, toluene, ethyl benzene, and xylenes) in field blanks indicates a low-level contamination during the sampling process. Detections of benzene, ethylbenzene, toluene, the o-, m-, and p- isomers of xylenes, and 1,2,4-trimethylbenzene are noted with a remark code of V to indicate systematic contamination. Trichloromethane (chloroform) was the most frequently detected VOC in samples from the ground water networks in Washington, ranging in concentration from at or near the limit of detection to a maximum of 0.19 μg/L in a sample from SU126. The fumigant 1,2-dichloropropane, and several degradation products were detected in some samples from the western Washington agricultural land-use network, in concentrations ranging from at or near the limit of detection to a maximum concentration of 0.35 μg/L in a sample from AG06. In the eastern Washington major aquifer network, 1,2-dichloropropane was detected in a sample from SU132 at a concentration of 0.23 μg/L. Tetrachloroethene and tetrachloromethane (carbon tetrachloride), primarily used as dry cleaning solvents, were detected in 2 samples from wells in the eastern Washington major aquifer network and in 1 sample in the western Washington urban land-use network, all at estimated concentrations of 0.01 and 0.02 μg/L. No VOC concentrations exceeding USEPA MCLs or advisories for drinking water were detected in ground water samples.

Radionuclide concentrations were higher in samples collected from ground water networks in eastern Washington than in ground water networks in western Washington. Average natural uranium concentrations were 12.89 μg/L in samples from the eastern Washington agricultural land-use ground water network, with a maximum of 29.9 μg/L in a sample from PN84, and 5.68 μg/L in samples from the eastern Washington major aquifer network, with a maximum of 10.8 μg/L in a sample from SU28. Samples collected from the ground water networks in western Washington had concentrations ranging from at or near the limit of detection to a maximum of 0.26 μg/L in a sample collected from UR-35B. Gross alpha and gross beta radioactivity, radium-226, and radium-228 measurements were not collected at all wells, but concentrations were higher in samples collected from ground water networks in eastern Washington than those in western Washington. Radium-226 concentrations ranged from 0.04 to 0.17 pCi/L (picocuries per liter) in samples from eastern Washington ground water networks and from 0.02 to 0.09 pCi/L in samples from western Washington ground water networks. Radium-228 was detected in all samples collected in Washington, but concentrations were less than the quantification limit (remark code M). Gross alpha radioactivity (72-hour) concentrations in samples collected from ground water networks in eastern Washington ranged from 1 to 9 pCi/L, and concentrations of alpha radioactivity (30-day) ranged from less than the quantifiable limit to a maximum of 6 pCi/L. Except for one sample collected from ABB1, concentrations of gross alpha radioactivity (72-hour) in samples collected from ground water networks in western Washington were less than the quantifiable limit. All samples collected for 30-day gross alpha radioactivity analysis in western Washington were less than the quantifiable limit. Gross beta radioactivity (72-hour) concentrations in samples collected from ground water networks in eastern Washington ranged from 3 to 24 pCi/L, and concentrations of beta radioactivity (30-day) ranged from 5 to 30 pCi/L. Gross beta radioactivity (72-hour) concentrations in samples collected from ground water networks in western Washington ranged from less than the quantifiable limit to 13 pCi/L, and beta radioactivity (30-day) concentrations collected in samples from western Washington ranged from less than the quantifiable limit to 7 pCi/L. No radionuclide concentrations exceeding USEPA MCLs or advisories for drinking water were detected in ground water samples.